

Redesigning the Planet Regions



Version 5.0

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Redesigning the Planet Regions

An Abstract and Annotated Outline to be
Filled in as Emergency Actions Fail or Succeed

A Challenge to **You** to Engage in Creating
Wild Designs for Wicked Problems—
To Transform Regions
In the Planet for the Extended Present
Using Common Sense, Synergetic Designs, Radical
Ecology, Eutopian Strategies & Thought Experiments

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You, *you* and *you!*

Version 5.0

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0.0. Introduction

This work is about sharing regional resources and services of the planet to meet the needs of all living beings and their community patterns. It uses ecological design to create a simple method to implement and manage the sharing: First, we assess what the planet needs to keep developing in a stable flow, then we set aside a satisfactory area of the planet to ensure the continuing operation of evolution in wild systems. Next, we measure the ranges of productivities of wild ecosystems as well as agricultural and urban systems, then use those results to determine optimum human populations for regions. Within human systems, every culture would claim a share of local resources and global services.

For example, the Colorado river would be allocated a percentage of water to keep the river and its downstream ecosystems healthy—this may require 50% or more of all the water flow. The remaining water would be divided between resident cultures sharing the river environments up and downstream. This approach promises a fair way to deal with carbon emissions, toxic wastes, and energy use, also.

The equal apportionment of ‘resources’ to all cooperating participants in a regional commons is supported by the practice of recognizing and honoring the legacy of the entire planet that hosts its legates as tenants and is supported by the ‘rule’ of all beings together, although in the human legal system, humans represent the interests of all other beings, much as they are starting to do now. This reapportionment is enhanced by the wisdom of harmony and the drawing and making of ecological zones, which emphasizes the relative separation of wild and artificial areas. This reapportionment of ‘resources’ that human communities have already claimed, as well as of resources that have been badly distributed as a result of theft or violence, may cause some degree of discomfort or suffering, but that is minimal compared to the suffering and death under the current industrial system, which encourages the consumption of everything and large differences in the distribution of wealth.

Like metaphysics, ecological design has a vision that exceeds its bounds and a reach that exceeds its grasp. And, we have to use it to explore possibilities of local and regional harmony, without having enough knowledge or experience. Ecological design requires participation and cooperation to accomplish its ambitious goals. It has to be flexible and adapt to changing environments. It has to be adaptive and accept feedback.

This means understanding challenges and problems, as well as natural and artificial ecosystems, histories and cycles, before using a variety of physical and conceptual tools to create ecological designs on regional scales, but considering the local and global implications. This means trying to design places, ecosystems and landscapes, as well as cycles and processes. It means redesigning flows of minerals and gases, wetlands and streams, domestic and wild forests, and animal paths and reserves. It means redesigning human patterns, from transportation corridors to traditional and modern cultures. It means redesigning agriculture, cities—traditional cities and proposed arcologies—buildings, neighborhoods, vehicles, industries, and medicine. It means trying to redesign civilization out of physical and social traps; it means redefining cultural adaptations, corporate goals and responsibilities, formal commons, styles of conflict, economic frameworks, political forms and sizes, religious applications, and even advertising. The purpose of all this is to restore harmony to systems that support health and development.

0.1. *Preliminary Thoughts on a Framework for Regional Design*

Redesigning regions in the planet is a conscious effort to correct the massive ‘unconscious redesign’—perhaps ‘unbalanced reordering’ is a more appropriate phrase—of regional systems. The ‘unconscious redesign’ is an unconsidered effect of the activities of changing economic and political structures devoted to self-growth and private profit. This unbalanced reordering is rapidly changing the social and environmental orders that represent the natural capital of social and environmental evolution. The reordering is also constructing an accidental trap that leads to massive catastrophes that will destroy that capital as well as the basis for its renewal. Only an equally massive response of a conscious regional ecological design framework can lead to some form of balance.

Buckminster Fuller suggested that the appropriate tools, such as eutopian design frameworks or advanced technologies, might help human worlds to work, given the right emergency. We have been encountering the right emergencies for well over a hundred years, and we need to refine and try these tools, now. The emergencies that he considered are the human responses to a variety of catastrophes, such as fires or earthquakes. But, we are finding that not all catastrophes are fast, human-scale or visible. The effects of those large, slow, invisible, long-term changes make us uneasy, but not really adrenaline-ready. The changes are reflected in starving children, hotter summers and stronger storms, failing food supplies, and collapsing infrastructures. We must learn to recognize and respond to these other emergencies. But, what are they? Ecosystem conversion, simplification, collapse, and destruction by agriculture; conversion of agriculture by cities, suburbs, factories, and roads; narrowing of agricultural diversity and species; animal and plant reductions and extinctions; creation of large quantities of waste; continued use of exotic and toxic materials and chemicals; disruption of elemental cycles; misuse and overuse of resources, especially minerals and fossil fuels; overuse of energy, pesticides and fertilizers; fragmentation of wild systems by roads; narrowing of cultural capital and languages, and the extinction of many; economic betrayal of trust; global homogenization of products and lifestyles; continuation of slavery, violence and war; gross inequities in wealth between people and nations; and, the refusal to consider climate change or respond to it.

Unaddressed, these emergencies are converging into one gigantic emergency that is going to have to handle one gigantic global catastrophe. And, we have to respond to it now, before it crests and becomes overwhelming. We can do it. We have the evidence that things are taking a downward turn—the original meaning of the word catastrophe. We need to respond with the best tools we have.

0.1.1. *What this work is not*

This work is not a list of regional emergencies. It is not catalog of losses. Many comprehensive lists and catalogs already exist. It is not a linear analysis of sudden problems and surprises. It is not a larger, more data-rich, compartmentalized model of change. It is not an abstract discussion of possible shallow changes. It is not a plan to avoid or minimize catastrophes. This work does not propose solutions to stop changes or to stop emergencies. It does not offer a way to save any one region or our industrial, capitalistic, semi-democratic civilization. It is not about saving the world, or nature, or humanity. This work is not about preserving the status

quos of industrial societies or formal democracies.

This work is not about greening our civilizations with more efficient automobiles or light bulbs. It is not about the continuity of market force into private lives, or about breaking with tradition to counter market intrusion. It is not about profiting with green businesses, after certifying mild improvements. It is not about sustaining our current styles of living or levels of luxury by recycling batteries or installing sod rooftops; it does not address sustainability as a solution. This work does not focus on the symptoms of a single small environmental crisis, or even several crises. This work is not about adapting to drier climates or finding immense forms of alternate energy.

This work is not about big institutions and big successes, or small ones. It is not about creating spectacles or spectacular successes. It is not about creating virtual worlds in a utopian fantasy of voluntary good will to minimize exploitation and waste. It is not about the management or a detailed design for a region in the planet. It is not about the stewardship of remaining resources or of other species, domestic or wild, in a region. It is not about a partnership or cooperation with nature—any region is much too large, complex and dangerous for pretense. It is not about the invention of cooperation or a map to achieve it.

Many other written or spoken works herald the smallness of animals, the end of nature or the death of wildness. Other books recount the themes of recent times, from the horrors of war to the triumphs of science and technology. Many authors and speakers have emphasized the urgency of responding to climate change, to extinctions, to trends of violence and victimization, and to growing inequities and financial crimes. Others have identified other emergencies, beginning with gender differences, border insecurities, travel dangers, and natural disasters such as hurricanes, tsunamis and earthquakes. Some have emphasized the importance of miscommunications, misinformation, violent attacks, terrorism, misuse of resources, epidemics, potential asteroid collisions, energy shortages, and desertification and ecosystem collapse. Others have recognized the momentum of short-term self-interest, self-deception, perceptual limits, overconsumption, polarization, and destabilization. And, they are all certainly right to do so—but these urgent problems are all *interconnected*!

0.1.2. *What this work is*

At a regional level, the problems are interconnected, so this work has to address everything *simultaneously*, because solving any one problem will only offer a temporary, limited solution as other problems affect the one in the center of the focus. This work is a recognition of the problems, as well as the relentless change and radical uncertainty, that now confront many species as well as human civilizations. It is a recognition that we do not have adequate understanding, knowledge or control to solve any problem once and for all.

This work is a way to adapt to ignorance, limits and chaos in regional systems. It is a call for immediate action to solve the problems to balance entire regions, rich nations and poor nations, methane and carbon dioxide levels, and bad designs and good designs. It is a call for large kinds of public investments to avert increasing risks and to avoid some kinds of regional catastrophes. It is a regional framework for simultaneous changes in consciousness and action, and a platform for people to self-organize and to create responses to challenges. And, also it is a framework for personal, immediate action.

This work is a process for assembling ideas into a nonlinear narrative for the development of interacting patterns of design. It proposes creative alternatives to the

business of business and the technological imperatives of progress. It is about reforming cities, agriculture, and transportation for survival. It is about reordering economics, putting constraints on businesses, but removing taxes from desired ends. It is about radical strategies to confront disruptive environmental and climatic changes. This work is about preparation for the immediate future, using ways to survive and prosper that are traditional, as well as adventurous, imaginative, and joyful, but that also may be hard, painful and demanding.

This work is about creating meaningful images and goals. It presents strategies to implement the images and goals. It attempts to create a framework for details, because we cannot know those details in advance or plan for them. It is about replacing the idea of sustainability with that of flexible creative fitness. It is about understanding the underlying causes and reactions to regional stress. It is a sketch of possible directions for ecological and cultural development.

This work is a thought experiment for a design framework to contain the creative coevolution of wild nature and human culture. It is an experiment on how to invent a new approach, given the immense body of knowledge that humanity already has, from the present and the long-term past. It is about recreating civilization from the bottom, by reducing our impacts and reducing our vulnerability to catastrophes. It is about managing and constraining humanity at a regional level.

This work asks neglected questions about big problems, about the long, deep, wet history of life, about how many wild ecosystems we need, as well as what humans really need—about our history with its images and goals. It asks questions about our cultures and our interference with natural systems and cycles. It is about acting heroically and exuberantly to live joyful, meaningful lives under stressful conditions. It is about respect and engagement with our living regions, so that we can accommodate changes. This work is a call to imagine, participate and then to act through a series of common, large-scale, regional design projects.

0.1.3. *What we Need & Why it would Work*

We need to act on a regional scale. We have acted on a large-scale before, in times of world wars. We were able to treat war as an emergency and to encourage or enforce remarkable changes, such as rationing or redefining jobs. We were able to take these actions without destroying our citizens or our cultures (or most of the planet).

Although nature, and our human nature, are not enemies to be vanquished, the current situation has similarities to war. Massive changes threaten our lifestyles. Resources are removed from our reach by thoughtless or inefficient use. Growing insect and animal populations seem to be attacking our food supplies. Species are being forced to extinction. Habitats are collapsing. Dangerous chemical wastes are accumulating. Ozone holes are growing, extreme climates pressing, and the entire planet seems to be wobbling. Changes in climate and ocean balance, as well as renewed diseases and infiltrated toxic chemicals, threaten our lives. And, it is happening everywhere, at once.

Although we want to respond with a warlike approach, we have been fooled by the fact that we cannot see an enemy—fooled by thinking there *is* an enemy. We have been misled by the slowness and subtlety of the penetration of our defenses. We have been betrayed by our own desire to continue our industrial dreaming at any cost. Some people have noticed changes and have been crying alarms, but they have not been loud enough or persuasive enough. Everybody needs to be awakened; everybody needs to participate, everybody needs to sacrifice

and work towards peaceful solutions.

The big problems seem insurmountable, and simple actions will not save our civilization from catastrophes. Part-time participation will not be enough to reverse the degradation of ecosystems, and partial business greening will not stop the unraveling of regional and global cycles.

What is needed is an immediate, peaceful, comprehensive approach to this situation—wise actions in a framework of intentional, reflective design. Why would regional ecological design work? Because life has over three billion years experience with changing and adapting, because human life and cultures have over 50,000 years of practical experience adapting and making changes, and because humans are immensely adaptable—if they can adjust to poverty and suffering, they can adjust to a few good changes. Perhaps it is already too late—limits may have been passed and the catastrophes cannot all be reversed. We do not know, and may never know, but we can still act as if we were wise, as if doing the right thing makes a difference. And, we will have worked together to help others, to improve things and to make good places. If we act *now*, this month, this week, this day, then the changes might be more effective.

0.1.4. *What can you do?*

Read this work. Correct it and supplement it. Extend it. Apply it. Is this work complete or original? No. Certainly hundreds of people have had ideas that are more original. Sometimes however, originality is aided by having many ready-made pieces to put together—for instance, Charles Darwin needed the works of Thomas Malthus and Adam Smith for his ideas. And, these were put into a new pattern. Earlier design work is almost always useful in later work and has value for later design. All our revolutions have to do with recombining ideas in new patterns rather than discovering a single, new, independent idea. This is a new pattern.

Is this work an adequate response to the pressing emergencies? Can it be effective? Maybe it could be, as a frame of ideas or as a matrix that could guide action. What's wrong with this work? It was written in a hurry. It is sloppy and unfinished. Why should you read it? Because it has many good ideas and it attempts to put them into a very large synthesis. People sometimes object to one person delivering finished material and ideas to a larger number of readers. That cannot be the case here. That is why this work is a crude outline. It is constructed as a frame that others, like you, can add to. In fact, think of this as a workbook to which anyone can contribute, as a sketchbook where you can fill the sketches, or as a dynamic corrective exercise that can be constantly corrected, improved, and expanded.

The attempt at regional design means accepting the opinions of everyone, regardless of their motives or level of understanding. The attempt therefore becomes the beginning of reeducation, which may be a long process, longer than single human lifetimes. This work should aim to be an extensive community of cocreation, like the Grameen bank or Wikipedia. This work is an open framework that addresses and limits the regional, but allows local designs within that scope and can mesh with global design. The work is a participatory process. That may be the only way it is useful. So, please think about it, but then become part of it and contribute to it. Otherwise, it will just be another impoverished, unread book, with a snazzy title.

0.2. *Redesigning Regions?*

Redesigning entire regions? With ecological design? What is regional ecological design? How can it be defined, much less applied to large areas? The title and subject of this book refer to the intentional design of the emergent regional aspects of the planetary system, especially living forms and more especially human forms, who are becoming a regional and global influence. Is regional design even possible? Why are there not a lot of books on it? Why is no one talking about it? This section outlines the goals of the book.

What does the word 'regional' mean? In the Old English Dictionary, it means 'of a whole region.' The word 'region' comes from the Latin word 'to rule.' A region refers to a part of the surface of the planet, characterized by a specific community of plants and animals.

The word regional refers to the unique features of the larger whole system; it is not used to mean things that are ubiquitous, such as potholes or soft drinks, or large, such as human trade and business exchanges between nations on separate continents. The word design refers to the entire range of human intentional behavior, as it is applied to regions in the planet, from benign neglect of some systems to complete control of other systems.

We have not designed patterns or structures for regions, so far, possibly because of the challenges of scale and complexity, or possibly because we have trouble thinking about large, slow, long-term processes. Regional systems have unique sets of ecosystems with interactive histories. The larger global system has unique properties and limits that have to be addressed in any design. It exhibits very-long term trends (called gigatrends).

0.2.1. *Starting with Regional Design*

The vernacular designs of many cultures are superb adaptations to their local environments. Many early cities were planned and built as a response to adapt to difficult conditions. Many of our modern buildings are models of beauty and efficiency. However, our modern cities are generally examples of wild, stochastic growth. Very few people, other than Paolo Soleri, are designing cities. Our habitations, fields and transportation seem completely haphazard. Instead of placing cities on mountains or barren ground, we are filling fertile grasslands and swamps. Instead of placing roads around vital breeding grounds, we are bisecting and fragmenting productive, wild ecosystems. Instead of integrating our food areas with wilderness, we are simply converting productive ecosystems to temporarily subsidized monocrops, that we then convert to roads and city squares, without regard to place.

One way to play with design ideas or proposals is through ecological thought experiments. The design itself must be considered as an ecological design on a regional scale. Many global factors must be considered, also, including the biogeochemical spheres of the planet, cycles, forests, and animals. Other factors, such as wilderness and the extent of human cultures, must be an integral part of any design. Wilderness areas, of many kinds from autopoietic to neopoietic, have to have appropriate sizes and shapes to thrive and provide 'services' to all living beings.

Human cultures have adapted to different environmental conditions over tens of thousands of years. These cultures need to operate within local and global processes, as well as within human structures. Cultures become critical design factors since their adaptive patterns, such as agriculture and technology, create opportunities and problems on regional and

global levels. Human populations have a significant impact on the planet, especially through conversion of ecosystems and the addition of exotic elements.

In fact, culture and nature are converging in a new pattern that can be referred to as 'domiture.' Domiture is concerned with regional and global designs that have to begin with a foundation of wild species in wild systems and continue to the common and artificial places that human cultures create and maintain. This new pattern is supported by ecological design and ecosystem medicine. Design operates on many levels and works upwards and downwards, as well as inwards and outwards. It has to incorporate numerous other factors relating to religion and urban shapes, as well as to economic and political forms. Corporations and the growth of inequality must be addressed in any designs, due to their negative characteristics, which can distort actions.

Creating designs for regions in the planet has to be done in a larger political framework, complete with new global political structures and corporate trusts. Cultural solutions to regional problems have to be applied, but global problems resulting from conflict and inequity have to be addressed in every culture, especially through a larger framework. Regional designs have to fit global patterns and limits. Redesigning the planet on the regional level has to be a coordinated, constrained series of actions that build local good places and adjusts them to good patterns in a global system.

We have had designs on large scales before, often presented as utopias, but most of these were rejected as impossible ideals. These rejected utopian designs can be replaced by realistic and achievable ones, that are based on a new image of the earth and humanity, that use an ecological perspective, to ease human societies into partnership models, to restore wilderness and common places we have destroyed, and to change international relationships into a poetic framework capable of limiting war and permitting the unique human expansion of cultural expressions.

Regional ecological design rests on a foundation of ecological knowledge, of biomes as well as cycles, as well as on an appreciation of historical problems and philosophical ideals. This work outlines how to create regional designs consciously, using our knowledge of how things work, but being aware of our ignorance, and by being careful and respectful. A regional design process would address many problems, from problems of scale to political inappropriateness.

0.2.2. A Snapshot of Regional Design

Regional design can create appropriate images for biomes and large extensive ecosystems to replace the inadequate image of the machine. We can build on archaic cultures, with the image of a Turtle, or expand a mythic image scientifically, as with the Greek Goddess of the earth, Gaia (with James Lovelock's theory). We must create an image of a whole living planet. Lewis Thomas suggested that the planet was like a living cell, and the atmosphere was its outer membrane that can edit the sun to promote life.

Regional design can formulate specific goals to be associated with a common image. These might begin with working towards a civilized human existence on a dynamic planet, characterized by interhuman and interspecies equities. They might include the reservation of the wild, to keep the minimum conditions and processes of the planet in motion. They might include the definition of optimum human populations based on normal ecosystem productivities and the limits of geochemical cycles. They might include a plan for the independence and partial isolation of independent cultures. They might include new kinds of

cities and immense areas of common lands for domestication.

Regional design could also develop strategies to discuss, refine and work towards these and other popular goals. Some of these goals would increase our ability to anticipate and respond to catastrophes. Others would work towards equity of human societies, within important ecological limits. And, still others would reduce our impacts and disruptions on wild ecosystems and cycles. Eutopias would encourage compartmentalization of cultures as regards food and shelter.

Other strategies could be coordinated to accomplish further common goals. A few of these would include:

- Create a steady state (in Herman Daly's term) framework of local and regional economies, that is, a homeorhetic state constantly changing with ups and downs, but without large massive disruptions or differences, a state constrained by optimum numbers, sizes and processes.
- Limit the use of fossil fuels to strategic uses, not cars, burning or fertilizers. Limit human use of everything within ecosystem limits. Conserve 80 percent of remaining fossil energy and resources by limiting heating/cooling, driving, and other uses.
- Manage the human end and impacts to avoid large-scale technological fixes that require constant monitoring, control and correction.
- Preserve small scales of everything, from cities and farms, to roadways and air transport. Deindustrialize agriculture. Make it more labor intensive.
- Monitor possible catastrophes, from asteroids to earthquakes and tsunamis. Insure readiness for dealing with them.
- Keep options open. Keep flexibility high. Flexibility is crucial for dealing with changes. Equally important is creative co-constraint to avoid entering a trap of our making.
- Compartmentalize systems more by following an ecological model, reducing connections and overintegration. Increase diversity and redundancy at multiple levels.
- Require a diversity of sources of materials and services for all kinds of manufacturing, with always at least one local or regional one.
- Restructure financial institutions from interest and profits to fees and community donations. The times and reasons for profits are gone; that age and those needs no longer exist. Not new exploration or new trade, but enoughness, support and equity.
- Create massive stores and vaults. Create long-term seed vaults, like the Norwegian doomsday vault. Create seven-year food banks of cereals. In fact, create long-term banks of needed technologies, tools, and physical materials. Keep reserves of everything needed for catastrophes. Make sure supermarkets have more canned goods. Pharmacies, medical supply companies and hospitals need more warehouse supplies for catastrophes. Keep oil reserves. This in fact is a pressing need for any Homeland Security office.
- Accept all of the effects of living on a dynamic planet: Extinctions, death, suffering, destruction, life, accomplishment, beauty, and joy. It has always been a wild ride and it will continue to be. The music is wild, the dance is wild.

These and other strategies will be expanded throughout the work. Some of the strategies will be constant and permanent, while others will be temporary suggestions for transiting to desired stable states.

0.2.3. *Starting Regional Design*

We can do this now! What would it be like, though, to accomplish this? It might feel similar to some times during World War II for some people in some nations. People could react in days. The economy could shift in months. Some things would be limited or rationed. Most spirits would be high because people would sharing all the losses and risks, the challenges and stresses—and they would be doing it for the common good, to avoid catastrophes that could affect everyone and to save their part of civilization. The world would not suddenly become peaceful and utopian; there would still be conflict and crime, cheating and violence. But, these problems would occur within a smaller scale, within the context of redesigning human structures to be in tune with the natural processes of the planet.

The thing is, we do not want a uniform—and likely boring—industrial planetary culture. What we want is a framework to insure the development of local and regional cultures. An analogy might be the atmosphere of the earth, which is essentially the same, but allows many kinds of life to develop in different places. Designing regions is a process of assembling ideas, a narrative for the development of interacting patterns. It is not a comprehensive model, but a working sketch of possible directions and developments. It is, in John Thackera's words, an incomplete score, because the composer, player, audience, site, all vary with every performance. What is important is the framework for action, with its understood constraints. The work is coadaptive with its participants, that is, everyone.



Figure 03-1. Buckminster Fuller's dymaxion ocean-air map

0.3. *Design Science as Poetic Production* (Conversations with R.B. Fuller 1982-3)

Buckminster Fuller dedicated his life to solving problems. The problems were big then, as they are now. And, what daunting problems they are now: Humans deaths on an unimaginable scale, perhaps over 200 million people in the last 100 years, from shortages and distribution failures to wars and diseases, as well as the conversion of vast areas of vital ecosystems to agricultural fields and deserts, resulting in the deaths of animals, species, habitats and ecosystems. All of these problems interact, so that it becomes difficult to isolate separate problems. These long-standing problems result from long-standing challenges to human health and happiness: Violence, stupidity, greed, forgetfulness—not just personal forgetfulness but larger forms of cultural amnesia—old diseases and new, lust for power, and the lust to consume. Some of these problems are the result of detachment. Corporations, a trademark form of our industrial civilization, contribute to this detachment. Fuller named an imaginary corporation, ‘Obnoxico,’ as a foil for his ideas on addressing these problems. Fuller dismissed the flatscapes that resulted from uninformed design and recommended a form of eutopian design—Eutopias is from the Greek word meaning ‘good places.’ This word, with Outopias meaning ‘no places,’ was the source of Thomas More’s pun ‘Utopias,’ which was also the title of his fictional account of human development to the beginning of the industrial era. This work is an extension of eutopian design to deal with long-standing problems.

We tend to think of problems as unwanted ‘side-effects’ of the wanted main-effects, but all effects are equal, as Fuller noted, and must be addressed as equal. A problem (from the Greek words ‘to throw forward,’ which is what we tend to do with them) can be considered as a question proposed for solution. Most things identified as problems are embedded in a network. Nothing is simple; there is not one problem, there is not one solution. Problems could be considered also as challenges that we must respond to continuously, in the process of living, not as puzzles that have to be solved once for all time. A challenge is a calling into question or a demanding task (a challenge is defined as ‘a call to take part in’). It is about consciously choosing to see what can be done, rather than dismissing a conflict as terrible and unsolvable. When challenged by some situation, we react by habit, although this may be disconnected from other habits. Habits protect us from many problems. Addressing a problem often has to do with a power struggle, which becomes part of the problem. If problems are regarded as challenges that require a social response, then much of the conflict can be avoided.

The problems of cultures, of natural ecosystems, and of modern, industrial, corporate, urban civilization, have been documented quite thoroughly. We have identified most of the problems in the problematique, from erosion, pests, and fertility loss, to population migration and diseases, and we have addressed them separately, using technological innovations or political adjustments. But, we have not dealt with them in a whole pattern. We have not understood them as equal parts of complex large dynamic systems.

Sometimes we forget, moreover, that the decisions of our ancestors saddled us with losses, just as our losses will encumber our heirs with deforested landscapes on depleted soils, despoiled by exotic chemicals and hazardous wastes, in a network of impoverished habitats with an unstable climate, and of course, compounded by large intergenerational financial debts. This network of problems can be grouped under large categories, each of which contains

a multitude of related problems. Each category also extends numerous threads to the other categories. The loss of nature and the wild, that is, the loss of ecosystems, habitat, species, and individuals, may be devastating to all self-renewing systems. The remaining losses, such as the loss of place and the loss of design, are fundamentally human losses.

0.3.1. *Allowing Flatscapes of Design*

Our habitations, fields and transportation seem completely haphazard. Instead of placing cities on mountains or barren ground, we are covering fertile grasslands and swamps. Instead of placing roads around vital breeding grounds, we are bisecting and fragmenting ecosystems. Instead of integrating our food areas with wilderness, we are simply converting productive ecosystems to temporarily subsidized monocrops that we then convert later to grazing areas, roads and city squares, without regard to place or appropriate use—and then let them degrade to deserts, ruined landscapes or placeless flatscapes.

Placelessness begins with adoption of an attitude, an abstract and a geometric view. With this inauthentic technique, places can be treated as interchangeable and unremarkable, where nothing is significant. Cutting historical roots and eroding symbols contribute to an awful placelessness, an alienation to place, and an inability, finally, to have a home and to live there. This becomes the fate of millions, and it keeps increasing.

After shaping ourselves to technology and necessity, we have lost the knowledge of how to care. We have learned to be dispassionate (uncaring), objective (uninvolved), and unattached (placeless). Other animals have used languages and tools, so it is not those things alone that account for the lost knowledge. We ‘not-care’ because we are confused. Our confusion results from being out of place and not having an identity.

People used to identify with place. The gain of monoplaces or flat spaces has led to a loss of identity for many. The commonness of industrial culture, at a low common denominator, has led to fewer identities to choose from. The mass production of homes, as well as of music and art, has led to fewer creations.

A number of scholars have noticed that we are creating flatscapes, devoid of depth and providing only mediocre possibilities. Flatscapes, Christian Norberg-Schulz’s appropriate term, have allowed landscapes and places to become monotonous and dull, displaying fewer unique qualities and fostering weaker attachments. Edward Relph outlined the disappearance of variety that results in placelessness. Places become homogenous and interchangeable, as people everywhere share limited ideas and limited ways of relating to others.

David Brower urges that the human sense of place needs to be revived. Places cannot be preserved, however, without cutting their vital connections and making them lifeless. Places cannot be restored to some Arcadian fantasy, without severely limiting their movement and development. Places cannot be created using a machine metaphor of substitution.

There have been attempts to define and design places. Christopher Alexander decomposed environmental objects and activities into their constitutive elements, to be reconstructed into designs that could fit local places. These formal solutions can improve strategies for design and can provide a matrix for the making of places. But, they should not assume that human variables can be manipulated to achieve a predicted response. And, they cannot ignore specific psychological or cultural patterns.

There must be a way to define places, using an ecological approach, and considering cultural modifications and adaptations to places. The approach has to be tradition-based and

partially self-conscious. It has to be responsive to the genius of place, as well as to human meaning derived from the existential and phenomenological significance of the place. The concept of place incorporates physical, biological, and cultural dimensions. The solutions cannot, and do not, need to be precise; they can be unfinished and ambiguous. They can be fuzzy. The design does not need to guarantee rootedness or workability, but it can identify limits. It can provide possibilities through a matrix that allows tradition and richness. It can provide direction from the understanding of the parts. It can understand how to make a fertile kind of soil, as a metaphor, where things can live in and develop. Living beings synthesize the parts and find meaning in living there, and in doing so revitalize a place.

Other human losses are equally important in understanding flatscapescapes. The loss of culture leads to the inability of humans to adapt to unique environments due to unstable social environments. The loss of health results in weakness and sickness, the inability to maintain the self or to produce necessities. The loss of fitness leads to the inability to function under normal environmental conditions and to reproduce. The loss of equity results from the massive breakdown of the distribution of goods and luxuries. The loss of renewal reflects the inability of social systems to renew themselves or to provide security and resources for their constituents. The loss of accord happens when people or cultures are unable to work together or control conflict. Finally, the loss of design is the inability to imagine, shape and build things that enhance life and safety; it is the inability to respond to changing circumstances with adaptive patterns.

0.3.2. *Designing Real Living Places: Eutopias*

Perhaps the problem lies in our images; we use old images of frontiers or simple, inadequate images, like the 'machine' metaphor for nature. Perhaps the problem is in a failure of imagination.

Ideal images of the world have been offered as ideal schemes for social and political development, but are dismissed as being unrealistic and flighty. On the other hand, many of these images would require too much change—rejecting the past or refusing the cultural present, then creating new institutions from nothing. Some utopias are thoughtful and imaginative, yet most of them are rejected as irrelevant dreams and self-indulgent imaginings. Yet, as Pierre Dansereau has said, the failures of pollution, poverty, and urban decay are failures of imagination. Rejecting the solutions of imagination, therefore, can only make the suite of crises worse. Dreams and imagination are needed to describe desirable futures, to support plans, and to outline goals.

These rejected utopian designs can be replaced by realistic and achievable ones, that are based on a new image of the earth and humanity, that use an ecological perspective, to ease human societies into partnership models, to restore wilderness and common places we have destroyed, and to change international relationships into a poetic framework capable of limiting war and permitting the unique human expansion of cultural expressions.

This work outlines how to create places consciously, using our knowledge of how things work, but being aware of our ignorance, and by being careful and respectful. Certainly this seems less radical than continuing to surround ourselves with nuclear weapons and habitat destruction in the name of a political reality. A eutopian process, quite different from the utopian, would solve many problems, from problems of scale to political inappropriateness. A Eutopian framework would allow many new nations, but alliances and networks would form

and reform, as they do now. Fuller once suggested that the United States was a collection of nations (much like Leopold Kohr argued in the early 1940s; see *The Breakdown of Nations*). Several sections on regional design are drawn from an earlier holistic framework, *Eutopias: Making Good Places Ecologically and Culturally* (1970). Most of this book is specifically based on an earlier book, *Redesigning the Planet* (2006). Some of the sections are shared between books, although they have been modified for this book.

Buckminster Fuller was one of the first to consider this other meaning of utopias, as good places or Eutopias. In the 1920s, Fuller began work on a Dymaxion Air-Ocean World Map, as an alternative eutopia that sought to define civic and ecological order through maps of known areas (Dymaxion is a word formed from the words dynamic, maximum and ion—an ion is an atom or molecule that has lost or gained one or more electrons). On this map, the North Pole is the neutral center around which land mass and ocean unfold; this de-emphasizes Europe, China or America as centers. In the dymaxion series of maps, Fuller superimposed a spherical icosahedron grid onto the earth's surface to limit the distortion of the relative size and shape of its components. The projection represents all areas with equal weight.

Later, he sketched the World Town Plan, a map that preceded and directly influenced his subsequent maps. The town plan map, in its projection method and form, highlights the connectivity of the “one world island.” Fuller saw his map as an operational tool to be used by the members of the global citizenry. He intended to establish a map that does not prioritize cardinal direction, political entities, or hemispheric organization. Instead, the Dymaxion map provides a base for presenting larger global themes such as human migration, natural resources, and population distribution. Temperature replaces politics as an organizing feature. World climate is shown in a range of coloration from warm reds to cool greens and blues. Even with these specific theme, Fuller's map emphasizes wholeness across the global surface.

The proposed framework of **regional ecological designs** is based on eutopian design, an ecological and cultural framework for making good places on local, regional and global levels. Eutopian design is a way to preserve what is good and useful in human cultures and sciences, and to reserve what is necessary for nature to keep regenerating itself, while addressing the cascading problems of the modern expansion and development with an emergency approach. Eutopian design is a practical framework for allowing the creative anarchy of traditional-size cultures to be able to implement appropriate technology to deal with their resources and with other cultures through a revitalized and empowered international body that has the power of taxing global resources and properties for its own support, as well as the power to disarm and neutralize the unhealthy influences of large nations and corporations. The framework limits human expansion to domestic and artificial areas, by specifying responsibilities and duties, while permitting the free operation of nature on the majority of the planet. It saves neopoetic areas and reserves wilderness. It encourages respect for natural and cultural capital. It recommends recognizing limits and planning for them using an ecological perspective and a metaphorical approach—it is the framework for regional and global ecological design.

Eutopias can integrate tools and designs. Tools and designs are important extensions of the human mind. Their purpose is to foster and assist survival, not to make it more difficult. Tools and designs can be made appropriate to environmental limits and cultural preferences, both of which are often ignored by industrial approaches. Eutopias can suspend the designing of noplaces by promoting the understanding of the inadequacies of bad characteristics and bad designs; it can stop the plague of uniformity and paucity. Through an understanding of

the consequences of human ambitions and actions, eutopias can avoid many of the evils that result from a civilization set on technical autopilot. Design can be used to reduce impacts from catastrophic events; for instance, by denying building permits on floodplains. The losses from some events, such as droughts resulting from El Nino, can be ameliorated by design and planning, e.g., by having surplus food and supplies stockpiled.

A single utopia would not work for the whole globe. That is why a network of eutopias is necessary. Most utopias expect a perfectly rational humanity in a stable, ordered nature. Eutopias accepts the imperfect nature of humanity and the changing ambiguity of nature. Most utopias have a finished, closed, completely planned society. Eutopias would encourage building an open, progressive, partially planned society. Utopias are the dreams of reason. Eutopias are dreams of small traditions and cultures, reasonable or not. Where an imagined utopia offers revelations promising a desired future, eutopias offers references from selves and cultures for producing good places on earth now.

The first strategy would be to create a eutopian structure for human societies that emphasizes self-reliance and international cooperation on regional resources and cycles. Eutopias would be less vulnerable to downward drift or collapses than nations because of its new approach to values and limits. Through the UN, the framework would allow for global coordination and planning of regional associations of nations. Archaic societies have experience adapting to local catastrophes. The variety of cultures, each adapted to different environments, would provide resiliency and functional redundancy to human survival.

The eutopian structure would create new goals and images that would be applied to priority approaches, starting with survivability and protection of the wild. Eutopias would offer redesigns of our cultural and economic systems so that they would become smaller and more independent and flexible, in order to respond better and faster to new environmental uncertainties and changes. Eutopias would provide a repository for the diversity of human knowledge (cultural knowledge) as well as the diversity of crops and animals—and of course the genetics of wild beings. People in different regions could catalog cultural legacies from archaic cultures, like the Appalachian project, to preserve folk knowledge from being lost from the transition to cities.

There is no mechanical prescription for designing and making good places, no blueprint or timetable. The current institutions cannot create good places; the market has not been able to create health and equity; even scientists and humanitarians have not been able to create a way—Eutopias is a fourth way. It is not an institution that benefits only the rich; nor is it a schedule of temporary handouts. It is a plan for a framework for local self-reliance and regional exchange, that is respectful of traditional cultures and ecological networks.

Eutopias has a low—but not too low—political feasibility. The benefits must be worthwhile to justify the costs. Benefits cannot be vague and unsatisfying when the costs are immediate and painful. Poetry and education must prove the benefits, so that the eutopian alternative can begin. This code emphasizes its flexibility. This strategy would avoid eventual hardening of the choices. But it must be instituted at once. The crisis caused by exponential growth and destruction cannot be solved just after some final limit is passed and a great catastrophe has begun. The crisis of ignorance cannot be solved by hurrying and creating more problems.

Eutopias exists in the extended present, incorporating past traditions and future values. It would concentrate earthward (down) and inward. Eutopias is a new comprehensive

philosophy to make sense of the world. Eutopias is local, regional and global. A broader frame of reference is assumed. It is concerned with unfolding and producing new emergent forms, not just a static description of one-time achievements. Eutopias is grounded in environmental concerns. Its values must be high cultural and natural values. It must develop from existing social and political forces.

Eutopias can reduce the losses of nature and culture by creating a framework to protect them. Eutopias can reduce the losses of health, fitness and accord, by emphasizing them and creating circumstances for their continuity. Eutopias can reduce the losses of equity, renewal and design by offering new designs that allow for a normalization of equity and for the normal processes of renewal. Losses from accidents and diseases can be reduced by preparedness. Losses from earth and climate changes can be reduced, also, with preparedness for 'normal' regular events, such as hurricanes, earthquakes, and droughts.

Eutopias can show how to preserve and restore, design and plan. Eutopias can provide an ecological planning process that offers a structure of limits and divisions for the planetary system that would permit the preservation and restoration of natural cycles and places. An ecological design process would be applied to ecosystems as well as to cities and fields.

0.3.3. *How can we Redesign the Experiment?*

For his commitment to a design science revolution, Fuller made "Ten Proposals" (from *Earth Inc.*) that would address the problems of our civilization. One of the most important is to learn the mathematical coordinate system of the universe. In fact, an educational revolution, based on synergy, should be the highest priority. It would start with an inventory of all known principles, using Fuller's world game for theoretical exploration. To inventory the resources of the planet, we would convert general accounting systems to a planetary ecological accounting system, intergenerational and cosmic rather than annual and agricultural. Wealth would be refined from a scarcity model to an energy model. By making ownership onerous, excess property would be eliminated, and we would be liberated from our slavery to 'thingness.' World sovereignties, with their suite of barriers, would be modified. Humans would apply their unique skills as problem solvers by realizing our competence at design science.

Fuller made many brilliant suggestions, and applied many ideas in brilliant inventions. His technical focus, however, allowed him to overlook many of the needs of people and cultures. One sovereignty, replacing many hundreds, would make things worse. As Leopold Kohr noted, bigness is the source of most problems, such as misery and conflict, and smallness is the simplest and most elegant solution.

For Fuller, the discipline of design science proceeds from a subjective search through experimentation and feedback to generalization, then development, including practice and regeneration, to evaluation and back to the subjective search in a loop. Fuller notes that humans have evolved from the local 'rejuvenation' of agrarian farming to a collective nonlocal rejuvenation of industrialization. However, industrialization has proved to be nonrejuvenating, as it has been stuck too long in a flow-through pattern of production, where everything is treated as commodity. Something that is capable of self-renewal is needed.

Fuller also argued that we have displaced ourselves as specialists and must again become generalists and 'comprehensivists.' We need greater degrees of freedom to increase the probability of cross-fertilization to solve design problems. We need new skills in design that can come from considering the regional context. We need to try new approaches and correct

the inevitable mistakes. And, we need to ask questions about the global systems, before we can try to answer them.

Fuller emphasized the importance of global communications, through radio signals, and global transport, complete with a computerized global transport system and traveling cartridges that would be assembled at local stations or loaded onto planes or ships. Fuller also proposed a global energy grid (the Global Energy Network International), which would connect all areas, although we would have to be careful not to create connections that are too rigid. The dymaxion house was to be a global dwelling service, which would optimize performance and efficiency.

A design science revolution, using a comprehensive anticipatory design science, would reform the environment. But, Fuller thought we could reform the environment without reforming people. This focus on the environment has resulted in more damage to the environment, instead of less. Therefore, design cannot be limited to simple mechanics, but has to extend to human cultures and behaviors, to ecology, economics and politics.

Fuller does suggest that a design scientist has to take the initiative rather than being retained by a client to carry out a limited design. The design scientist has to perform the fundamental invention, underwriting, development, and experimental proof of a project. Design science has to provide effective anticipatory strategies for formulating and managing the regeneration of industrial organisms in the same way that the medical profession deals with human metabolic regeneration, according to Fuller (WDSD No. 5, 1962). Design has to be holistic. Fuller states “the design scientist would not be concerned exclusively with the seat of a tractor but with the whole concept and distribution of food.” For the field of regional ecological design, this means siting the total human industry within the context of the global system.

0.3.4. *Poetic Production*

According to Aristotle, productive science, or poetic knowledge, has a product as its end, not knowledge or action. Productive, or poetic, science derives many propositions from theoretic and practical sciences, and because it involves more elements, poetic science is the least exact of all. Yet, in a sense, poetic science is more basic than the others, since all sciences produce an end. Poetic knowledge is inseparable from the power to make. Poetic knowledge is a kind of knowledgeable activity with a product for an end. Aristotle defined poetic art at various times as having to do with creation. Poetic science is a making, a fashioning of random data into a whole. The whole is structurally unified into a complex thing. This unity is based on organic themes, for Aristotle. Art is a mimesis of nature, but it does not copy nature's products. It presents unified wholes, in the manner of nature. Works of art are structured like unified living things; when things exhibit unity, then they have order, and when things have a definite size and order, then they are beautiful, in art and in nature. Fuller once said: “When I am working on a problem I never think about beauty. I only think about how to solve the problem. But, when I have finished, if the solution is not beautiful, I know it is wrong.” In fact, only by being organically structured can art be mimetic; and only by being mimetic to life can art works be organisms. Art, design and poetry imitate, not fragmentary reality, but the essential whole.

Our regional designs of ecosystems, of wildernesses, of cultural forms need to be poetic productions. By following the principles of ecology and applying them to the characteristics

of good places, we can make regional designs. According to David Orr, certain design principles work with ecosystems and nations: Small units dispersed in space, redundancy, short linkages between modules, simplicity, diversity of components, self-reliance, decentralized control, large margins, and immediate feedback. A megaframe like Eutopias would allow this scaling of design from the local to the global.

Ecological design is the design of whole communities. We can design places as organic wholes to promote the well being of individuals and the common good. But, we can only really do so as participants of ecosystems (and this takes us back to the fundamental lessons of physics: that we cannot not be part of an experiment, that disorder creates order which creates disorder, and so on). Humans need to recognize that they automatically participate in everything. Furthermore, due to the uncertainty in dealing with large, long-lived systems, we have to learn to accept that the system needs most of its own productivity and to limit our use of the systems to well below critical limits, that is, within the flexibility of the system.

Regional ecological design is the design of human impacts on unique regions in the planet. It may require patterns of constraint more than specific technological applications for that level. It requires the participation of everyone, dealing with small actions and very large cycles. But, the designs and actions, and certainly, our awareness, have to extend to the region and perhaps beyond the planet.



Figure 034-1. R. Buckminster Fuller explaining his Dymaxion car 1959

0.4. Techo-utopia Or Peaceable Kingdom: Where are We Going?

By Dr. Michael W. Fox

In America, I have seen the bioconcentration camps of the industrial holocaust of the animals – the factory farms, the puppy mills, and the biomedical animal research facilities. I have also seen the biological deserts of agribusiness' monocrops that blight the land and impoverish the soil and rural communities from coast to coast. What I saw, I suffered. What I suffered was as much for the animals, for Nature, and for indigenous peoples as for the evident loss of humanity – the spiritual disease of my own species.

The inhumanity of wholesale animal and environmental exploitation with its core of rationalism, fatalistic acceptance (in the name of progress), desensitization and denial, and its veneers of efficiency, necessity, productivity and proficiency, fill me with outrage as a veterinarian, and shame as a human being. The animal welfare and environmental regulations and reforms that the life science industry has adopted have more to do with public image than with real concern for animals, rural communities, and Nature's beauty and biodiversity.

The plight of animals in less developed countries, like the sacred and suffering cows and elephants of India, and especially the poor donkeys, buffaloes and dogs, is not a consequence of poverty or culture. I have found a similar core of rationalization, desensitization, denial, and fatalistic acceptance (in the name of karma), as in the West.

Many people who claim to care for animals only do so more out of concern for their own spiritual purity or public image. It is all simply a matter of choice: To be humane or inhumane; to care or not to care. That is the question for every culture and community, industry and institution, East and West. This choice, I believe, is our final choice.

Theologian Pierre Teilhard de Chardin saw it as "the final choice between suicide and adoration." That is why I link animal liberation with human liberation as others have linked liberation theology with human rights and egalitarianism. I equate the survival of our humanity with the survival of the natural world; and the recovery of humanity with the recovery of organic, sustainable and socially just agriculture and agroforestry.

Between the antipodes of hope and despair is our faith that is based upon different beliefs, values, and traditions. My faith in and passion for animal liberation, and more broadly for the liberation of all life from human ignorance, arrogance, and greed, are put to test everyday. I do not hope or despair because I am neither an optimist nor a pessimist. I am a realist, and what is real is what we feel and how we respond to the reality of the suffering of others and to the holocaust of the animals and the natural world. My faith and passion guide, sustain, and inspire me. But without the renewal and affirmation of hands-on animal healing and wildlife habitat conservation work, coupled with the support of kindred spirits, I would question the purpose of my existence. I see that faith without service, compassionate action, and honest confrontation with the evils of inhumanity, amounts to nothing more than feel-good denial: And silence is complicity.

I do not put my hope in the "future." There is only the eternal now and the everlasting presence in which we are transient, mortal participants and witnesses, with the power and freedom to choose between good or evil, humanity or inhumanity, service or stewardship and compassionate action, or denial and indifference. These are not choices for the future for us to make, initiate, or legislate tomorrow, next week or next year. They are choices to be made

right now and every waking moment of mindfulness. This does not mean that we should not consider the future consequences of our actions.

Without the ethics of consequentialism and the global bioethics that I discuss in my book *Bringing Life to Ethics*, science is as dangerous as religion is blind without science, to paraphrase Albert Einstein. But when we are fully engaged in the eternal now, guided by humility, reason and compassion, and inspired by loving concern and reverence for all life, we are free to do as we will. We gain this freedom when our will is in harmony with the will-to-be of the rest of the life community that was here on Earth long before us and which, in myriad ways, contributes to our health and well-being. This is the way of human liberation and to a better world, a way very different from the better world to come that science and technology have promised us from one generation to the next.

0.4.1. *Absence of the Sacred*

I am aghast at the absence of the sacred in the hearts and minds of so many people today. The state of mind – the rationalist instrumentalism of Techno-Utopians – is part of the dominant culture, like the bioengineers of cloned, genetically engineered, and patented animals, including insects and fish that even contain human genes, and of transgenic crops for us all to eat that contain and produce their own pesticides and contain alien DNA of potentially harmful viral, bacterial and other self-replicating molecular configurations. This dominant monopolistic culture of materialism and consumerism sees life not as sacred but as a commodity and as capital. In so demeaning life, we demean ourselves in participating in a value system that sees Earth's (or God's) Creation as a resource, and sentient life forms as a means to human ends rather than as ends in themselves, possessing intrinsic value and extrinsic (ecological) purpose.

Perhaps the mind behind the virtual reality of a utopia through techno-eugenics, where endangered species are “saved” by cloning and even improved through genetic engineering, has an abnormal conception of what it means to be human in the absence of the sacred. A public that condones without question such activities in the interests of conservation and endangered species preservation has been deluded by the enchantment of others involved in animal cloning and transgenics. The primary beneficiaries of this new biotechnology are its investors and corporate empires that increasingly control agriculture, medicine, world trade, and our universities, academia, and government. New discoveries and uses for the genes of endangered animal and plant species is a venture capitalist's dream. So the last of the wild is being prospected and exploited and also the DNA of soon-to-be-gone indigenous peoples and their food and feed crops and medicinal herbs. Gene saving and gene-prospecting and piracy is the market-driven wave that is turning the natural world into a virtual reality, with cloned panda bears; organ and blood donor pigs, and eco-friendly pigs whose manure is less polluting; cows that produce human milk and valuable pharmaceuticals; pesticide-producing wondercorn and supersoy resistant to herbicides, and “improved” golden rice with more vitamin A to promote monoculture farming and public acceptance of genetically engineered crops and foods; even bio-ethnic bombs made of self-replicating constructs of recombinant DNA that are lethal to Arabs or Jews, or to rabbits, rodents, insects, and other pests of plague and pestilence, famine and war.

Consider the creation of transgenic seeds by some multinational life science corporations that only produce sterile seeds so that farmers can't save seeds from the best plants. The pollen

from these crops could genetically contaminate other crops and wild plants with the so-called terminator gene construct of self-replication DNA. Such genetic pollution has already occurred with other types of transgenic crops of corn, canola, and soybean, and could have devastating economic and ecological consequences. This is a technology nobody needs.

As Kahlil Gibran said, “Pity a country that has another make its own bread,” so I would say pity a species that exploits and harms more than it serves and heals. The biotechno-utopia of genetic engineering sustains and justifies itself because it profits from harm by promising techno-fixes for a multitude of harms like disease and malnutrition, and yet has no scientific or ethical basis to assure that it will not cause even more harm.

This is likely, because the advocates of biotechnology, like the predecessor advocates of agrochemicals and the “Green Revolution,” have ignored both the law of unforeseen consequences and the precautionary principle in their assertions that this new technology is safe and is the best, if not the only way to keep humankind adequately fed and healthy. People need new organs from transgenic pigs in part because of what they consume in a poisoned environment.

Agricultural biotechnology is evolving into a monopolistic monoculture of conspicuous consumption that is annihilating the natural world; the First Creation, soon to be supplanted by the virtual reality of the second, human creation of a bioindustrialized system that is turning the Earth into a wasteland. This is the terminal reality of an exterminator species that we are fast becoming as we misapply science and technology for pecuniary and desperate ends.

Rather than changing radically, and for many, painfully, the way we live, making our values and wants truly democratic, egalitarian and wholly ethical, we look to science and technology instead to make the world a better place. Wise animals seek to adapt themselves to the world. Foolish ones try to change the world for themselves. The natural world is no place for fools or foolishness, and the fools who fool around with Mother Nature, as history and environmental health science and medicine inform, will suffer the consequences: The law of karma indeed, as exemplified by the public health costs of pesticide-contaminated food and antibiotic resistant strains of bacteria from factory farmed animals.

0.4.2. *Homo technos—the Parasite*

Any anthropologist will attest to how adaptive cultures and communities accommodate to their environments in order to achieve sustainability. They can identify those that became extinct because they tried to force the environment to accommodate nonsustainable needs (wants and greed), which is a maladaptive, pathological, and pathogenic relationship. It is parasitic. Most parasitic creatures regress and degenerate physically and mentally, and many kill their hosts. Being in human form may not give any significant adaptive-survival advantage to a culturally mutated, parasitic way of life.

It could be a distinct disadvantage. Looking at the long-term success of lice and fleas, tapeworms and ringworms, I would say that being a parasite with the technological appendices and capacities of *Homo technos* (the mutated form of *Homo sapiens*) that today is becoming the one dominant culture of the entire biosphere, is a distinct disadvantage. It is poisoning and destroying the Earth and peddling science and technology to heal and make whole as the poisoning and destruction continues unabated. Too far regressed in spirit, body and mind, the parasite *Homo technos* will eventually become extinct.

Humanitarians—all who cherish the natural world and whom I call the “first people”—

today are moved to protect and heal all whom and what they can of the First Creation, so that there will be something left of the life and beauty of the Earth after this techno-parasite has had its last consumptive suck, and as Chief Seattle foresaw, suffocates in its own waste. The “end of living and the beginning of survival” is the recent history of his and other indigenous peoples. All who belong to the Earth and feel that deep connection in their souls and in their hearts of longing and ever deepening communion, must rise up and suffer the nemesis of Homo technos. This is the apotheosis of those who are twice-born and having died to the culture of industrialism and consumerism, seek to live simply so that others may simply live, and sow the seeds of humility, gentleness, and loving kindness toward all sentient beings. They have no time for rage or rhetoric, since they know that only with respect for each other, for Nature, plants and animals, can wisdom and love find expression and peace on Earth be restored. As the luminary Vincent Van Gogh wrote to his brother Theo, “When one really loves Nature, one will find beauty everywhere.” But many now see beauty in a different light – in ordered monocultures of forests, orchard, and crops, and even in industrial factory “parks” that are sanitized versions of the “satanic mills” of the industrial revolution that revolted the sensibilities of another artist and seer, William Blake.

We would all be well advised to reflect on the wisdom of medicine man Black Elk, who observed, “It is from understanding that power comes; and the power in the ceremony was in understanding what it meant; for nothing can live well except in a manner that is suited to the way the sacred Power of the World lives and moves.”

0.4.3. *A Virtual World Devoid of Virtue*

The use of cloning and other biotechnologies to propagate endangered species and to even resurrect extinct creatures, like the woolly mammoth, the marsupial wolf, or Tasmanian devil, puts us on the threshold of creating a virtual reality. A virtual reality that supplants the sacred reality and organic wholeness and integrity of the natural world may well become the norm for a virtual humanity in the near future; a future where virtue is supplanted by the instrumental and self-serving values of rationalism and materialism.

Technology will then be the dominant religion. Scientists and economists will be the priests and prophets of a market-driven global monoculture that treats life as an exploitable and patentable commodity, and Nature’s creative processes are perverted to become the means to satisfy purely human ends for an increasingly desperate and depraved existence. This future is not inevitable, provided we can conserve ethics, virtue and a sense of the sacred from the tyranny of rationalism and materialism and the narcissistic enchantment of technology, especially biotechnology.

0.4.4. *Global Bioethics*

Recent industrial, agricultural, medical and military advances and applications of science, especially in the realms of information technology, robotics, genetic engineering and nanotechnology have been proceeding in an ethical vacuum. While ethics without science is lame, science without ethics is blind. Biotechnology without bioethics is a danger to all. Hence, the urgent need at this time to challenge the scientific community worldwide to become ethical by making ethics an integral part of the scientific paradigm in order to properly address risks and benefits, and to be publicly accountable. A techno-dystopia, based upon industrial imperialism, narrow scientific determinism, and materialism, has been created that

is now a threat to the integrity and future of both humankind and the entire earth community. The kind of ethics that needs to be adopted is in part science-based (with biological, behavioral and ecological perspectives) and was first called bioethics in 1976 by the late Prof. Van Rensselaer Potter. Because of the worldwide need to incorporate bioethics into science and all other fields of human activity—agriculture and all petrochemical/fossil fuel based industries, and world trade in particular—I offer the following synopsis of global bioethics as potential guideline and antidote, from my book *Bringing Life to Ethics: Global Bioethics for a Humane Society*:

1. Global bioethics calls us to give equally fair consideration to three spheres of moral concern: Human well-being (rights and interests)
Nonhuman well-being (rights and interests)
Environmental well-being (biodiversity and ecosystemic integrity).
2. Global bioethics calls us to be accountable for our actions and appetites in relation to these three spheres; and to examine how well society, our politics, laws, economies (industry and commerce), religious, educational, and other traditions and institutions, as well as our own personal lives, are in accord with the bioethical principles that unify these three spheres in the light and language of compassion, humility, and reverence for the sanctity of life.
3. Global bioethics calls us to actualize our natural, innate empathic sensitivity, moral sensibility and powers of reason, reflection, and also self-control by embracing the precautionary principle.
4. Global bioethics calls us to consider the purpose and potentials of human existence, the significance of the virtues that make us humane beings, and our duties and responsibilities for the Earth Community, and for the integrity and future of Creation.
5. Global bioethics calls us to understand and respect the cultural ecology of moral pluralism, and from this diversity of human beliefs, opinions, and desires, create a common ground of equalitarianism and respect for all life.
6. Global bioethics calls us to develop a unity of spirit for more effective and immediate crisis management, conflict resolution, and humane intervention where the compass of compassion directs reason and action toward world peace, justice, environmental and animal protection, conservation and restoration of biological and cultural diversity, and security and fulfillment for all living beings.
7. Global bioethics promotes and unifies Earthcare, Peoplecare, Animalcare, and Healthcare for the good of all.
8. This unification is expressed as Human Wellbeing = Healthcare + Earth care + Animal care.



Figure 042-1. Dr. Michael W. Fox with Patients, India, 2002

1.0. Preparing for Challenges to Design

Human consciousness of the complex changing beauty of the planet, and our effects on it and on each other has gradually increased, as shown by recycling programs and by celebrations such as Earth Day, which has been getting larger every year—as a celebration, anyway. But, celebrations do not seem to have lasting effects. We are willing to endure small amounts of discomfort to make minor cosmetic improvements to our industrial machine, but we are afraid to question the basis and goals of our civilization, especially after we have invested our lives and identities in it. Despite the tinkering and celebrating, environmental deterioration has worsened in most places. Levels of consumption have increased; populations have increased. We need to implement radical emergency actions.

The earth does not need to be saved or healed, as if we could do either. The ways of life that we remember and prefer, the places that depend on other species and natural processes—these can be saved. Our own divided minds, that let the poor be enslaved by the wealthy, that let ‘good’ animals be domesticated and ‘bad’ animals be eradicated, can be healed. The sacrifices will have to be great; the changes will have to be radical. But, the celebrations will be meaningful only then.

One of the biggest challenges to ecological design are the gifts that came with industrialization, more than just premature celebrations. Gifts that we thought we wanted, but which seem to have many kinds of costs associated with them.

1.1. *The Gift of Bigness* (The Curse of Unending Growth)

Early in our history, when the very success of the species was in question, we humans learned to reproduce more rapidly than our rates of mortality. To extend our families, we have increased our numbers and our rate of increase exponentially. To ensure the success of our species, we have appropriated the places of other species. Our overpopulation has led to aggression against other cultures and species, then to indifference at their suffering. Even low levels of food and fulfillment at our current size can be maintained only through theft from other species and from future human generations, and through the degradation of billions of humans as well as the ecosystems on which they depend.

To provide for the needs of many and for the extravagant luxuries of some, we have produced waste and pollution on a geological scale, from islands of garbage to skies of acid rain. Manufacturing processes result in the production of new dangers, such as recombined genes, and new substances, which are not easily incorporated into natural cycles. The overuse of ecosystems results in deforestation, devegetation, and desertification, then in depletion of raw materials and depletion of agricultural land. Economic and political pressures, derived ultimately from population pressures, force farmers to intensify their efforts to increase crop production, instigating a dismal cycle of population expansion, environmental deterioration, and poverty.

To provide for our needs efficiently, we have increased the scale of our activities. But we have decreased the diversity of habitats by filling in wetlands, felling forests, plowing grasslands, and irrigating deserts. Agribusiness has caused widespread landlessness; people who try to grow their own food are forced onto marginal lands or off the land. Acquiring fossil fuels also creates landlessness; coal mining in the Black Mesa mountains of the United States,

for instance, may force the resettlement of twenty thousand Hopi and Navajo people. Without land, and the economic independence it allows, cultures are more likely to disintegrate.

Our local communities are proud to attract more people and larger industries, but do so thoughtlessly, without regard for the limits of population size or the rate of energy use, without sufficient consideration of the effects on the quality of our lives or on the quality of the environment. Although we make plans for people and their activities, the plans are usually reactions to growth and change. The formal development from planning results in a complex of problems, from pollution to ugliness.

Our societies are big. Our corporations are big. Our impacts are big. This creates discontent because people feel powerless. They feel powerless because they feel that democracy is not working. The country is run by the rich, rich corporations, rich people, rich politicians, and they secure their needs for more money first. In fact the decline in earnings, relative to costs of goods, forces people to struggle with jobs and increased conflict everywhere. Now, at the perceived “end of history” and the “victory of democracy,” it is difficult to imagine a better future, at least without questioning the rich, the ideals of democracy, and the corporate good will to society.

We have economic growth; we can see the numbers. But, the growth is premised on saving costs by forcing down wages, or by reducing the number of workers in the name of efficiency, and forcing overqualified workers into service jobs. The growth promotes inequality, improvement for a few and impoverishment for most. It is the growth of a tumor, issuing a healthy glow from a fever and the false image of health. Profits go up, but public services decline for lack of funds. There is no money for schools, none for libraries or parks, little for private institutions, and little for national, state or local governments. Where did it go? Profits? Profits for individual corporations, profits for individuals? Could we find them, can we track the money? We should be able to, since the management revolution has made paper trails everywhere. Perhaps the trails are too complex.

Bigness overwhelms the ideals of cultures, which is why large nations such as China or the United States cut their forests, regardless of respectful religions or special cultural values regarding nature, regardless of the desires of local communities. The nations are willing to sell the wealth of the provinces, even though the provinces want to conserve them.

Something is wrong. But who is to blame? Where is the target? People rail against liberals or conservatives, against corporations or protesters, against big government, or big corporations, big permissiveness, big violence, the lack of faith or lack of prayer, the failure of responsibility or the failure of nerve, against guns, leniency, illegitimacy, bad rock, bad lyrics, bad welfare, bad politicians, bad people, and bad police. But, the real enemy is unseen. Who can argue against democracy or corporate wealth or the general vague feeling that things have improved? Against a reasonable system? Against the bigness of the system?

The course is downward. How can it be turned? How can we diagnose the problems? How can we suggest a path to health? Charles Reich says that we need a science of social change. Ecology is science-based. Conservation is science-based. Even management is science-based. Now economics and politics needs to be science-based, instead of dominated by an old ideology and weak mythology. Reich suggests that between citizens and government is a third entity, economic government, to which has been ceded power to determine the direction and type of economy. The only knowledge we get is knowledge from the economic government, and the numbers look good. We have no other knowledge, except for a weak self-knowledge,

and vague social knowledge, that tells us something is wrong.

Leopold Kohr identifies the basic conflict between man and mass, citizen and state, large and small communities, as a result of bigness. Kohr's theory of size states that the cause of most forms of social misery is bigness. We have always tried to exceed the physical and biological limits of places rather than recognize them and be guided by them. Every advanced country is now over-technologized. Past a certain point the quality of life diminishes, not improves, with each advance. Big science serves big technology, which supports and is supported by big government. And there is no science like big science, and no administration like big administration. But this enthusiasm is misdirected. Scientific advances and technological changes result in unforeseen consequences, good or bad. They cannot be controlled or legislated against before the fact. But the investment seems too big to abandon.

The planet, including human society, is threatened by the bigness of things. Although nature is big, it has evolved slowly; human size is new and sudden. A snail's pace is good enough for nature most of the time, but with our brief life span, we argue that we need quick changes. The technological advances have not been paid for yet, although the cost in pain and death is incalculable. We will be paying for hundreds of years for those past advances. The economic style is too great, and reckless for ecological systems to absorb its impacts. The scale of things is an independent problem, that can ruin the best intentions of policy. A bigger system to control systems that are now too big might be a mistake.

But some solutions are even bigger. Buckminster Fuller, Alvin Toffler, and the Club of Rome favor a supertechnocracy. Science fiction visions predominate: Gerard O'Neill's orbiting cylinders or Simon Calder's floating domes. R.A. Smith, in "Unibutz," claims that we could achieve a pantheistic-humanistic-cosmic awareness, in achieving technology without materialism, plenty without selfishness, and community without tribalism. His Unibutz is a global goal for leaving the earth and reaching the stars. The voyage would help shape new world structures and give a purpose to humanity. But to what end? Bigness and wealth elsewhere?

Perhaps big science and big technology have too much momentum. Theodore Roszak acknowledges its schizoid attraction and repulsion, with the twin promises of glorious accomplishment and hideous death. Who could escape being torn between yes and no, if even our end would shine with radioactive, Promethean grandeur? Our image of big science—the scientist as tragic hero, isolated in chaotic nature, but strong in his proud individuality, perhaps driven to research by hubris and madness—is a barrier to any new vision, especially a small vision.

1.2. *The Gift of Speed* (The Curse of Momentum)

To achieve even greater efficiency, we have increased the speed of our activities, converting materials and cultures into new designs without consideration of the meaning of, or need for, efficiency. The speed of our economy is too great for many cultures to adjust to; and the thoughtless transformation of cultures may result in great, irreversible mistakes. The speed of our conversion of wild habitats to domesticated lands is too great for many species to adapt.

Alvin Toffler foretells a dramatic redistribution of power, from slow countries to fast. Speed is the critical factor for Toffler, who states that, historically, power has shifted "from the slow to the fast," whether speaking of "species or nations." Certainly, being faster to the industrial market has advantages for many international corporations. But, this kind of speed

is not applicable to species. Slow species have survived as well as fast, either adaptively or neurally; many fast dinosaurs perished before their slower mammalian contemporaries.

Toffler notes that the industrial revolution stepped up the metabolism of economies, but does not seem to make any distinction between good or bad metabolism—fever as well as excitement speeds up a metabolism. Truly, we are speeding up our use of resources without knowing where they are coming from or going to. Modern economies, embracing the idea that “nature is capital,” draw on the accumulated “capital” of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth—similar to the healthy flush of a fever, perhaps—and a long-term imbalance. When an economy falls out of balance with its local environment, massive disruption often results; industrial economies have only avoided disruption by trading advantageously with other economies, by using fossil fuels, and by promoting general institutional inequality.

Continuing his paean to speed for its own sake, Toffler states that fast economies generate wealth and power faster than slow ones. But, what kind of wealth? Financial or cultural, agricultural or symbolic? And, what kind of power? Mechanical or organic, political or personal? Industrial economic wealth is merely a small part of the wealth of the earth and humanity, most of which has little value to that economy.

Toffler describes an acceleration effect that makes each unit of time saved more valuable than the last, creating a positive feedback loop— inadvertently identifying the archetypal problem of modern economics: *Runaway positive feedback loops leading to catastrophe*. The fast economy he describes seems to depend on fleets of hypersonic jets racing around the world with the elite and their tonnage of possessions. Telecommunications, transportation, and tourism will accelerate, blithely unaware of their impacts on family structures, biogeochemical cycles, including the ozone layer, and wilderness. Have we learned anything?

Toffler sees revolutionary consequences in new management methods, but not the negative effects. Managerial decisions regarding resources are made often on short-term economic grounds and lead to material shortages and human and environmental degradation. Newer methods seem only to offer a higher degree of impersonality.

The new wealth creation system, Toffler claims, holds the possibility of a better future for the vast populations of poor, if their leaders anticipate changes. The new system for making wealth consists of an expanding global network of markets, monetary, and production centers in instant communication with increasing flows of data and information, but not necessarily wisdom or understanding. He argues that the availability of this information flow gives more power to consumers, voters, workers, and small businessmen, taking it away from a centralized few. The potential is there, but Toffler does not go far enough to envision alternate economies and communities. The power still operates under the old assumptions and divisions in his speedy synthesis.

Of course, Toffler is right to recognize the problems of nonindustrial countries, many of whom depend on cheap labor or strategic military location for foreign investment. But, where does that “investment” go? To the local poor or to remote, rich politicians? Wealth could be distributed fairly, depending on many factors, such as synergy, generosity, reciprocity, and cooperation, but it is not. The gaps are growing. Toffler acknowledges that they will keep growing. But, we can redistribute wealth without industrializing. We should try to achieve economic justice before accelerating to new glories.

Toffler concludes that a great technological and cultural wall will separate the slow from the fast, making problems for joint ventures. But, what are the products of these ventures? The debris of advertising fads, such as mink toilet seats, or the tools of real needs, such as evaporative water purifiers? Toffler foresees the emergence of an electronic neural system for a global economy, without which any nation will be doomed to backwardness. What kind of backwardness? Lack of fast things? Lack of professional enslavement? Lack of art, play, or culture? Lack of food, tradition, freedom, or happiness? Perhaps these have already been stolen.

There are other gifts of course: The gift of abstraction, of rationalization, of centering—whether of the self, family, city, or culture—the gift of delusion, of progress, perhaps of blinders, and many more. These gifts also have costs that we did not notice or calculate when we accepted them. And these gifts have real consequences in terms of death and destruction, but now we are afraid to refuse them, in case we might be unhappy or suffer.

1.3. *Eight Terrible Regional & Global Losses*

The problems of cultures, of natural ecosystems, and of modern, industrial, corporate, urban civilization, have been documented quite thoroughly. We have identified most of the problems in the problematique, from erosion, pests, and fertility loss, to population migration and diseases, and we have addressed them separately, using technological innovations or political adjustments. But, we have not dealt with them in a whole pattern. We have not understood them as complex large dynamic systems.

Sometimes we forget, also, that the decisions of our ancestors saddled us with losses, just as our losses will encumber our heirs with deforested landscapes on depleted soils, despoiled by exotic chemicals and hazardous wastes, in a network of impoverished habitats with an unstable climate, and of course, compounded by large intergenerational financial debts. The losses indicated by these numbers can be categorized simply, under eight large categories, each of which contains a multitude of related problems. Each category extends numerous threads to the other categories.

1.3.1. Loss of Nature (Habitat Species & Pieces)

The overuse of ecosystems results in deforestation, devegetation, and desertification, then in the depletion of raw materials and the depletion of agricultural productivity. Economic and political pressures force farmers to intensify their efforts to increase crop production, instigating a dismal cycle of population expansion, environmental deterioration, and human poverty. This overuse results in the attendant losses of many habitats, species, and individuals. Many species are not hunted to extinction; they are being lost as a result of the simplification of their habitats for human uses, from the expansion of agriculture to the pavement of cities and road systems. The rates of extinction are now far higher than the natural, unassisted rates. The loss of habitat also decreases any new speciation processes.

1.3.2. Loss of Culture

With the globalization of trade and the domination of national languages, smaller cultures are being absorbed into larger ones. Although people retain some of their traditions, the loss

of their language means that the whole perspective of their culture, related to the uniqueness of place and human adaptation to place, is being lost. Knowledge of plants, animals, and processes is being lost at a time when modern science is halfheartedly trying to catalog knowledge of every place. A lack of knowledge is often related to illiteracy—or the lack of numeracy or ecolacy, to use Garrett Hardin's words, but this kind of loss is personal and cultural—it had been learned once and is lost as a result of a set of circumstances where it is devalued and ignored. Smaller, less-competitive cultures are being abandoned by new generations of people or subverted by global comparisons of luxuries and expenditures.

1.3.3. Loss of Health

The instability of cultures, as well as stress, insecurity, and insufficient diets, results in physical and psychological problems for people. Individual powerlessness and disillusion provoke further disintegration. With disruption of agricultural and manufacturing productivity, as a result of conflicts, people have less food and fewer necessities. Hunger affects over half the people in the world, in every culture, including many of the dominant cultures in China, Russia, and the United States. Extended hunger not only alters behavior and intelligence—that is the ability to evade hunger—but it allows diseases to flourish. Many diseases have made dramatic comebacks in unsanitary conditions with inadequate food.

1.3.4. Loss of Fitness

Fitness is the ability to function under normal environmental conditions. Stress, obesity, illness, weak sperm, social conflict, and other kinds of dysfunctions, can reduce fitness. Some of this reduction, evidence of poor personal or reproductive health, is caused by chemicals, especially persistent chlorinated organic chemicals. Some of these chemicals also reduce our ability to reproduce, raise young, make good decisions about consumption and social conflict, and to persevere in general. The cost of fitness ranges from lower fertility and sperm viability to early death. However, a lifestyle dependent on physical and energy slaves, not to mention a diet riddled with addictions to cheap fats and sugars, decreases our fitness. As human populations expand and shift to cities to live, they are losing the ability to fit with natural ecosystems.

1.3.5. Loss of Equity

Although many resources are distributed unequally over the globe, as a result of different kinds of historical geological processes, trade can allow shared access to those resources. However, as a result of long-term processes of inequity, from keeping people enslaved to cultural hoarding, many people have far less than others. This has resulted in permanent overclasses and underclasses, which are maintained by physical force, as well as by the force of economic and religious myths. These myths tell all people that they participate in the “best possible economic system” regardless if it justifies the differences of inequity based on history or on perceived racial abilities. Continued growth is amoral and pathological, benefiting the elite of authoritarian regimes as much as the oligarchs of democratic ones. It refuses to recognize, much less to pay, all of its costs, such as depletion, loss of security—which may be most important—or extinction. The entire system perpetuates mass poverty and justifies it by blaming individuals, but the system itself fails to reduce inequity or poverty.

1.3.6. Loss of Renewal

Self-renewing systems renew themselves through a process of renewal—the definition is self-defining and circular. But, renewal is limited when too much of the system is lost through waste. Manufacturing for a large population in “free” economies results in the mass production of waste, and in the storage of solid wastes in landfills. The waste is unavoidable in the current system, which is unable to renew itself and has to force a linear flow, trusting that natural recycling systems will be able to adjust to immensely higher volumes. Much loss in the current economic system is wrongly identified as waste. It is simply not economical to recover the waste from this system, due to the volume of “free” resources and goods from nature. People themselves are treated as a waste product of capital-producing system, although the system could be viewed as a waste-producing system that also makes capital.

1.3.7. Loss of Accord

As a result of the unequal distribution of natural resources, including unincorporated waste and pollution, and the unequal distribution of materials and wealth between people, economic conflicts arise, often becoming violent political conflicts. Accord, by definition, means agreement or the concurrence of will or action. It can mean harmony of mind, as well as harmony of sounds. As an agreement between the parties in a controversy, accord allows people to reconcile their injuries and interests. As the rules change, and conflict includes noncombatants, as well as plants and animals, there is less accord between conflicting groups. Accord requires the ability to trust, which requires self-reliance and confidence. The loss of accord leads to other related losses.

1.3.8. Loss of Design

During the evolutionary development of human responses to environmental challenges, people tested many kinds of designs for their tools, houses, and living habits. These initial designs often worked well in situations of limited resources or limited power. With the application of more power and the acceleration of the interchange of dominant designs, we have been able to force standard designs to work under almost any conditions, often replacing locally adapted designs. Many of our current problems are design problems, Victor Papanek judges—that is to say, bad design causes all varieties of suffering and waste; it causes death, from accidents or collapses, and it causes immense waste by relying on power to overcome its flaws. Other problems are caused by human demands and the design response to them.

1.3.9. A Bad Combination of Losses

All of these problems interact, so that it becomes difficult to isolate separate problems. These long-standing problems result from long-standing challenges to human health and happiness: Food shortages, disruptions in distribution, violence, stupidity, greed, forgetfulness—not just personal forgetfulness but larger forms of cultural amnesia, old diseases and new, lust for power, and the lust to consume. These problems result in the death of many individual plants and animals, as well as entire species and whole habitats and ecosystems.

People die for many reasons: Environmental catastrophes, such as earthquakes, accidents, old age, lack of food, diseases, or personal violence. We know that people also die “indirectly” as a result of the destruction of natural ecosystems, specifically, as an example,

the lack of clean, drinkable water. People die for economic reasons, such as not having a job to afford food, or not having a place to live, as a result of war or dislocation. It is almost impossible to calculate how many die in each category. It is difficult to say how many die directly from hunger, since hunger leads to disease, such as pneumonia, and disease gets the credit; or, how many die from unclean water, since the contaminant or the accident gets the credit. It is also difficult to calculate deaths from theft, economic dislocation, lack of planning, bad designs, or depression. Only specific diseases, accidents or bullets seem to be unambiguously fatal, and even these are often causally linked with other contributing factors. We need to use better tools to understand and solve these problems, as well as to understand how a cosmology or economic system can promote problems yet fail to solve them.

1.4. [Empty Topic]

1.5. *Grand Thefts* (Converting, Stealing, Killing, Destroying)

Despite our bigness and speed, most of the world's human population goes hungry; even fewer are fulfilled as actualized human beings. The utilitarian aim of greatest good for greatest number has been vulgarized to mean the greatest number of goods for those who can afford them. In our attempts to manufacture the good life for those who can afford to buy it, we have deprived everybody of clean air and water, quiet nights, darkness, open spaces, and other indefinable qualities. Soils are destroyed, wildlife is killed. We devour nature to assuage our disease; we try to fill our emptiness with goods. We can only gain past a certain point before our gain causes the loss of something else that we need to be healthy.

Modern technological society ravishes nature and mutilates humanity with the products of its materialism. Industrialization has distorted people's lives and cheated them of bread and justice. Oppression darkens the mind and narrows the spirit. In a mass consumption society, people impoverish themselves spiritually while impoverishing others materially. This is theft. As with the Christian ten commandments, most loss can be reduced to theft, whether of a life, mate or name. Most of our modern problems can be considered the consequences of forms of theft, such as of life, common sense, and finally choice.

1.5.1. Theft Of Life

The relationships of humans and animals have changed drastically. The increase of humans and the destruction of animals have unbalanced the relationships. The destruction of habitats is accelerating. Up to a point, niches can be enlarged or increased, but with so many humans, it becomes a case of supplanting other species entirely.

In developing countries, hundreds of millions of rural people strip the trees and shrubs around their homes for fuel. In Gambia, it takes 360 woman-days per year per household to gather wood. Even when firewood is available for sale, it may be beyond the budgets of the poor. In South Korea, it can cost up to fifteen percent of a household budget; in the Sahel, it can consume twenty five percent of a budget. When wood is scarce, the poor are forced to use millions of tons of crop waste and dung, which should be used to regenerate soils. The poor are destroying their means of survival, in order to survive now. Then, the soils on which they live become even more vulnerable to erosion. Deforestation causes siltation, which cuts the useful lifetimes of reservoirs in half, decreasing hydroelectric and water potential. Deforestation causes floods, which devastate settlements and crops, incurring even greater

replacement costs. Lack of soil and forest conservation contributes to rising energy costs and the financial costs of providing essential goods and services.

Tropical rain forests, genetically the richest land environments on earth, are being felled and burned at the rate of 27 million acres a year—50 acres a minute (in 1972). At that rate there will be no more tropical forests left by the year 2050. The lowland forests of Malaysia, Indonesia and the Philippines are being ravaged the fastest. The rape of the tropics is endangering hundreds of thousands of species. Over 25,000 known plant species and over 1,000 species of mammals, birds, reptiles, amphibians, and fish are threatened with extinction, as their habitats are eliminated. Many of these species may be economically and culturally important; others are different and unique. Unknown species, perhaps half of all species on the planet, are not valued at all because of our ignorance.

Even the ocean is not invulnerable to human impacts. The most productive areas, which are close to shore, are being polluted, overfished and destroyed. Estuaries and coastal wetlands are being destroyed. Overfishing has deprived people of millions of tons of seafood. Overfishing is destroying the fisheries' support systems. In the U.S., losses to fisheries from shore "improvement" and degradation cost \$86 million a year.

1.5.2. Theft Of Common Sense (& Humility)

The industrial machine is out of balance and defective, but we have been making it run faster to process more material. Western civilization still selects cultural changes in terms of wealth and power. This is destructive to most individuals, as well as maladaptive for a society under ecological restraints. Over the past two centuries, industrialized countries used great quantities of raw materials to create luxuries. Then they disseminated the ideas of wealth, equality, opportunity, and indulgence to many countries without industrial opportunities. There can be no peaceful future for civilization when such disparities, and popular knowledge of them, exist. The cult of competitive consumption seems to be the universal solvent of the modern world. Everyone wants what some have. The industrialization of Asian nations is seen as a solution to shortages of manufactured consumer goods, although imbalance and pollution are down-played. Even worse is the unavoidable waste. Probably over fifty percent of the productive effort in United States goes into making things which contribute nothing to the material standard of living.

Consumer desires must be satisfied promptly or despondency results. Although life, art and science depend on organization, the civilized consumer feels that organization implies stasis and death. Believing the line of succession ends with his claiming of the inheritance, the industrial consumer feels no obligation to provide for the next generation. The consumer justifies narcissism as a preliminary condition in the search for consciousness, truth and morality. Consumers become embroiled in their own causes, locked in the idealism of adolescence, and repudiating the lessons of history. Hegel noted that the greatest lesson of history is that nobody ever learns the lessons of history. Americans and the people of some other nations seem intent on validating this insight.

This repudiation of history creates a historical amnesia. Consumers retain little more than a dim notion of the past. Universities report a lack of interest in events that occurred before the current year's athletic season. The sense of time falls in upon itself, collapsing like an accordion into the present. Knowing nothing of history and expecting nothing of the future, people cannot escape the fearful isolation of the present. They join together in a melancholy

herd, clutching at everything, but holding nothing fast.

Even good eating habits can be forgotten in quickly. The eating habits of many people in industrialized countries are unrelated to nutrition. There is no instinct for good nutrition; it is a kind of empirical learning from trial and error, although young children are often good choosers. As South Africa became colonized, for instance, the natural diet of Zulus changed from millet to corn. Malnutrition also resulted from this overdependence. Yet after a generation, tribesmen thought they had always eaten corn, even though their ancestors were stronger and healthier than they are now.

Without the depth of history, experience is shallow and short, and intelligence is thin. Technology has reduced the globe to a single, closed system, which humans can share according to their financial powers. Our direct experience of the world has become shallow, in spite of faster travel. Travel used to broaden the mind, but now it narrows it. We travel in sealed corridors like boxed goods, comforted by homogenized foods and the English language. Our cultural adaptations to the pressure of homogenization throttles individuals and groups.

John Fowles observes that most of us remain firmly medieval and distanced from what we cannot own or fully control. We assess most of nature as what is not clearly for us must be against us. We cannot accept indifference, the nonhumanity of nature. We seem incapable of realizing that the destruction of the Amazon, much as we deplore it in its remoteness, is our responsibility; we consume the materials from tropical forests. Our growing emotional and intellectual detachment is the greatest threat to nature. Heroic narcissism has replaced nature with humanity; nature no longer provides the mirror to reflect human aspirations—a television screen does. Narcissism is a threat to nature and humanity.

Unbridled consumption in a laissez-faire economy for fifty more years will probably carry humanity beyond a point of no return, leaving industrial society with insufficient resources to maintain itself and insufficient flexibility to retract. If lack of planning permits rapid increase in population and consumption, then our options may be diminished to two: A nasty, overplanned existence, or a squalid collapse. But the future seems as unreal as the past. The historical origin of the ecological crisis is in the failure of people to use their intelligence to anticipate the long-range consequences of their activities; this is a perennial problem.

1.1.6.3. Theft Of Choice

We follow false models. Our civilization is dominated by all of the ideas of the industrial revolution, which form the outlines of a tragic world view: The primacy of humanity, anthropocentrism, the supercession of the individual, the achievement of happiness through the accumulation of things, the perception of the incompetence of nature, the requirement of humans to control the environment, the expansion of the frontiers of technology and opportunity, and, the identification of solutions for every problem. But, these ideas are false; programs that assume them for conditions are doomed to fail eventually, and perhaps destroy the kinds of environment that humanity needs. Cities and factories reproduce themselves exponentially through a industrial genetic code. They are the addicts' dream of affluence using science to create a dream pill from the dust of a bare earth. But, simply removing the causes of unhappiness may not produce happiness.

Industrial culture has been distorted by the modern emphasis on the scientific method, with its devaluation of philosophical concepts and emotional values. Rational values are exaggerated and spiritual events are ignored or suppressed. Most scientific studies

seem specialized or irrelevant. Some parts of problems are identified and analyzed, but the conclusions are trivial and weak. The ethical impulse to solve the problems is even weaker. We choose to let them slide, or to label them as nonproblems.

The unified direction and responsibility of science is nonexistent; there is not even a concept of what is good. Control has been the goal of science and technology. Scientists are obsessed with the treatment of weeds and vermin. The scientific view has put humanity at war with the planet, which always misbehaves; weeds and vermin are perceived to threaten us. Stability has been raised to a sacred scientific state. Our path has been worn so deep, it would be difficult to leave it. The interlocking of technologies and institutions makes it impossible to reform policy in any one part, separate from the other parts. This interlocking also makes people powerless to choose any alternative. The systems managers are preparing to operate the planet, according to systems principles applied to routine methods (mixing good principles, bad methods and inappropriate scales); they are making the decisions for everyone.

The safety of the environment is too important to be left to scientists, even to ecologists. The crude history of science shows that scientists fall willingly under the dominion of money and power, like Christianity, communism, and most movements. The actions of narrow science and industrial politics reduce the possibilities of choices.

1.6. *Model Fields as Context*

How are we to understand our situation, with its challenges and problems, thefts and losses? We can start by placing things in their larger physical and ecological context. We can describe them as being in a field, whose properties can be related to those of human culture and the practice of design.

The universe at large, with its clusters of galaxies, clouds, stars, and planets, extends itself through space and time. Parmenides held that space was a plenum. On the other hand, Leukippus conceived of space as emptiness. The physicist David Bohm combines both ideas in the concept of a field. He describes the universe as a field with waves of infinite size. The universe is permeated by septillions of waves at all times. A wave is an integral pattern of the physical continuity of a particle. Waves shape the field, that is, they excite the field. The field is an invisible, nondetectible source from which elementary particles draw order and energy. There is no place for both field and matter, “field being the only reality,” according to Einstein. The field here and now depends on the field in the immediate neighborhood at a time just past. Excitement is generated with a temporal dimension. Humans generate their own waves that are added to the infinite variety coursing the universe.

The field concept was originally introduced by Michael Faraday into studies of electricity and magnetism, and was expanded by Clifford. The field concept is central to the unification of theories of light, electricity, and magnetism. Einstein extended Clifford’s ideas of the field in his theories of relativity. In large systems, time acquires a new meaning associated with irreversibility. The classical mechanical concept of time results from simplifications. Einstein induced that time is relative to the frame of reference. Space-time is an ensemble of occasions and places, held together by duration. The future and past are tied together by duration. To the largest duration—the universe—all time is present. Time is not empty or abstract. According to Einstein, every change of coordinate systems mixes space and time in a mathematically defined way.

In his *Special Theory of Relativity*, Einstein included gravity in the picture, making

space-time curved. But as massive bodies have greater gravities and mass can be converted to energy, all four perspectives form a field that can alter each component. Through the principle of equivalence of gravitation and acceleration and through the use of a symbol that mathematically described the local rate of ‘turning’ of the curvilinear coordinates, Einstein was able to relate curvilinear order and measure to the gravitational field. Both the electromagnetic field and the gravitational field can be understood as aspects of curvature. The particle affects the field only in its own locality. Particles move along paths that are intrinsic to curvature of space-time field independent of coordinate frame used for measurements (but not from the act of measuring). These paths are called geodesics and are the shortest distances between two points. Einstein’s 1907 principle of the local equivalence of gravitational and propulsive accelerations (geometrodynamics law) linked the two currents of thought from Riemann (“geometry is part of physics”) and Mach (“inertia is influenced by mass elsewhere”).

The physicist John Wheeler regards curved geometry itself as the building material of the universe. Gravity can be regarded as slow curvature; the electromagnetic field is rippled with different curvatures, and the particle is a knotted up region. Wheeler hypothesizes that a pregeometry is necessary because geometry fails to explain some events such as gravitational collapse. If one regards geometry as an abstraction from a moving Space-Time-Energy-Mass field (STEM), the pregeometry is the STEM field, the ground of being. The STEM matrix is a cosmic, transformable field. The STEM field is primary; time and space are secondary to the field that contains them. No one component is ontologically subordinate to another. The fundament is an immense multidimensional ground, from which orders are projected into a unified field. The STEM field is a meso-field in the universe; it vanishes at both ends as a knot dissolves into the identity of rope after being analyzed. Particles dissolve into identity with the universe. The field is a paradox; localities are part of it but do not communicate instantaneously, by light. The speed of light is still a limit for most communication, but not for the behavior of the field as a whole. Space is filled with local relationships. The limits of the array are undefinable. The STEM field has general properties, such as motion and autopoiesis (self-making).

1.6.1. Properties of the Field

A property is an attribute proper to a thing or characteristic quality common to all members of a class (by comparison, characteristics are qualities that distinguish unique individuals, systems, or patterns. Gregory Bateson calls them differences that make a difference). The properties of a field are shaped by the historical operation of the field itself. This means that these properties are reflected in different levels of organization.

Mario Bunge distinguishes three kinds of collective properties: Aggregate, structural, and global. Aggregate properties are often statistical, as in ‘the average age of the wolf pack is 3.9 years.’ Structural properties can be possessed by individuals or groups on the basis of their relations to others, e.g., high-tail is the daughter of nick-ear. And global (or emergent) properties are possessed by wholes, regardless of components, as in ‘the territory of the wolf pack is eighty thousand hectares.’ This property emerges with the system and submerges if the system breaks down. It is an emergent property if no component of the system has it individually. History, structure and stability are emergent properties of an ecosystem. Role and scarcity are not. The basic properties of a field, any field, are: Motion (process), autopoiesis (self-making), differentiation, integration, constancy, and development.

1.6.1.1. Motion as a Property of a Field

Nature, for Alfred North Whitehead, consists of patterns whose movement is essential to their being. These patterns are analyzed into events (or occasions). An event is a change of state. An event is described by two points, an initial and final state. A process is a sequence of states (also called history). Process is the dynamic change in an unfolding flow. Process is a fundamental feature of nature. A process creates a path, described by a trajectory of states. A process is described as evolutionary if it involves emergence and the creation of new things (general speciation; to be a species, however, the novelty has to reproduce itself or multiply or diffuse). The concept of state precedes the concept of process, although process can define state. In complex systems the past contributes to or constrains the state (from the magnetic hysteresis of ferromagnets to organisms, which have memory).

1.6.1.2. Autopoiesis as a Property of a Field

The field is autopoietic, that is, self-making (from the Greek), according to Francisco Varela and his colleagues. Autopoiesis refers to the dynamic self-producing and self-maintaining activities of living beings. The tenets of autopoiesis are presented in six principles: (1) Identity: Identifiable components are organized internally with structural boundaries; (2) Integrity: The self is a single, whole, dynamic functional system; (3) Self-boundedness: The boundary is produced by the system; (4) Self-maintenance: The boundary and components are produced by the functioning of system; (5) External supply of materials: Elements, such as carbon or water, are obtained beyond the boundary; and (6) External energy supply: Light or chemical energy from beyond the boundary is converted into organic bond energy. In an autopoietic framework, every being (or system) is embedded in a world and observed by an embedded observer.

1.6.1.3. Differentiation as a Property of a Field

The field universe is a vast order of individual events, discrete unfoldings within limits, following certain laws, but in unique patterns. Patterns of complexity shade and grade into one another endlessly. A large family of similar unstable particles can be classified phenomenologically in a complex set of interrelated orders. It appears to many physicists as if the beginnings of new orders of natural laws are being revealed, in which particles would be like flower designs on a carpet pattern, while something unknown corresponds to the structure of the cords of the carpet. In fact, orders reform in the 'carpet,' as John Wheeler suggests. Analyzing the world as if it were made of particles would be similar to analyzing the carpet as if it were made of flowers: It would give some results and have some predictability, but the metaphor would limit better understanding. Wheeler states that patterns in the 'foam' are seen as subnuclear particles. The foam can be seen as a metaphor for the self-reconstruction of the universe from standard parts to novel structures, through a process of metalysis, that is, the break-down of parts to form new structures. Order is measured through relationships. That which cannot be related to something else, i.e., to a curve mathematically, is referred to as disorder. In fact, Bohm himself states that order is basically a set of similar differences. Differences can be related to degrees of freedom. An order with more differences has more degrees of freedom. The macro-order limits degrees of freedom in underlying orders.

1.6.1.4. Integration (& Participation) as a Property of a Field

John Wheeler believes that since law, field and substance all exist after the theoretical big bang, the universe owes its existence to trillions of acts of registration. The phenomenon comes through an elementary act of participation by different observers. Wheeler asks if the universe might not be brought into being by the participation. Quantum mechanics strikes down the concept of the neutral observer; participation is vital. Wheeler noted that “To observe the electron even, the experimenter must shatter the glass—must reach in with instruments.” The quantum principle destroys the observer behind glass (in vitro). The universe is not the same after measurement; the observer becomes a participator. Einstein said that no event can be postulated without the presence of an observer; but no observer can see the whole system; and anything can be an observer or participant. A world without participants is impossible. The observer is part of a natural or social community. No system can exist without observers. Fortunately, nature contains many eyes. There are no lone observers. The autonomy of our social system goes beyond our individual autonomy; the knower is the observer-community. Humanity participates in the natural world, so human history is part of natural history. All beings participate in relationships that make up their worlds. Through participation, consciousness is released to a thing so that it thinks in the participator. Full participation removes the barriers of language or thought; “otherness” pours through.

1.6.1.5. Constancy as a Property of a Field

Bishop Berkeley proposed a bootstrap principle when he argued that the inertia of any body is determined by the distribution and masses of all other bodies in universe. Ernst Mach’s principle repeated the same idea, demanding the closure of the universe, to make it finite and bounded. The mechanical properties of space are determined completely by matter only in a space-bounded universe. In the bootstrap principle, the universe is what it is because it is consistent with itself; we are not free to sort out accidental properties and distribute them with various values among different universes. No properties of the universe, however, are fundamental; they follow from other properties in a web of interrelationships. Specificity can be a property of a path, what Whitehead named a ‘conrescence,’ and Waddington called a ‘chreod.’

1.6.1.6. Development as a Property of a Field

The loss from motion creates a sediment, which is history. Sedimenting is irreversible and gives direction to time. The sediment of the past is a given and different for each present. The ceaseless activity of being in history creates newness. Novelty is born from the womb (‘hystera’) of change. History is the result of this hysteresis process. The universe restructures itself constantly at a more complex level. The evolution of the universe is a history of the unfolding of differentiated order or complexity. Building up emphasizes structure and levels of hierarchy by joining systems from the bottom up. By comparison, unfolding implies an interweaving of processes structured at different levels. Evolution acts in sense of simultaneous and interdependent structuration of microworlds and macroworlds. Complexity emerges from the interpenetration of the processes of differentiation and integration, processes running simultaneously from top and bottom and shaping the hierarchy from both sides. Patterns of complexity shade and grade into one another endlessly. Reciprocal causal processes can increase structure, differentiation and complexity in natural systems, according to M. Maruyama.

1.6.1.7. Properties Across Levels

The properties of the field are modified by the operation of the field. Different properties emerge at different levels. For instance, stability at the ecosystem level is replaced by loyalty at the social and psychological level. It is possible to trace the changes in characteristics from the field to the ecosystem and then to place and society. All levels can be addressed as systems.

Table 1617-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
<i>Field</i>	<i>Ecosystems</i>	<i>Place</i>	<i>Culture</i>	<i>Good Places</i>	<i>Good Society</i>
<i>Process</i>	Course	Dynamicism	Conduct	Action	Method
<i>Autopoesis</i>	Self-making	Identity	Wholeness	Individuality	Extension
<i>Differentiation</i>	Diversity	Uniqueness	Flexibility	Richness	Variety
<i>Integration</i>	Construction	Investment	Adaptation	Conviviality	Cooperation
<i>Constancy</i>	Stability	Regularity	Endurance	Consistency	Loyalty
<i>Development</i>	Productivity	Renewal	Vitality	Health	Harmony

Animation and ecological value changes the differentiation of the field to the openness of the ecosystem. The addition of communication and cultural values to that characteristic of the ecosystem results in the richness of place. And, the addition of social values and awareness of a place leads to variety in that society. These six properties of a field can be related to equivalent properties in different aspects or parts of the field, from ecosystems to human societies.

1.6.2. Field Changes

Field changes result from the operation of the field. Some relevant changes include growth, breakdown, emergence, patterns, trigger, scale, and history.

1.6.2.1. Growth (Anabolic Change)

To grow is to come into being or to increase in size or in some other quantity such as mass or energy. The universe and its field grow from some unknown impulse (not explained religiously or scientifically). We have observed that the universe has been growing, as has our local solar system. Everything seems to grow. Gravity encourages accumulation of mass and energy in black holes. Everything tries to expand, to survive within serious constraints or limits or to exceed them. Why is that? Some metaphysical urge? Growth seems to be a primary thing, yet limited, from aggregation to organic size. A living body, for instance, produces many more cells than are needed, and then it corrects the excess by signaling some cells to die. A body also produces many more sperms or eggs than are ever used. In some cases, many more offspring are produced than ever can mature to reproduce themselves. Life seems geared to cycles of overproduction and correction.

The first growth of an organism is to fill out its form within the limits of its genetic possibilities. The most obvious aspect of form is its constancy in spite of growth. In some cases, growth is necessary to sustain the form. The growth of one part must affect that of all. Growth serves as a mechanism of evolutionary adaptation, by carrying out genetic instructions in an environment; but growth is also conservative and stabilizing rather than innovative and reorganizing. Growth, from fertilization, embryo states, birth, and maturity, represents

a homeorhetic process following more or less fixed chreods, programmed genetically and conditioned environmentally. Chreods must be like electron paths, multiply probabilistic.

In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancers and populations are constant or accelerative. Some economists assume that growth is limited to one of two kinds of growth, steady or logarithmic, but that is palpably untrue. Three particular causes of growth can be distinguished: Additive, an accumulation of more; replicative, an accumulation of more through reproduction; and mutualistic, where all agents change structure, as in meiosis in cell development.

1.6.2.2. Breakdown (Catabolic Change)

John Wheeler states that patterns in quantum foam are seen as subnuclear particles. The foam is more like the fabric of a dream. The foam can be seen as a metaphor for the self-reconstruction of the universe from standard parts to novel structures, through a process of metalysis, that is, the break-down of parts to form new structures. The quantum principle is only a principle. It is self-organized and virtually determined.

The process of renewal through breakdown by discrete units can be called metalysis (the neologism means ‘loosening change,’ from the Greek roots. The foam is a metaphor for the self-reconstruction of the universe from standard parts to novel structures. Metalysis is a technical term for the process of dedifferentiation in biology. It can also be used to describe physical processes like quantum foam or social processes like institutional revolution. It is used here to describe biological processes, such as metamorphosis, where changes are often so extreme that the organism constructs many specialized parts of the adult from cells set aside in the embryo and that are nonfunctional in the juvenile; these cells are imaginal disks, which are controlled by juvenile hormones. These rules work well with natural processes that operate in ecosystems. There is an operation of metalysis with nations as well. Through isolation and identity, people divide into cultures and nations. Nations have unified and disunified. The process of dedifferentiation is also forwarded by catastrophes.

1.6.2.3. Development (Complex Change)

Development means the introduction of an innovation. The evolution of matter, for instance, proceeds through a spiral process, as exemplified in the carbon cycle in stars, where a carbon nucleus captures four protons and emits them as an alpha particle at the end of the process. In some cases physical behavior depends on past history. Magnetic hysteresis is one case. Hysteresis is not confined to magnetism—structural deformation and colloidal behavior also may depend on past history.

The development of life since the Cambrian era displays a diversity of forms in an expansion of life into places that can only be described as ‘self-realization,’ according to Arne Naess, since it is far more active than the passive adaptation of self-preservation. This development is guided by reciprocally constrained construction. The organism and environment are co-implicative, co-defining, and co-constructing. They engage in a process of self-assembly, where the self is the organism/environment system. A biological organism grows to maturity, which is a stopping point for size. The organism continues to develop, however, experiencing and learning the environmental complexities through mating and then to the end of life. Development may include growth at some stages, but refers to the continued change after growth has stopped.

1.6.2.4. Emergence (Novel Change)

Complex adaptive systems display emergent behavior. As an example of emergence, slime molds can form a community without a pacemaker cell that determines when the cells need to combine. It seems that self organization is bottoms-up. Emergent systems are rule-governed, though; slime molds explore by adhering to low level rules. Individuals coordinate work, even if they cannot assess the global situation. Emergent systems are local; individual molds “think” locally and act locally. Random action serves to explore local space. Individuals pay attention to their neighbors, and patterns emerge from local activity. Simple behavior seems to work, with local feedback, and more sophisticated behavior “trickles up” to approximate a global perception. Mathematical analysis measures those behaviors with standards and converts them to numbers in an abstract space.

Emergent properties (or global properties) are possessed by a whole, regardless of its components, as in “the territory of a coyote family is twenty thousand hectares.” This property emerges with the system. History, structure and stability are emergent properties of an ecosystem. Role and scarcity are not. The emergent properties of organisms include discreteness (physical), genetic homogeneity, recognizable subsystems, the coordination of parts, irritability (response to a stimulus), and reproduction (genetic consistency). Of course ecological design should consider these properties as well.

1.6.2.5. Pattern (Constant Change)

A pattern is an arrangement of form of elements. Process applied to components yields pattern. Nature is composed of patterns. Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth’s orbit for example). Regularities in systems are patterns. Patterns can be seen in things or even cultures. For instance, laws of genetics are natural patterns; human customs are artificial patterns. Where the natural ratios of females to males are altered by female infanticide or other action, the pattern is semi-natural.

Paul Shepard describes living natural “objects” in terms of events that constitute a “field pattern.” Relations are not prior to objects; they arise together. The wasp and the yucca coevolve; they are not co-linked by prior relations. Furthermore, a specimen is more than the sum of its species’ relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. Because the STEM field produces life, the qualities of life cannot be separated from its physical qualities. While it is true that living subjects are at a different level of description than events in field patterns, they should not be treated as ontologically subordinate. All of the aspects of the field have equal status. This field determines the limits of any ecological field of activity, and no field of ecological activity can be described without taking the physical field into account. The field is living and intentional, as well as physical, and an ecosystem model must address intention or other emergent properties.

1.6.2.6. Triggering (Explosive Change)

Mario Bunge distinguishes two types of causal mechanisms in systems: Energy transfer, and a triggering signal, where the energy is far disproportionate to its effect. The triggering signals are small changes in energy that cause large changes in the physical or cultural output of energy. With a trigger, information guides energy use. The trigger mechanism applies to

simple phenomena, such as explosives, or to complex biological and cultural phenomena. For instance, there does not seem to be a single trigger for El Nino. One trigger has to do with water overflow and then back flow from the western pacific; others may have to do with sunspots, which would reduce radiation, or volcanic eruptions. Many of these atmospheric, oceanic and geophysical triggers may converge. Nineteenth-century famines may be correlated with ENSO events that influenced China, Indonesia, Brazil, and southeast Africa.

In a way, culture is like a trigger. It allows bits of information to activate the system. And, this is the only way to increase information handling, when the system is larger and more complex—of course, this is what stereotypes and metaphors do. Leaders or chiefs can give signals that channel energy into large projects. Population growth triggered competition and conflict, which lead to positive feedback of the thing that caused the stress, that is population growth and conflict. Art can be a trigger for change (or explosive decompression, to continue the weapon metaphor). The metaphor itself is compressed information that can be uncompressed by the receiver.

1.6.2.7. History (Irreversible Change)

History is a sequence of states. In complex systems, the earlier state, also called the 'past,' contributes to or constrains a subsequent state, such as the magnetic hysteresis of ferromagnets or the behavior of organisms having a form of memory. The ceaseless activity of being in history creates newness. Novelty is born from the womb ("hystera") of change. History is the result of this hysteresis process. Motion, Version, Scension—all together form the ontological spiral of being/environment. The motion of the field creates a turning, which leaves a history, out of which patterns arise. Scension is a precession of motions, resulting in directional change—evolution. The transformation is a historical expression. Perhaps some of the problems attendant in scientific inquiry arise from the inability to take into consideration the complex history of a particle (compare Heisenberg's uncertainty principle). Nature is unpredictable. Its fuzziness is due to indeterminate states—indeterminate to us, who have limited perspectives in a local system.

1.6.3. *Living Fields*

Field theories in physics provide for continuity, in space-time, for instance. Charles Sherrington developed a field theory of subjective space. He distinguished between exteroceptive, interoceptive and proprioceptive fields; the exteroceptive receptive field was coextensive with the body surface and richer in receptors. These elements comprise a biological explanation of subjectivity. The subjective field is characterized by a broadening of lived time. This extension includes the lengthening of responses.

The subjective field of self is parallel to Kurt Lewin's concept. The self is a creature committed to a specific association, a genome plus place; the fitting of self to setting is partially definitive of both. Place/person/act are as indivisible as the physical STEM field. Lewin thought that the psychological fields joining the personality to its life-space, the immediate environment, and life-space to a larger environment, were strong enough to alter objective facts, that is, to make them normative.

Lewin was willing to study the objective factors that were potential determinants of life-space. The organism's own world is usually left out of consideration by Psychology. Ludwig Binswanger broke the life-world into three interrelated modes for human beings:

umwelt, *mitwelt* and *eigenwelt*. The first refers to world of natural objects (environment); it is approximately equal to von Uexkull's idea of *umwelt*; the second to the human alone, the interrelationships of humans; the third is one's self-world (equal to a thought world). The same division could be made for animals, but would be more difficult to describe.

Lewin's life space combines the *umwelt* with the life-world (of Edmund Husserl). Topology provides the mathematical model for Lewin's representation of psychological processes. Topology is a geometry in which spatial relationships are represented in a strictly nonmetrical manner. Lived space requires a three-dimensional representation. It may be horizontal or vertical. The horizontal dimension requires reciprocity; it is an intersubjective domain. Older cosmologies balanced the horizontal and vertical, but unbalanced cosmologies exhibit problems. New mathematical treatments of fields tend to be three-dimensional. Rene Thom's catastrophe theory and Conrad Waddington's epigenetic landscape are two such theories. The epigenetic landscape field can be used to explain why chickens rarely walk around a fence to get food. Often the chicken's need chreod is deeper than the path of a cognitive chreod around the fence, so the chicken can only go toward the food. If the need chreod is too deep, it cannot explore first with its cognitive chreod, where a less hungry chicken could. In humans, this explains why necessity cannot be the mother of invention; the broader landscape of leisure is needed.

1.6.3.1. Field of Person

Our direct intuitions of nature tell us that it is bottomlessly strange; it is alien, yet beautiful, and ruthless, yet gentle. It has innumerable modes of being that are not human modes of being. It is always mysteriously impersonal, unconscious, and immoral; sometimes we interpret it as hostile or sinister. Although we can intuit the interdependence of nature, we sometimes mistakenly conclude that our skin is the boundary to ourselves. We extend tentacles of personality to other things and people. As Whitehead pointed out, everything prehends everything else. The human skin is a delicate interpenetration, like a pond surface, according to Paul Shepard. The skin's interpenetration links a living field to a larger field.

What is impaired in the absence of a rich ecology is the individual's knowledge of self, not only as a person, but as a member of a species. Harold Searle's thesis is that the environment constitutes one of the most important ingredients of human psychological existence. There is within the individual a sense of relatedness to the total environment or field.

A deep relationship with a place is as necessary as one with other people. Without such a relationship, existence loses much of its significance. A range of experiences can spring from a place, from depression to the peak experiences described by Maslow. Then there is the opposite feeling, the dullness of place, where everything becomes oppressive and life becomes tedious. Drudgery is part of a commitment to place; it is acceptance of restrictions. The word nostalgia was coined by J. Hofer (1678) to describe an illness characterized by insomnia, palpitations, stupor, fever, and persistent thought of home. The disease could result in death. Thus far, the sense of place cannot be gleaned from an analysis of the nervous system. Yet a place shapes the nervous system, somehow, until it becomes a necessary part of health.

1.6.3.2. Field of Place

The making of places from undifferentiated wilderness is the living ordering of the world into places. A place changes qualitatively as it becomes structured. Natural complexity decreases as the human increases, although the two are not mutually exclusive. Places are ecosystems intimately associated with living beings. Fitness is achieved after progressive reciprocal adaptations; it requires a stability of relationships between societies and the place.

The specificity of place is important. The earth extrudes itself into particular plants and animals; flexes mountains; and sweats weather. The spirit of each place may remain to influence successive generations.

Ecology relates to at-homeness; a dwelling in the neighborhood of its source. A. Portmann observed that insects and animals displayed a powerful attachment to places, that was best understood as home. The attachment to a place is rootedness. Human beings exhibit a fundamental ambiguity of existence. Some feel strongly about a place or home; others never do. We need only to reciprocate and be available; to be and let be; reaching out and being ready to receive the other—any being. But home is also an enclosure, a place for protection and privacy.

A place is a part of the environment claimed by feeling. Emotion binds together motion and perception. Emotion can transcend distance. Emotion creates an ‘in-place.’ It must be made. Home requires rootedness, at-easeness, and regeneration. Von Uexkull described the importance of rootedness in his concept of the lived-world (*umwelt*). Feeling at home is a state of awareness; losing the feeling may cause crises. A house is a place that provides shelter; it answers social needs; it is a repository of memories, a field of care. For the private self the house is a world; for public selves, the world is a town or civic center.

The ecologist Neil Evernden asked what does it do to a person to see his place, his context, destroyed? What does it do? It creates violence and apathy. After such destruction, modern populations become rootless, moving about from city to city. We are suffering from a placelessness, which arises from our style of efficiency and proclamation of mass values. The environment of few significant places becomes a flatscape. It is turned into uses. John Fowles states: “We shall never fully understand nature (or ourselves) and certainly never respect it, until we dissociate the wild from the notion of usability—however innocent and harmless the use.” Fowles continues, “This uselessness lies at the root of our hatred and indifference toward it.” Wild places have no use; their value is their unique existence.

2.0. Approaching Regions with Design

How can we approach a region as a whole? Scientifically? Technologically? Aesthetically? Any region is relatively old and large, with a unique history and dynamic ecosystems. There are ways of dealing with regions that are not scientific or technological; they are aesthetic or ethical. To examine something that is larger than our logic or perception, we need a different approach. To examine nature in general, we must shift to a taoistic approach, asking rather than telling, and observing rather than manipulating. We need to be receptive and passive, rather than active and forceful, and nonintruding and noncontrolling, instead of pushy and manipulative. A taoistic approach stresses noninterfering observation rather than controlling manipulation; it is receptive rather than forceful. This is part of the paradox of duality; it is detached yet concerned, free yet committed, and independent yet responsible. Perhaps the Taoist is another path to objectivity with greater perception.

We are skilled at iconic perception and aesthetic perception, but seem unable to use a double perception. Aesthetic perception offers a reassuring vision, which interprets or identifies nature—we need a naive vision, which surprises, shocks, fascinates or seduces the senses, which awakens desire and stirs the imagination, and which furnishes a feeling of the invisible. Iconic perception offers a cognitive view of a region in the planet that reduces a region to the limits of logic—we need a holistic view, compounded with the unconscious and feeling.

Nature is an extremely sensitive nexus of means and ends. Nature is a feeling system. We need a new animism to approach nature, the understanding that perception is part of feeling. This animism would allow us to behave “as if” nature was intelligent and sensitive, and as if we were loving and wise. Loving perception provides kinds of knowledge not available to nonlovers; this is especially true in ethological literature. Abraham Maslow cites his own work with monkeys. K. Lorenz, N. Tinbergen, G. Schaller, J. Goodall, and M. W. Fox have found it to be true. This is the way a good psychotherapist, teacher, scientist, parent, or friend functions. And that has to define our approach to the planet.

We can apply designs to regions on many levels. We are doing so accidentally now. But, the designs have to consider the limits of a region, as well as limits to the human enterprises. We might start by designing ecosystems, artificial ones on a small scale, for the express response to problems caused by inappropriate scale, interference and waste disposal.



Figure 20-1. Silk Road through Iran (Satellite view)

2.1. *Human Design & Regions*

Humans have designed many things, from tools to trade routes. And, we have changed many different ecosystems to be more productive for us. But, we have not attempted to design humanity and its influences as a system, or regional patterns of changes.

2.1.1. *Why Design?*

Why should we need to design regions in the planet? They are self-making, self-managing, and self-renewing. What can human design add to that? As a young, exploring innovative species, we have added diversity and interest to other living forms. We became hosts for many new parasites and types of bacteria. Our feeding patterns encouraged other species, which did not taste as good to us, to compete successfully. Other animals and plants found us useful to live near. As an older, confident, successful species, we started to convert ecosystems to what we wanted. Now that we are self-satisfied and arrogant, we find that we are influencing every natural system, taking what we need from some ecosystems, enhancing a few, misusing others, and interfering with the rest; we are creating patterns that we cannot control. So, what can we do? We can control ourselves, we can control our influences, and we can abstain from trying to control every variable in a system and every region in the planet. That may be the concern of the design of human limits.

There is no guarantee that nature can provide humans with everything they want. Recognizing the lack of guarantee is simply recognizing that nature is wild and we must come to terms with nonhuman beings and processes. It is not enough to arrange trees in rows to maximize future harvests; it is not enough to preserve small areas of old-growth without natural disturbances. We must pay attention to the processes that make up the habitat, for example, the role of herbivores on trimming vegetation (and diversifying it by predation). The design of an ecosystem and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved; an ecosystem cannot be considered outside of the context of the entire landscape, including human institutions and structures.

We need good ecological designs to restore the balance between human needs and natural processes. Ecological designs focus on whole communities that work in the same self-renewing and self-limiting ways as nature. By consciously creating meaningful order, we can develop ways of producing widespread community wealth while positioning the community for a long, productive future in a healthy environment.

What are we considering when we talk about the design of regions? Should we build new islands or paths? Restore species or guilds that have dropped out or become extinct? People often discuss solutions to regional problems, such as deforestation, that would entail massive planting programs across continents. These technical aspects may also be the concern of a design, but the design has to consider all species and their timing and patterns.

2.1.2. *What is the Regional Level?*

What does the word regional mean? A regional system, for instance, has unique characteristics that emerge from local interactions. What does it mean to be regional? These terms are terms of scale, used to describe a field.

2.1.2.1. Use of the Field

The concept of the field allows many things to be related internally and connected by scale. These operations of the field scale to other aspects of the field need to be addressed by designs on various levels. These properties of the field are important to design because they must be considered if the design is to be stable and useful. Regional design has to address these properties to be successful as design. Regional design has to consider the emergence of new characteristics and the qualities of patterns, especially those related to connectedness and scale.

Regional systems properties are a set of constant constraints on local systems. These differences will have important affects on regional ecological design, especially at the level of the planet. Cultural systems develop patterns (especially as related to design): Paths, Nodes, Networks (hierarchy), Fractals (Explosions Implosions, traps), Spirals, and Cycles; These can create problems with feedback to regional design (if there is not enough feedback or none).

2.1.2.2. Regional & Local Scales

Differences in scale are often called local or global differences (in systems theory). Concepts of scale apply to physical and biological fields. Local fields or events are those separated from other fields or events and exert minimal influence on the others. That is, the internal connections inside a local field are stronger than the connections between local fields. Both quantum theory and relativity consider that local fields are generally noncausally and nonlocally connected—that is, no communication is instantaneous.

Local systems create a regional system; at the same time local systems emerge from a regional system, which has characteristics that emerge from the interplay of local systems. Regional systems have properties that no local systems have, such as an overall climate or global biogeochemical cycles. James Lovelock suggests that the interaction between hardwood forests and softwood forests may act as a global regulator of oxygen for the entire planet. Many things, such as human poverty and species extinctions, only seem global because they are happening in many local systems at the same time, and may effect regional cycles.

Local fields have characteristics that distinguish them from the regional fields. Local fields can be characterized by: Separation, limited influence, disjunctiveness (the future is not like the past), reflection of local conditions, contribution to the regional, and territoriality. Separation refers to location in the regional field (space-time), as well as having different make-up and different environment. The local is independent of other local fields. Local properties may not determine the variables in other local fields. Having a limited influence means that there is often a weak connection with other local systems, and sometimes little effect on the global. A local field has an immediate effect on only a small fraction of the totality of parts of a regional field. A local system reflects local conditions. Of course, local systems can create regional ones, as well as affect them. They develop historically. In this case regional fields have similarities with local fields.

Regional fields can be described as: Emergent, with new properties; internally organized; constraining the local, affecting all locals, and independence from any local. In general, regional systems emerge from local systems; they have unique properties that local systems do not have. The properties are not repeated independently in local systems. Often the properties are too interconnected to be independent. Ashby uses the example of chemical and biological reactions that form protoplasm. Properties are emergent if they are not predictable

from the analysis of local systems. For example, hydrogen and oxygen are gases; under certain circumstances, they combine to form a fluid, water. For another example, the tasteless gases hydrogen and oxygen can combine with carbon, in certain biological processes, and form a sweet, solid sugar. In a third example, amino acids, which can form as a result of volcanism in an early atmosphere of the earth, can be combined in living processes to make protoplasm, which is self-making; this new property is a surprise. The new emergent properties are protected from factors that could reverse or destroy them. Furthermore, they are not reversible due to historical development. The regional can organize local systems in internal relations (and have relations with an external environment). The regional puts constraints on the local; that is, it limits the actions of local systems. The regional has connections to all local systems, even those that have no connections to other local systems. Regional change affects all local systems. But, a regional system is independent of any local system; the local may have minimal influence on the regional. Regional systems develop historically. As regional systems become larger, when the range of size of part to the whole is larger, the properties of the whole are more likely to be very different than the local.

Table 2122-1. Local and Regional Properties

<i>Local</i>	<i>Regional</i>
Separation	Connection
Limited influence on other locals	Affect on all locals
Reflection of regional influence	Constraint on local
Disjunctiveness (future different)	Internal temporal organization
Contribution to regional	Independent of any local
Limited by regional	Emergent properties from local

The regional level has many more kinds of feedback, as it consists of many more subsystems. Furthermore, the rate of feedback is expected to be much slower. This means longer times and longer lag times or delays. Laws defining constraints on the whole cannot be derived from the laws of parts. Regional systems properties are a set of constant constraints on local systems. These differences will have important affects on regional ecological design.

Switching our attention from a focus to the larger frame usually involves a change in scale. Scale has several meanings. Basically, as it is used here, it has to do with the level of measurement in a space/time energy/mass context. For instance, in forestry the measurements of leaf litter by foresters can be made at several scales: Single tree, stand, annual measurements, or stand life measurements. Processes that are unimportant at a small scale might be vital at a large scale. Too much litter by one tree might be unimportant, but too much litter in one stand in one year, for instance, might suppress a soil cycle; too little litter over a century might interfere with several regional or global atmospheric cycles.

Because the region is a unique whole, regional design has to address the uniqueness of the whole, the special emergent properties of the whole. For example, it makes no sense to discuss the amount of CO₂ in the atmosphere without paying attention to the carbon, oxygen and water cycles—or in fact, any cycles, ecosystems, or organisms that impinge on carbon dioxide—or in fact the deep history of the atmosphere and planet, as well as the structure and function of the atmosphere.

All the layers and processes within the whole are subject to restraints and limits on the

whole. The whole is not equal to its levels; it is more than the sum of the levels, to sharpen an old saw, so to speak. The region moves and develops as a whole, subject to planetary constraints. The whole system maintains its identity through continuous self-making, or through autopoiesis in the words of F. Varela. The system develops through a continuous dance of autonomy and control. By reducing the study of the planet to the chemistry and physics of a subwhole, or holon, science can lose sight of larger emergent patterns.

The framework of our thought has to be concerned with the whole idea of regions in the planet, bound up in living patterns. A coherent, flexible framework can provide the context for the problems of atmospheric warming or extinction pulses. The organization of our thought requires the vision of the whole. Our efforts have to be directed to the good of the whole planet.

2.2. *[Empty Topic]*



Figure 22-1. Agricultural Terraces in Indonesia

2.3. *What is Natural Design?*

Poets and biologists often look at patterns and events in nature and express appreciation at how well nature designs things, from eyes to sunsets. But, we have to ask, is it design? Does nature design? Does life design living beings? What about self-designing systems? Does nature really design forests or streams? Perhaps we should say that nature is self-organized. The self is a scaled phenomenon. The small self is organism-centered. The larger self is part of a self-organizing web. But, self-organization is not self-design. Are living beings designed? Nature obviously produces complex beings over long periods of time, and it does so in a way that has been referred to as design by people for several hundred years at least. It seems possible that motion, over time, at various scales, results in greater complexity of elements and arrangements, automatically resulting in living beings. This process takes place in a changing biophysical environment, as a form of ecological play, complete with system economies and with living values. The process of nature is described in those four categories.

More complex kinds of patterns, such as the circular pattern, suggested by the myth of eternal recurrence, depends on regular repetition, as with the seasons. It allowed disintegration to be replaced by regeneration. The helical pattern is innovatively cyclic, and the cycle is additive and seems to reach a higher stage with each repetition. Finally, there are nonlinear patterns. These seem to have more surprises due to the acceptance of complex nonequilibrium systems. They may evolve in a definite direction, but can do so by leaps and turns.

Of course perception is a large part of patterns. And, we perceive the direction as being towards more complexity and more integration, until we have a global society, coordinated on several levels, within a more complex biosphere.

2.3.1. *Natural Design?*

The patterns of nature form due to the characteristics of nature. These characteristics can be grouped according to their human use, from the surrounding biophysical environment to valuing. Biophysical properties include self-making, self-patterning, form creation, wholeness, systemic, pattern processing, development, place generating, place responsive, dynamic equilibrating, and interaction limiting. At the ecological level, natural 'design' is nature-based, aggregating, trial and error processing, trial generating, novelty generating, reciprocally interacting, bottom-up organizing, physically restraining, process, and actually existing. At the level of economizing it is productive, interrelational, nested, interdependent, solar-driven, aesthetic, waste generating, free playing, and forming gigatrends. Finally, at the level of valuing it is living, fitting, harmony building, existing, learnable, adjusting, forming, and chaotic.

2.3.2. *Principles of Nature?*

Are there principles of nature? Can we say that explosiveness is a principle? Or intensity? We often describe design principles as being based on basic principles of nature, such as the principle of change. It might be more accurate to consider change a property of nature, that can then become a design principle or scientific principle. Nature is in flux, culture is in flux, everything is. The climate will change, the shorelines will change. Human understanding and behavior is changing. But, nature is also self-regulating—this is the principle of self-regulation. Nature has evolved to maintain its stability in the face of many kinds of disturbances from

planetesimal impacts to changes in atmospheric composition. Nature will continue to regulate itself even as human beings make dramatic changes. The danger is not so much that nature will collapse, as that humanity will lose those things that it values the most, such as cool air.

Nature seems to flow, which is necessary to the functioning of organisms as well as to the biosphere. Flow can only be realized through structure, however, a cell or an ecosystem. It is the problem of free flow or division by membranes. At each level of a natural system, from cell to biosphere, the units involved do more exchanging internally than externally with other units at the same level. Flow and division must be in balance.

Individuals in nature exist through separation, by walls, barriers or membranes, which means nonflow or limited flow. Barriers are necessary to maintain form and integrity of individuals as well as of ecosystems. By removing some barriers, such as releasing carbon that has been locked up for eons, we unbalance natural cycles. Even though ecosystems exist within large ecoregions, which exist within the biosphere, they need closure to maintain their integrity. At the level of local ecosystems, there need to be fewer closures, so that there is a flow of genetic information within a species as well as between species. Human activities have the effect of blocking the flow at local ecosystems, with asphalt and wires, yet increasing the flow between large regions with ships and airplanes—mostly the flow of pests and domestic species.

Nature exhibits error, or play, which permits diversity. So many things are thrown at the flow of life. There is not just a little error. Half of everything seems to be error: Billions of pollen grains, billions of eggs, millions of species. Transmission is not flawless or efficient, but it is generative of difference and diversity. The diversity of the current ecological world evolved through the breakup of Pangaea, which provided the distances and barriers to isolate species. Many other properties of nature, such as least action or complexification, can become the basis of principles.

2.3.3. *Summary: Natural Patterning*

Nature produces many complex patterns. Living beings create further complex patterns, but this is done without conscious design, without plans. Natural ordering of the world makes places from spaces. A place changes qualitatively; it becomes structured. Some change, such as growth or decay, is quantitative. Other change is qualitative, resulting in breakdown or formation of the entire system. Life is also a property immanent in an organization of molecules; and language emerges in a higher level of organization. New qualities that emerge at every step are unpredictable on the basis of the past; natural reality is creative. Nature is more like an artist than an engineer in this sense, that is, nature provides novel patterns that can be duplicated or reformed by living beings within nature.

The scale of nature is fundamentally different than the scope of any design. The time scale of evolution is measured in billions of years. The size scale of evolution is measured in trillions of living individuals. These scales permit any speed of operation of selection through reproduction and genetic mutation. Nature does not design at all in the human sense, limited by a single lifetime or even group longevity. Nature makes patterns that change, on many levels, over an immense scale.

2.4. What is Traditional Human Design?

Human beings have an ability, shared with many species, to alter their environments. They are able to reform natural forms and flows with their hands or with tools that have been made for that purpose. They are able to design the tools, as well as other larger objects and patterns, such as landscapes.

2.4.1. What is Traditional Design?

The word ‘design’ comes from the Latin word for “to mark” and means ‘marking off a pattern.’ Tracing lines can be inclusive or exclusive, but if the line is more like a membrane then it permits certain sizes and shapes of intrusion. The verb form of the word ‘design’ means to make a pattern or plan, or to intend for a purpose. A design is a purposive plan, which itself is a diagram in two dimensions. Design is a human project in which, as Oliver Lucas says, “visual and physical parts are assembled in order to achieve a specific end result.” A design can also be an orderly arrangement of parts in an overall pattern. Designers make visible creations from plans, using the resources available.

Most design is concerned with products, from magazines, clothing and toys to houses and buildings. Our designs are often shaped by the impulses of technological feasibility, assembled randomly in neighborhoods and cities. Of course, cities are the results of complex adaptive behaviors in response to environmental conditions. Cities are not designed as whole systems, with a few possible exceptions, such as Paolo Soleri. Landscapes around houses and buildings are often designed. But, large landscapes are not considered or designed. They are made up of individual patterns, such as farming and manufacturing. Sometimes the landscape is charming; other times it is not. The landscape is a common property that can be understood and integrated by perception. The loss of design is the inability to imagine, shape and build things that enhance life and safety; it is the inability to respond to changing circumstances. Too much of a world is overdesigned by professionals, according to Victor Papanek, with the result that design simultaneously ignores things that need to be design and creates further dangers with many designs.

2.4.2. What is the Difference between Natural & Human Design?

Design is creation for reproduction. Design is intelligent reproduction. Life is experience that continues by reproduction. Life is experiencing and reproducing forms to continue experiencing. Design is the production of forms for experiencing and reproducing.

2.4.3. The Principles of Traditional Design

In addition to the basic elements, structure and variations, design can be presented through a number of principles. Principles are fundamental rules or laws, based on the characteristics of objects or systems, that we can use to create images or models to meet stated objectives, that is, the goals towards which our actions are directed, such as a functional beautiful bicycle or a comfortable inspiring city park. Principles unify our images. Select principles are introduced briefly to show the depth and breadth of design.

The principles presented are derived from the typical characteristics of design objects. Characteristics are qualities that distinguish unique individuals, systems, or patterns—Gregory

Bateson refers to characteristics as differences that make a difference. From these principles, standards for design activities can be established. Standards are models or examples of quality or value, established by authority or mutual consent, which can be repeated as procedures.

The principles identified form the basic axiomatic truths of design. They represent the basic assumptions of the human world that guide the practice of design. These principles affect the arrangement of objects, elements or components within a composition. These principles, not exhaustive by any measure, state that any composition has to display: Proportion, Rhythm, Emphasis, Balance, and Unity.

2.4.4. Applied Design Stages

Traditional design proceeds in four stages. The first is to review the function or goal, asking what the composition is supposed to do or inspire, or whether it is to be a public or private composition. The second stage is to find appropriate materials. Some materials are better than others for certain purposes. Understanding the purpose, as well as the potential materials that can be used, insures a better design. The third stage is to create an outline or plan of the design, using elements and principles to guide the design. And, the fourth stage is to build the object. If a single object, it is given or sold. If it can be reproduced or mass-produced, it usually is.

2.4.5. Levels of Traditional Design

The traditional design process considers three levels: Components, products, and the community. Many cultures have found, released and used materials for tools and designs. The materials themselves were often the thing itself. Often, materials were melted, woven, or combined into specific objects or products, such as tools or chairs. The objects that were made were usually integrated into an order described by a culture, based on knowledge and techniques handed down through generations. These things acquired social value even when their utilitarian value diminished. Chairs, for instance, beyond being useful for sitting, can grant authority to the person sitting in it.

2.4.6. Summary: Design as Human Action

As a profession, design is a special self-consciously separate, economic discipline that adds value to human artifacts, and in fact distinguishes its objects from lower-quality goods. It is the separation of specialists from the vernacular design of self-sufficient people. Design is a historical process of the development of a profession. Of course, it can be regarded as more. Victor Papanek characterizes design as the “primary underlying matrix of life” and states, “All men are designers.”

The basic elements and variations apply to all kinds of design. But, as traditional design expands to ecological design and to global design, the number of groups and principles has to increase to reflect the larger scales and increasing connections. Heroic design and extravagance in life is needed. It is not contradictory or antithetical to frugal lifestyles or to restoring a healthy environment. Life is exuberant; energy is used, lives are lived and used, not saved. Life is the accumulation of individual experiences that cannot be saved, stored, or owned. Design is a way of expressing conscious life.

2.5. *What is Ecological Design?*

What is ecological design? Benign design? How is it different from traditional design? Is it different enough to justify more words about it? This is an academic question. Ecological design is, in Nancy Jack Todd's words: "design for human settlements and infrastructures that incorporates principles inherent in the natural world ..." David Orr defines ecological design as: "the careful meshing of human purposes with the larger patterns and flows of the natural world and the study of those patterns and flows to inform human actions." Let us take these ideas as a working definition and expand on them, by comparing ecological design to traditional design and 'natural' creations.

2.5.1. *Definition of Ecological Design*

As Lewis Mumford pointed out: All thinking must now be ecological. Ecological design has to consider the context and the long-term implications of any designed object. Van der Ryn has qualified design as ecological by stating that it "is any form of design that minimizes environmentally destructive inputs by integrating itself in living processes."

Ecological design has two meanings in this discussion. The first regards the connection of design to its ecological context, while the second refers to the design of ecosystems. In its large sense, ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity. Diversity, as in biological diversity, means species richness, different age and size classes in a population, and genetic differences in a species, as well as kinds of habitats present in an ecosystem and the kinds of communities occupying the habitats; and the kinds of ecological processes that maintain habitats; and the variety and richness of the planet's genetic heritage. Ecosystems that are designed so are healthy. A definition of health is the condition of being sound in body or well-being.

2.5.2. *Differences between Traditional Design & Ecological Design*

The four topics from the design matrix— Biophysical systems, ecocultural play, economies, and values —are expanded to highlight the differences between traditional design and ecological design. The characteristics of natural systems are also repeated with both kinds of design.

2.5.3. *Ecological Design Components, Elements & Variations*

Ecological Design builds on the basic geometric elements of traditional design, and it shares the same variations—number, position, direction, size, shape, interval, texture, color—as traditional design (see Section 2.4.3.2.), but there are many more occasions: Sand blowout and a forested tertiary dune, the diagonal lines of hills, the path of a corridor, the framing of a skyline by the shape of hills, a talus slope on the side of a mountain, the volumes in and around an Oregon creek, the shape of an agricultural field squared by a road, the texture of an old-growth forest compared to a young tree plantation, or the palettes of a coral reef.

However, time in ecological design is ecological time, which ranges from the lifetimes of bacteria to the development of landscapes over tens of thousands of years or the lifetimes of species in millions of years. Trees in the temperate northern hemisphere tend to grow in

stands. Nearness for ecological design can range from the interpenetration of endophytes to a general community grouping in a desert mesquite landscape. Blades of grass in a prairie may be perceived as dense from a low perspective. With fewer elements, a Japanese garden of the same area as a Dutch Tulip garden may look smaller.

2.5.3.1. Organization into Patterns

Ecological design shares the same organization into patterns—structures, rhythm, tension, balance—as traditional design (see Section 2.4.3.4.). The structure may be more complex for ecosystems, as when a tropical forest ecosystem has a typical structure (of interrelated parts) of six levels, from the herbal layer to rising emergent trees. Rhythm in ecological design has units of time that may range from milliseconds to thousands of years, although most will seem to be daily, seasonal, or long (in 2-25 years). A large clearcut area could create tension in a mature forest landscape because it would rarely develop under natural conditions. In forest design, a larger meadow could balance a dense woods, due to differences in perceived masses (especially if it reflected differences in soils or topography).

2.5.3.2. Ecosystem Complexity & Wicked Problems

There are not many examples that give the interests of the ecosystems independence or priority, perhaps because the project would be too large or complex, or perhaps because there is no funding for it. Eric Higgs thinks that this may be a wicked problem for ecological design. Rittel Horst, in 1960s, defined a wicked problem as a kind of social problem that is formulated with confusing information, too many clients, and confusing values. Imagine how wicked ecological problems are when they include all those nonhuman perspectives and values. Problem definition is subjective based on a point of view (or two or three). The solution is participatory design, which can reduce domination by one point of view. Design is political; there is no way of envisioning other approaches.

Complexity is not the only variable that can make a problem wicked. The scale is a problem if we think we can destroy the planet by burning fossil fuels. And, it is a problem if we think that nothing we can do will affect the planet.

Orientation is another variable that can influence the wickedness of problems. Design can be object oriented, like a building, and not seem wicked. But, design can be pattern-oriented, like planning for minimized polarized light surfaces on buildings in sensitive ecosystems, and then it pulls in scale and complexity—we are finding that we cannot avoid the things that make design problems wicked, and that denying them does not make design good.

But, design can work things out in an artistic way. There are ways in which design can be subversive; *Adbusters* is an example. Perhaps that might solve the wicked problem situation of design. Being subversive may turn over and expose wicked design problems. That artistic way is a wild way of thinking and meshes or can mesh with restoration design better than a simple technical approach. Ecological design requires an ecological perspective, systems understanding, participation, and standards of knowledge. However, it does not require a degree or certificate, which means that fewer people, educated or self-educated, will be ecological designers.

2.5.4. *Characteristics of Ecological Design*

The characteristics of ecological design have to address the properties of ecosystems and places. The courses of the design have to imitate the processes of systems and places. The wholeness of the design has to address the ideas of spirit of place and sensory force.

After the processes are identified, they have to be related to the patterns. Design may have to try shortcuts, unless it can afford to take ecosystem time, which is often many human lifetimes.

These six characteristics—imitating courses, extending identity, enhancing diversity, participating in coconstruction, investing in stability and constancy, stimulating productivity and health—have to be related to other levels by ecological design (Table 254-1).

Table 254-1. Properties at Different Levels.

— Nature —		— Culture —		— Design —	
<i>Field</i>	<i>Ecosystems</i>	<i>Place</i>	<i>Culture</i>	<i>Good Places</i>	<i>Good Society</i>
Motion Process	Course	Dynamic Change	Conduct	Action	Method
Autopoesis	Identity	Self-making	Wholeness	Individuality	Self-extension
Differentiation	Diversity	Uniqueness	Flexibility	Richness	Variety
Integration	Coconstruction	Integration Investment	Adaptation	Conviviality	Cooperation
Constancy	Stability	Regularity	Endurance	Consistency	Loyalty
Development	Productivity	Renewal	Vitality	Health	Harmony

For instance productivity of the ecosystem level promotes vitality in cultures and harmony in good societies, which are embedded in human places, which are embedded in ecosystems. And, diversity at the ecosystem level promotes flexibility at the cultural level and variety in good societies.

2.5.5. *Principles of Ecological Design*

Principles reflect the differences between local and global systems. Principles cannot be reduced to other principles, because they emerge from earlier ones and they expand into new forms. This expansion is why we cannot fit them into the old can of old principles. These design principles are based on basic principles of nature, such as the principle of change. Nature is in flux, culture is in flux, everything is in flux. The climate will change, the shorelines will change. Human understanding and behavior is changing. But, nature is also self-regulating. This is the principle of self-regulation. Nature has evolved to maintain its stability in the face of many kinds of disturbances from planetesimal impacts to changes in atmospheric composition. Nature will continue to regulate itself even as human beings make dramatic changes. The danger is not so much that nature will collapse, as that humanity will lose those things that it values the most, from cool air to wilderness.

2.5.5.1. Ecological Principles

Principles of ecology, such as stability, have to contribute to the design of landscapes because those landscapes have derivative principles, or maybe emergent principles. Design has to incorporate those principles because it is in place, in an ecosystem, in a culture. Some cultural

principles, such as sacredness, are actually emergent from ecological principles, such as the principle of pattern. It expresses the values of the locale and the culture. Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity in fact. Ecological principles include: The principle of flow, the principle of separation, the principle of growth, the principle of self-regulation, the principle of error (or play), and the principle of pattern.

These principles seem to be interactive, each forming part of the environment for the others. These principles result in a definite set of standards and behaviors that can guide ecological design. For instance: Work within the scale and duration of an ecosystem. Processes like succession can be assisted, slowed, or speeded up, but not skipped or ignored. Or, Make the smallest number of changes, in case they are not effective and have to be modified. Nature seems to follow its own principle of least effort.

2.5.5.2. Ecological Design Principles

Ecological design principles emerge from knowledge of ecological principles. They must combine the constraints of ecology with the ascendant sensitivity of design. Ecological design principles include: Spirit of place, sensory force, and the precautionary principle.

Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity and redundancy. These principles also result in a further qualification of standards and behaviors. Some actions based on these principles might be listed. For instance: Contribute to excitement and to life (being); Act from the bottom, restrain from the top (and act locally in parallel, within the constraints from the top and blueprint); Cultivate feedback; Develop rather than grow; Use a sideways approach, rather than focus on details; Work with errors, learn from, and allow them; Work with and allow disequilibrium; Structure the design to allow change; Pursue the satisfactory (*satisficing* in H. Simon's words) instead of a perfect maximum or even optimum.

2.5.6. *Applied Ecological Design As Lessons from Nature*

Design can imitate nature on many levels, from structure and process to landscapes. We can imitate the structure of mature forests by planting on every level of the forest hierarchy, from canopy to below ground. We can use native species. We can imitate the process of forests by allowing birds, bats, and other animals opportunity to distribute seeds and energy to other areas or prey on "pests." We can create microclimates within the landscape that may shift the landscape in new directions. Planting trees, for instance, allows new species to become established under their protection. Ecosystem health is one of the goals of design. Although the goal is not an end point that can be reached once, but is rather a continual striving.

The landscape provides its own metaphor for design. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one. Most products of an ecosystem are produced and consumed and recycled within the ecosystem. Humans need to minimize the external inputs in the form of energy and exotic substances. The community must be restored to health. This means balancing human needs with birds or fish needs in a sustainable pattern. Each element in a pattern relates to others and to the whole.

Natural patterns can suggest a number of regularities to understand for the design

of ecosystems, according to Michael Soule. Well-distributed species are less at risk than concentrated ones. Large blocks of habitat are safer from species extinctions. Blocks close together are more effective than those far apart. Contiguous blocks are better than fragmented blocks. Interconnected blocks are better than isolated blocks. Corridors can make functionally larger blocks functionally. Roadless blocks are better. Human disturbances similar to natural ones are more likely to be resisted.

These rules work well with natural processes that operate in ecosystems, such as metalysis (building up and breaking down), animal movement, interelement flows, human interactions, and shifting mosaics. For instance, forest fragmentation can be reduced through the design of forested areas, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects. The survival of organisms usually depends on one of two factors in the web of relations. These factors can be modified by design.

Wild landscapes are affected by climate, soils, interactions, and disturbances. Domestic landscapes are affected by these and by land use as well. The greatest changes have been brought about by the destruction and creation of forests. With the predominance of artificial forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people. But, forests are also expected to look natural. The patterns established at these times may persist for many years or centuries. Good design maybe able to resolve conflicts between characteristic qualities of the landscape and the changes from use. Also, the design should last as long as possible and should be self-sustaining.

2.5.6.1. Levels of Ecological Design

As a design process includes the planning of ecosystems, this means a fourth and fifth level of design— notice that numbers lower than number four, all are properties of traditional applications of design: (5) Regions, landscapes, and watersheds (as well as airsheds), (4) The community, for instance forest, city, or corporation, (3) systems, such as ecosystems, traffic, or industrial areas, (2) products, as habitats, houses, roads, or plant sites, and (1) components, such as trees, fungus, bats, tools, rooms, cars, or land. Many problems occur at level three—more are to be expected at the new levels four and five.

All levels of design need to be addressed, from the conceptual to the political, and are involved in all stages of the process. This involves new challenges for ecological design, which has to: Relate a project to its regional context (fifth level of design); this is the level of regional cycles relating to precipitation and waste recycling. Relate a project to its ecosystem context (fourth level of design); be concerned as much with cultural survival, justice, and wilderness preservation as with efficiency and aesthetics. Consider the whole perspective (ecocentric, perhaps)—the proper vision is of the whole community in which we dwell—and apply ecological concepts, such as networks and carrying capacity. 2. Make designs that are anticipatory, flexible, pluralistic, polyvalent, and polytechnic; make open guidelines for long-term decisions. Essentially, work backwards from values and goals, and from the bottom up and inside out, drawing designs from the genius of place. Finally, participate in place, care for all inhabitants, and assume responsibility for the designs. One of the shortcomings of design has been the lack of consideration of the higher levels, which can result in specific problems with safety or recycling.

2.5.6.2. Stages of Ecological Design

Ecological designs can be applied in eight stages. These stages should be typical of all designs:

- First, Decide to design; Use a design management matrix, review the situation; Evaluate ecological history of the site, observing patterns of movement; Account for interconnectedness, population change, land use, building and development, boundaries, limits, and life; Conduct ecological and functional analyses.
- Then Inventory, record all of the resources, from physical resources to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system. Delineate and balance components.
- Create a series of plans, from site to value plans. Integrate with biosystem services. Kinds of integration: Horizontal, vertical, temporal. Consider aesthetic-perception factors.
- Start to design, which is a community process requiring the participation of all people, including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot voice their concerns. Synthesize simulations and models (conceptual, capability, and suitability). Make another series of plans, from landscape plans to policy plans, within a master design.
- Implement the design together. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Create new connections, Reduce unwanted effects, such as road effects or heat island effects. Integrate into context. Optimize passive mode; integrate water, biomass, and materials flows. Conserve water and energy
- Maintain and manage design. Provide services for continuity and management. Monitor and improve constantly. Monitor, Reassess.
- Prepare for undesign and disintegration.

Ecological design must work within the components, structure, and function of ecosystems. Unless it does, it will not be long-lasting or satisfactory. Because ecological design has to work with wild ecosystems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the ecosystem.

Ecological design takes far more time than graphic or automobile design, due to the complexity, size and longevity of its subject. A number of factors have to be carefully assessed before design work starts. Wild ecosystems require a lot of observation before activities can take place. Wild ecosystems can be highly reactive to change. Some people value different character of such ecosystems than others.

2.5.7. *Applying Ecological Designs to Places*

All design elements are related psychologically by designers, as focus or frame, as contrast or uniformity, as dominant or recessive, or in a number of other pairs. Good ecological design means not violating any of the aforementioned principles and ideas.

Design can improve the results of bad practices. Bad forest harvesting practices, for instance, often result in geometric wastelands. Good design can correct reliance on straight lines, parallel lines, right angles, and perfect symmetry. In cutting or planting forests to

improve natural appearance, a number of things have to be considered, including the age of the forest, windthrow, the width of corridors, and the minimum size of the habitat.

2.5.8. *Ecological Design Management*

Ecological design is not finished with the design. The system may need to be managed as a result of the design. Noninterference matrix management is proposed as a technique for design. An ecosystem exists as part of matrix that many interacting elements. Any activity in the matrix can have some effect on these elements. The whole matrix needs to be managed with the ecosystem in mind.

Understanding of the principles of ecology can lead to better management. One critical message of ecology is that if we diminish variety in the natural world, we debase it—and our own—stability and wholeness. Many ecosystems have been simplified and degraded. Perhaps we do not have sufficient knowledge to manage a complex landscape because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction with minimal intervention. We must do all that we can to restore its richness and the natural processes that created the richness.

2.5.8.1. Principles of Ecological Design Management

Management, whether it is archaic, traditional, industrial, or ecological, should adhere to basic principles. The principles of ecological management include: Holistic practice, retention, noninterference, least effort, respect, managerial flexibility, work with changing ecosystems, appropriate scale, profitability, keeping wild, and accepting management limits.

2.5.8.2. Noninterference Matrix Management

A noninterference approach to ecosystem management, the essence of a taoist way, is to let the system take its own course. Therefore, once temporary constructs were in place, whether planting or cutting or any other manipulation, the system would be allowed to develop without further interference.

In nature, noninterference means ‘letting be.’ Noninterference matrix management (NMM) is not indifference, which is diffuse. It is caring. Noninterference will not lead to chaos, poverty, and stagnation. The technocratic vision strives for “life under control,” but an ecosystem is self-managing, productive, efficient, and orderly. We need to practice the rule of noninterference so that all beings can enhance themselves. Noninterference can be derived from nonviolence, or from taoist nondoing. This attitude would entail using what is necessary, exploiting parts of some ecosystems, changing a place to fit human aspirations, and killing plants and animals for sustenance. But it would also mean limiting humanity and its technological effects, limiting human use to local impacts, and letting other beings live without interference. It is not necessary to dominate or terraform the ecosystem completely to save it. Noninterference matrix management weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes.

2.6. *What is Regional Ecological Design?*

Regional ecological design is not the additive design of ubiquitous factors such as roads or popular products. Nor is it the design of common structures or symbols, such as cities or money. Although it has to address truly regional (and sometimes global) phenomena, such as the atmosphere or ocean, there is not the knowledge or power to change or reconstruct those structures and processes. So, regional design has to do mostly with fitting human activities within the framework of regional limits of moisture, vegetation and cycles. It can minimize the impact of human activities on regional structures and processes, and it can minimize impacts of the region on human fields and structures. To do this, it has to be based on regional ecology. Regional Ecology itself is broader than community ecology, which is broader than human community ecology, which is broader than human ecology. Regional ecological design is a human process that considers the emergent and unique factors of the region. We have to change the framework so that we can shape new approaches. We no longer can afford to have an abstract or external point of view. We are inseparable from the environment and each other, although we can still differentiate between things to develop fitting designs.

2.6.2. *How is Regional Design different from Ecological Design or Global Design*

Although a region is a whole system, every region is part of the whole planetary system. Both systems are logically global, but the planet is emergent from regions and ecosystems, and as a result has unique properties. In this discussion, a region is presented as having essentially the same properties as the planet.

The major difference between ecological design and regional ecological design is scale. The scale of a region requires changes in design. In some cases, design simply permits regional processes through benign neglect. In others it has to provide the constraints for local designs. Four areas of differences—biophysical systems, ecocultural play, economies, and values—are detailed between these two levels of design.

2.6.2.1. Physical & Biological Environment of Regional Design

At the biophysical level, regional design has to address many more systems as well as the new emergent properties of the region.

2.6.2.1.1. *Repatterning*. The patterns of concern here are regional patterns that are limited by climate and regular catastrophes. This includes the cycles of elements and well as extended distributions of species and communities.

2.6.2.1.2. *System emergent*. As the result of the local creation of forms and ecological constraints on systems, larger-scale patterns emerge, but, these patterns depend on the continued operation of local processes, as well as on new regional cycles. Design has to consider both scale levels.

2.6.2.1.3. *Growth/Development*. The autopoietic process is not just about generating forms, it is about degenerating and regenerating, where the two anabolic and catabolic process run up and down simultaneously. It is about making, demaking and remaking regionally.

2.6.2.1.4. *Whole system*. The frame of a local system that may be the focus of local design, but the whole system also needs to be considered by regional design. Regional design has to pull back from a focus and consider the aspects of the entire frame. The regional system

has unique properties that have to be given opportunities to continue the process at that scale.

2.6.2.1.5. *Feedback cultivating*. The region acts as one system in which energy from the sun is cycled, before flowing into planetary flows and to solar system space. The functioning biomass is integrated by feedback responses to extract the maximum of energy and still maintain a balance. Most of the solar energy is used for maintenance by the region. James Lovelock hypothesizes that every element in the system is related in a feedback network to every other element, from the very strong to very weak. Cycles that do not operate with the right kind of feedback function as traps. Thus, on an elemental level, phosphorus becomes trapped in an ocean sink, and can only be recycled by long geological processes on a global level. Regional design has to consider feedback to promote cycles and minimize traps.

Table 2621-1. Comparisons of Biophysical Levels of Design

<i>Natural Creation</i>	<i>Traditional Design</i>	<i>Ecological Design</i>	<i>Regional Ecodesign</i>
Self-patterning	Patterning	Repatterning	<i>Repatterning</i>
Creating forms	Conscious intention/ form	Ecological restraints / Experiential	<i>System emergent</i>
Autopoetic	Making/Generation	Remaking Regeneration	<i>Growing/developing Degen-regenerating</i>
Complete	Focus	Peripheral frame/system	<i>Whole system</i>
Systematic	Feedback accepting	Feedback driven	<i>Feedback cultivating</i>
Processing patterns	Objective/object- oriented	Dimensional process	<i>Diversity allowing</i>
Development change Filtering/Sorting	Growth-permitting	Development after initial growth	<i>Evolution</i>
Place generating	Place independent / isolation	Place specific	<i>Place framework /context</i>
Place responsive	Principle limited	Fitness-oriented	<i>Place-supporting</i>
Dynamic equilibria	Equilibrium	Disequilibrium incorporated	<i>Change permissive</i>
Interaction limiting	Maximizing/ Optimizing	Optimizing/Satisficing	<i>Possiblizing</i>

2.6.2.1.6. *Diversity allowing*. One of the important factors in diversity is locality. Differences emerge from communities and species developing in isolation. So, isolation must be an important part of regional design. Regional designs must erect or allow barriers to human-assisted migration of exotic or invasive species to allow diversity to develop as it has. Combining many organisms at random may increase diversity briefly, but it may decrease it in a new settled-out system. On the other hand, human additions to some systems, such as reintroducing camelids to North America, could increase diversity in the long term.

2.6.2.1.7. *Evolution*. Evolution is the process of development. Although it applies to the survival of individual species, it also applies to their communities and ecosystems, even on a regional level. Regional landscapes evolve as well, up to the continental scale. As species compositions shift, the regions shift also. Regional design has to consider the fact and direction of evolution and not try to 'freeze' a system in one configuration.

2.6.2.1.8. *Place framework*. With regional design, we want a framework that permits the natural processes that form places to operate freely. Place itself generates design through participation. The framework of place comes with a long history of changes and successful patterns that can inform and limit designs. Regional design considers all the places simultaneously.

2.6.2.1.9. *Place-supporting*. Although ecological design is place-specific, regional design has to be context-aware. The framework for making and maintaining places has to be healthy and productive.

2.6.2.1.10. *Change permissive*. The matrix of nature occurs in a dynamic disequilibrium. The framework of regional design has to permit the processes to continue, to change, in order to have designs on the local level.

2.6.2.1.11. *Possibilizing*. Living beings in local systems may maximize or optimize their populations, depending on their environment and qualities, such as territoriality. They may settle at satisfactory levels of population or feeding. Regional design needs to keep many sets of possibilities open, rather than striving for explicit structures with optima or maxima.

2.6.2.2. Ecocultural Play of Regional Design

At the level of ecocultural play, regional design considers the sum of cultures and evolution acting on planetary patterns.

2.6.2.2.1. Planet-based. More than being nature-based or culture-based, or nature and culture-based, regional design has to consider the entire planet, so that processes of natures and cultures may be isolated or limited when necessary. The health of the planet, in all its history and variety, is considered first.

2.6.2.2.2. Nesting. Nature deals with aggregates. Ecological design may assemble species to restore an ecosystem; it may connect the niches and behaviors of species. Regional design needs to nest the systems and species in the regional framework.

2.6.2.2.3. Cyclic linking. The trial and error process of design works well with traditional design and even some ecological designs, where species are assembled in restorations according to their functions and allowed to sort out over time. Regional design is concerned with making sure that adapted local species are not replaced with faster-growing or tougher exotics over large areas. Furthermore, species have to be linked with local and regional cycles.

2.6.2.2.4. Failure allowance. Ecological design incorporates the failures of previous designs into newer designs. Regional design has to be sure to allow failures to continue to occur within the framework of the designs. The failures are only of concern if a critical level is reached or if the failure is at the cellular level of life.

2.6.2.2.5. Novelty from history. Regional design has to consider novelty as well as tradition and historical processes. In fact, it has to allow the processes of novelty and the history of traditions to both operate on a larger scale.

2.6.2.2.6. Reciprocal Quality breaks are important. In a system of regional design, quality can be submerged by quantity. This can be a limit on the lifetime of products and patterns, as things break down and are reformed.

2.6.2.2.7. Chaotic development within restraints. Although local systems are formed bottom-up, regional systems provide the context and restraints that limit not only regional cycles and patterns, but local ones as well. At the regional level, a designer can assess the overall situation and tune some of the limits and patterns. Trickle-up and trickle-down processes can

be identified and monitored to make sure that both processes continue.

2.6.2.2.8. Courageous neglect. Although traditional design and ecological design may be very attentive to forms and their consequences, regional design has to display a courageous neglect, when it comes to allowing natural processes to work. That may mean that not every charismatic species should be saved in zoos or gene banks. Not every favorite ecosystem should necessarily be restored. Unique patterns of plants and animals may come and go rhythmically, without human design trying to freeze them in one configuration.

Table 2622-1. Comparisons of Ecocultural Levels of Design

<i>Natural Creation</i>	<i>Traditional Design</i>	<i>Ecological Design</i>	<i>Regional Ecodesign</i>
Nature-based	Culture-based	Nature & culture-based connecting	<i>Region-based</i>
Aggregating	Bricolaging	Niche-assembling/ connecting	<i>Nesting</i>
Trial & error Novelty testing	Conscious Trial & Error process	Ecological redundancy	<i>Cyclic linking</i>
Trial generating	Learning from failure	Failure incorporation	<i>Failure allowance</i>
Novelty generation	Novelty emphasis	Historical tradition	<i>Novelty from history</i>
Reciprocal interactions	Rules/Geometric grids	Quality emphasis	<i>Reciprocal</i>
Bottom-up organization	Top down direction Control of actions	Bottom-up action top-down constraints	<i>Chaotic development within constraints</i>
Physical restraints	Creative Play	Consequences attention	<i>Courageous neglect</i>
Natural process	Goal-directed	Permanence sustaining	<i>Health emphatic</i>
Actual Existing	Conceptual	Perceptive	<i>Receptive</i>

2.6.2.2.9. Health emphatic. At the regional level, the overall health of the system, with degenerative and regenerative processes continuing, is more important than sustainable permanent patterns. Health is a measure of the harmony of the degenerative and regenerative processes, which may recycle dwelling places, especially those badly sited in earthquake or tsunami zones. Designer should take care to create good places, but on the regional level especially, they have to be aware of short or long-term destructive processes at work. Health is related to stress, both good stress and bad stress. Stress may be related to the rate of change for the system, in addition to loss or gain of components or changes in structure. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. Obviously, a pioneer community may change the conditions to favor a new level of the system with new components. The regional level may require a balance of mature and young systems.

2.6.2.2.10. Receptive. Simple behavior seems to work, with local feedback, and more sophisticated behavior “trickles up” to approximate a regional perception. A regional design level has to be aware of local centers and their places in a regional context. Receptive in this sense means incorporating patterns that may not be conceived or perceived.

2.6.2.3. Ecological Economics of Regional Ecological Design

In terms of ecological economics, regional design has to consider economics as the basic exchange of energy and elements at all levels.

2.6.2.3.1. *Capital-creating*. Ecological design is concerned with using natural capital at renewable rates, with a minimum use of the productive accumulated “interest.” Regional design considers the capital-creating process on several time scales. Regional design has to take care that those long-term processes are allowed to continue, even while we use renewable energies and materials.

2.6.2.3.2. *Symbiotic*. At a regional level it is easier to identify and appreciate the advantages of systems living together for mutual benefits. These benefits extend to the regional level. Although integrated, it seems that many of the partnerships become obligatory.

2.6.2.3.3. *Reintegrative*. All levels are integrated by global cycles. But, the patterns weave and reweave so much that regional design has to constantly reintegrate the pieces. It can do this by following a monitoring program that is concerned with regular changes in patterns. Tools and designs are important extensions of the human mind. Their purpose is to foster and assist survival, not to make it more difficult. Tools and designs can be made appropriate to environmental limits and cultural preferences, both of which are often ignored by industrial approaches, by integrating them into regional and global patterns.

2.6.2.3.4. *Constructively indifferent*. Where ecological design is dependently constructive and minimally destructive, regional design has to appear indifferent to the destructive parts of the process. The destructive is a necessary part of the cycle, in balance with a constructive process. Both are necessary; neither can be overemphasized. Small-scale operations in general, are less harmful to the environment than large-scale operations. But, we are pulled by our idea of global economics to make large-scale decisions beyond our immediate comprehension. Wendell Berry suggests that we are not smart enough or conscious enough to work on a global scale. This kind of design would assume that and scale down things to understood limits

2.6.2.3.5. *Energy scales*. More than appropriate energy use, regional design has to balance all kinds of energy use. For example, energy use on a local scale, for instance capturing tidal energy in bays, might have negative consequences on a regional scale, perhaps affecting local life styles in the bays or even the rotation of the planet. We have to ask if wind farm energy on a regional scale will affect the quality and kinds of winds on a local level, as well as populations of avian and mammal species.

2.6.2.3.6. *Minimal technology*. Appropriate technology in ecological design is crucial. We cannot be sure what appropriate design is on a regional scale. At the very least, technology on a regional scale implies the ability to predict, control, and respond to the technology and its consequences. For instance, placing millions of small mirrored surfaces in orbit to reduce the solar constant might have effects on many species, as well as unforeseen impacts on ecosystem surface that have developed with expected light levels. Van der Ryn states that ecological design is about merging nature and technology. Certainly technology is emergent from human activity which is emergent from “nature” but regional design also has to consider separating technology from nontechnical species.

2.6.2.3.7. *Waste sorting*. The adaptive ecological design applied to a regional level has to be sure to channel the unavoidable waste of local systems into the global cycles that reuse it. This means limiting waste and eliminating unnecessary kinds of waste that come from lack of design or bad designs.

2.6.2.3.8. *No costing.* Ecological design has to be cost effective at local levels. At the level of the planet, however, cost is not as important as effective survival. When we approach regional design, it is because we have already thrown global cycles out of balance, and we have interrupted or interfered with local systems crucial to regional functioning. In most cases design at this level is more about control of human interference than about replacing regional functions. Losses from accidents and diseases can be reduced by preparedness. Losses from earth and climate changes can be reduced, also, with preparedness for ‘normal’ events, such as hurricanes, earthquakes, and droughts. Design can also be used to reduce impacts from these events; for instance, by denying building permits on floodplains. The losses from some events, such as droughts resulting from El Nino, can be ameliorated, by having surplus food and supplies stockpiled.

2.6.2.3.9. *Multiscalar trends & Interweaving.* Scale constraints are equally important at the regional level, but perhaps it is more about minimizing the scale of designs. The patterns of designs can be interwoven at a regional scale rather than trying to replace processes with specifically regional ones. Scale-linking is important. Scale-linking in nature occurs from energy and matter flows (which can be represented by fractal geometry). Global biogeochemical cycles link organisms across many levels of scale, from photosynthesis chemistry to the planet surface. This has holistic ramifications, as any action at any scale impacts others at other scales.

Table 2623-1. Comparisons of Economic Levels of Design

<i>Natural Creation</i>	<i>Traditional Design</i>	<i>Ecological Design</i>	<i>Regional Ecodesign</i>
Productivity	Capital-using	Natural capital-using	<i>Capital creating</i>
Interrelational	Constructive	Adaptive process	<i>Symbiotic</i>
Nested	Auto separation	Integrative	<i>Reintegrative</i>
Interdependent	Independent/ destructive	Dependent constructive minimally destructive	<i>Constructively indifferent</i>
Solar-life driven	Energy use (fossil)	Appropriate energy use	<i>Energy scales</i>
Aesthetic creation	Technological tool use	Appropriate technology	<i>Minimal technology</i>
Waste generating	Waste production	Waste integration	<i>Waste sorting</i>
Free play/change	Cost consideration Market-oriented	Cost constraints based on physical constraints	<i>No costing</i>
Gigatrends	Fashion fads Style	Size/scale constraints	<i>Multiscalar trends</i>

2.6.2.4. Values of Regional Ecological Design

At the level of regional design, values are expanded from human and species to those useful for the planet.

2.6.2.4.1. *Responsibility* to not interfere with living cycles. Ecological design has to be responsible for the local environment and community. At a regional level, responsibility has to be concerned with not interfering with natural cycles and landscape processes. In fact, it might be practically impossible to be responsible at the scale of the planet. Much of design, again, becomes concerned with limiting and directing human influences, rather than replacing and controlling natural cycles.

2.6.2.4.2. *Whole goals.* At the local level, we can design strategies to accomplish

our ends. At the regional level, we have to consider regional goals and impacts before implementing those strategies.

2.6.2.4.3. *Whole order geological time.* Regional ecological design is concerned with much larger frames of space and time. The recycling of elements regionally, for instance, should consider at least a 10,000-year time frame for many compartments and pools, and millions of years for geological shifts. Although there is quite a bit of flexibility for local orders, at the regional scale, it would be better to keep flows in dynamic equilibria. Long-term catastrophes teach long-term thinking, Large catastrophes teach large thinking.

2.6.2.4.4. *Free motion interchange.* The goodness of a traditional design can be related to any destruction it may cause. Ecological design considers how the design fits into the environmental context. At the regional level the design has to permit the free interchange of elements and patterns, before any human design is applied to the pattern.

2.6.2.4.5. *Respectful.* As the precautionary principle needs to be followed in ecological design, a principle of respect needs to guide interactions at the regional level of design. Perhaps even a principle of nonintervention should guide our thoughts of changing global cycles. By promoting the understanding of the inadequacies of bad characteristics and bad designs, eutopias can stop the plague of uniformity and paucity. Through an understanding of the consequences of human ambitions and actions, eutopias can avoid many of the evils that result from a civilization on technical autopilot.

Table 2624-1. Comparisons of Value Levels of Design

<i>Natural Creation</i>	<i>Traditional Design</i>	<i>Ecological Design</i>	<i>Regional Ecodesign</i>
Living	Responsibility to product, consumer	Responsibility to living community & environs	<i>Responsibility to not interfere with cycles</i>
Fitting	Planning	Strategies	<i>Whole goals</i>
Harmony-building long-term	Meaningful order short-term	Flexible order Living-order-times	<i>Whole order Geological time</i>
Existence value	Goodness concepts	Fitness concepts	<i>Free motion interchange</i>
Learnable	Teachable	Limitable Cautious	<i>Respectful</i>
Adjusting	Exclusive	Inclusive	<i>Bindings/spiritual</i>
Formation	Information	Knowledge Ecology	<i>Wisdom/harmony</i>
Chaotic/Free	Exciting	Inspiring	<i>Dangerous</i>

2.6.2.4.6. *Binding.* Design needs to be inclusive at every scale, but at the global scale it can also bind us to the planet spiritually. Yi-Fu Tuan suggests that topophilia, the innate love of place, may suggest proper ways to attempt changes that could affect regional health. With declines in religions, we have lost a meaningful frame of reference. Our fabulous cyborgs, computer communications, and genetic engineering coexist with burning poverty, urban violence and ethical erosion. Few of us can bear to look at the total situation. No one wants this other dimension, the slums and the pollution, but they are emergent characteristics of an unplanned, free society—just as a leader may sincerely not want a war, but may be helpless to stop the mechanisms that trigger a war. The social roles that determine the social action that could correct these sad things do not seem to exist. But, can they be designed?

2.6.2.4.7. *Wisdom.* Knowledge, and the understanding of its limits, is important for

ecological design. At the regional level, the right application of knowledge, at the right time and in the appropriate way, is necessary. This is in fact one definition of wisdom by Jonas Salk.

2.6.2.4.8. *Dangerous*. Nature is chaotic, exciting and inspiring, and these emotions add content to ecological designs. Regional ecological design accepts that nature, and the planet, is dangerous also. Although design can allow us to prepare better for natural catastrophes, through siting or not, through fit designs or not, design cannot guarantee complete safety.

2.6.3. *Regional Ecological Design Components Elements & Variations*

Regional Ecological Design builds on the basic geometric elements of traditional design, which can vary in numerous ways, by number, position, direction, size, shape, interval, texture, color, and temporal. Furthermore, the elements can be organized into groups by nearness, similarity, and difference (diversity). Then they can be combined into whole structures by principles of rhythm, balance, and finally sensory force.

2.6.3.1. Elements

Regional ecological design has the same elements—point, line, plane, volume—as traditional design (see Section 2.4.3.1.), but they are understood in a regional ecological context foremost. That is the context of climate, watersheds, landscape, and vegetation provinces.

2.6.3.2. Variations

Regional ecological design shares the same variations—number, position, direction, size, shape, interval, texture, color—as traditional design (see Section 2.4.3.2.), but there are many more occasions: In regional ecological design it is the degree or process of change in appearance. Thus, there is great variation between a seabed and a cloud formation. At a global level, the spin of the planet pushes air and water patterns ‘eastward.’ The moon looks larger than it is when it is near the horizon. For instance, the continents have unique shapes that effect air and water flow and quantities, as well as animal and plant movements; animals on the Eurasian continent can move along latitudes that have similar climates much easier than those on the American continents, which are oriented north-south. On the regional level, the effect of human activities on the shapes of landforms and seaforms is less evident. For instance, storms in the Caribbean form at certain times of the year, depending on dust storms and water temperature near Africa. The larger palettes of regions seem more uniform than the local variations in a rainforest, for instance.

2.6.3.3. Organization of Variations

Regional ecological design shares the same organizations of variations—time, groups, nearness, similarity, density, diversity—as traditional design (see Section 2.4.3.3). Regional time is almost as long as planet time, but measured in millions of years, and covering dramatic changes from rainforests to deserts. Regional ecological design has to consider much larger time scales for design patterns and events. Large islands seem to appear on the east side of continents, as a grouping. Nearness for regional ecological design refers mostly to landforms. Cloud pattern density can be related to land elevation and wind currents. On a regional level, diversity seems to decrease due to the scale, as elements become more difficult to perceive individually.

2.6.3.4. Organization into Structures

Regional ecological design shares the same organization into structures—structures, rhythm, tension, balance—as traditional design (see Section 2.4.3.4.). On a regional scale, biomes form that reflect similarities of temperature and precipitation. Many regional rhythms are influenced by the tilt of the earth and its orbit around the sun, as well as its movements in the plane of the planets and through interstellar dust lanes. The dramatically large clearcuts in the Brazilian state of Rondonia create tension in the mature tropical forest landscape, as well as with regional chemical cycles and rainfall patterns. In regional ecological design, many human landscapes can balance wild landscapes.

2.6.3.5. A Thought on New Scales of Design

Regional ecological design extends the scales of design from the traditional and ecological to the planetary level, with associated changes in perspectives, for example, in the following sequence:

- Designing objects (in a product-centered environment)
- Designing interacting objects and human subjects (user-centered)
- Designing systems of interacting objects (practice-centered)
- Designing systems of interacting objects within dynamics of living subjects
- Designing systems of interacting objects within systems of interacting objects (multi-centered)
- Designing systems of interacting objects within ecosystems of interacting objects, species and nonliving things (ecologically conscious).
- Designing systems of interacting objects within ecosystems of interacting objects, species and nonliving things within a global system (noncentered, regionally conscious)

2.6.4. *Characteristics of Regional Ecological Design*

The characteristics of regional ecological design are similar to those of ecological design (Table 264-1). Due to differences in scale, they have to address the characteristics of ecosystems, places, biomes, continents, and the planet and its environment. The courses of the regional ecological design have to imitate the processes of systems and places. The wholeness of the design has to address the ideas of spirit of place and sensory force. After processes are identified, they have to be related to the patterns. Design has to try to accommodate regional time, which is longer than the lifetime of species or many landforms.

2.6.4.1. Method of Imitating Courses

Design has to identify patterns of movement and construction, and then it has to imitate the processes and patterns, modifying them to include the things of human interest and need. This is more difficult than copying a shape or structure. Fortunately, imitation is a human strength, even if the recognition of complex, long-term, moving patterns is not. Courses can be thought about using topological and mathematical models representing a four-dimensional landscape.

2.6.4.2. Self-extension of Identity & Wholeness

Regional ecological design has to capture the integrity of a set of places, or restore them as a unit. Unity is a fundamental objective of landscape design. Unity is the way the elements, including shape and scale, of a landscape are combined. For instance, visually, a forest ecosystem usually dominates the landscape. From a distance, even-aged forests have much the same impact, in terms of color, shape, and scale, as uneven-aged forests. Diversity becomes more important visually at a smaller scale. Natural forms of the forest are unified with the landscape because the margins are very uneven, and open space in the forest is part of the mosaic caused by birth and death of individual or groups of trees.

2.6.4.3. Variety Openness & Flexibility

Because the operation of the universe tends to change systems, the design of a place should be open to the types of processes that could destroy the design. Furthermore, flexibility, defined as the unused capacity for change, can be designed into the system. The parts of a system have to maintain the potential for all possible behaviors that could flow from any other part of the system. Openness and flexibility are characteristics of healthy ecosystems, and they can be considered and enhanced by design.

2.6.4.4. Cooperation in Coconstruction

Designs are limited by the real biological constraints of ecosystem processes and biogeochemical cycles. We must know the constraints in order to create a healthy design. The design has to work within the constraints of the ecosystem. Rather than emphasize static equilibrium, the design should emphasize heterogeneity and learn to adjust to disturbance. People have needs, animals and plants have needs, the site does have constraints, and these things can be married into a good pattern. Harmony is a constraint of the whole system. Design is the participation in the process of the ecosystem as a harmonious system, with mutually restrained conflicts and constrained influences. An ecological design is a form of co-constrained construction, where the organisms, environment and designs are co-implicative, co-defining, and co-constructing. They all engage in a process of self-assembly, in a whole.

To participate means to take part with others in some activity. Designers should participate in a complete design process, guiding involvement and commitment to the art of living together as a community. Adaptation is a process of making fit by adjusting to circumstances, environmental or cultural. Here it means fitting into a regional system, within established large-scale cycles and functions. It is adaptation that improves the chances of survival for communities of species.

2.6.4.5. Loyalty Stability & Constancy

People often judge the health or wholeness of ecosystems, or the goodness of designs, by how they look. Traditional design has emphasized visual results above all else. Ecological design has achieved the same results by paying attention to the structure and function of the ecosystem. Regional design has to be concerned with making balancing domesticated landscapes with wild ones. This may mean preserving, then restoring and creating, the conditions for wild ecosystems so that they are stable or constant within the processes shaping and affecting them. It may mean limiting or reconverting areas of domestic lands.

2.6.4.6. Harmony Productivity & Health

Most products of an ecosystem are produced and consumed and recycled within the ecosystem. Humans need to minimize the external inputs in the form of energy and exotic substances. The community must be restored to health. This means balancing human needs with bird or fish needs in a sustainable pattern.

Ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity.

Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. Ecosystem health is one of the goals of design. The goal, of course, is not an end point that can be reached once, but is rather a continual striving.

Responsibility is the condition of being accountable for one’s actions or obligations. Here it means undertaking all aspects of a design, regardless of the expected level of success. The very purpose of regional design is to respect limits (that means not trying to always exceed them and to be cautious) and especially to keep the capital intact, to allow cycles to operate in a constant building up and tearing down. These six characteristics have to be related to other levels, especially by regional design (Table 264-1).

Table 264-1. Properties at Different Levels.
— Nature — — Culture — — Design —

<i>Field</i>	<i>Ecosystems</i>	<i>Place</i>	<i>Culture</i>	<i>Good Places</i>	<i>Good Society</i>
Motion Process	Course	Dynamic Change	Conduct	<i>Action</i>	Method
Autopoesis	Identity	Self-making	Wholeness	<i>Individuality</i>	Self-extension
Differentiation	Diversity	Uniqueness	Flexibility	<i>Richness</i>	Variety
Integration	Coconstruction	Integration Investment	Adaptation	<i>Conviviality</i>	Cooperation
Constancy	Stability	Regularity	Endurance	<i>Consistency</i>	Loyalty
Development	Productivity	Renewal	Vitality	<i>Health</i>	Harmony

For instance productivity of the ecosystem level promotes vitality in cultures and harmony in good designs in good societies, which are embedded in human places, which are embedded in ecosystems. And, diversity at the ecosystem level promotes flexibility at the cultural level and variety in good design in good societies.

2.6.5. Principles of Regional Ecological Design

Principles of regional ecological design reflect the differences between local and regional systems. Principles, as fundamental rules, cannot be reduced to other principles, because they emerge from earlier ones and they expand into new forms. This expansion is why we cannot fit them into the old can of old principles. These design principles are based on basic principles of nature, such as the principle of change. Nature is in flux, culture is in flux, everything is in flux. The climate will change, the shorelines will change. Human understanding and behavior is changing. But, nature is also self-regulating. This is the principle of self-regulation. Nature has evolved to maintain its stability in the face of many kinds of disturbances from

planetesimal impacts to changes in atmospheric composition. Nature will continue to regulate itself even as human beings make dramatic changes. The danger is not so much that nature will collapse, as that humanity will lose those things that it needs or values the most.

Ecosystem ideas can be formulated into principles that can be used for designing and building cities. These principles of centering or timing. Connectedness to global cycles.

2.6.5.1. Regional Ecological Principles

Principles of regional ecology, such as stability, have to contribute to the design of landscapes because those landscapes have derivative principles, or maybe emergent principles. Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity in fact. Many regional principles are similar to ecological principles, such as: The Principles of Being Flow, Separation, Growth, Self-regulation, Error, and Pattern. Other principles either emerge at the planetary level or become more important at that level, such as the Principle of Wholeness, which states that a whole emerges from the interactions of parts and that whole is more than the total number of parts.

Wholeness is a characteristic of the field of nature and of any region in the planet. The whole is the environment of all parts. The parts cannot survive without the whole. Although the whole can survive without many parts, it is reduced in terms of completeness or resolution with the loss of any part. A whole is an organized system of subwholes. Each subwhole behaves as a whole to its components, as a self-contained whole, and as a dependent part in context. These subwholes, or holons as Arthur Koestler calls them, are stable in a hierarchy that displays rule-governed behavior and structural Gestalt constancy.

These principles, whether we accept or deny their applicability, influence our interactions with regional patterns, cycles, and biomes. They influence our objectives, our standards, and our operations. The interplay of these principles with examples and exceptions will refine our approach to and understanding of regional patterns. This is part of the process of living with and understanding regional patterns. These principles are not a final presentation of a limited number. They are meant to be questioned, discarded, or expanded. You can help with that. From a limited set of principles, we can distill a definite set of standards and behaviors, for example: (1) Work within the scale and duration of the planet. Processes like long-term succession can be assisted, slowed, or speeded up, but not skipped or ignored. (2) Understand the patterns and connections. Make sure they are not broken.

2.6.5.2. Regional Ecological Design Principles

Regional ecological design principles emerge from knowledge of ecological principles. They must combine the constraints of ecology with the ascendant sensitivity of design. Below are five examples.

2.6.5.2.1. *The Principle of Spirit: Act as if the Region is Alive.* The spirit of each place is unique; many, including C. Norberg-Schulz, emphasize this in their designs. Place is not just location; it is the total sum of objects in the landscape combined into a unique whole. Every place has certain characteristics that enforce the spirit of place, for instance, a strong definition of place or indicators of great. A sense of wildness and water also contribute greatly to the spirit of place. Each place expresses a unique combination of elements, including contrasts, dramatic features, and the presence of water. Design can work to be consistent with the recognized spirit of place. If the design recognizes this aspect of the landscape, it may be stimulated by the spirit

of it and may further enhance it.

The identity of place often leads to human identity, thus people call themselves by their place names. The more unique a place the stronger the emotional attachment of the inhabitants. One of the goals of regional ecological designs is to relink people with regional and global cycles that support specific places. Identity with the planet allows people to save all the planet, not just the beautiful places and the charismatic species, the whole planet, with hurricanes and parasites and viruses.

2.6.5.2.2. *The Principle of Sensory Force: Use Every Sense to Appreciate Life.* Visual force is a psychological interpretation of perceived power in a landscape. As a principle, it is embodied in psychology, art, graphic design, and architecture. The human mind responds to visual force in predictable and dynamic ways, for instance, where lines in landscapes draw the eye down convex slopes and up concave ones—the strength depending on the scale and irregularity of the landform.

The effect of any landscape is not completely visual, however. Smell, sound, touch, and even taste play a large part of our appreciation of them. Crawling, which is highly recommended by Gary Snyder, climbing, listening, and tasting things, such as soil, bark, or lichen, can expand our perception of other aspects of the forest.

2.6.5.2.3. *Principle of Valuation: Everything has Value to Itself or Someone.* All beings have value in themselves (what is called intrinsic value in the Platform of Deep Ecology). These values are independent of the usefulness of the nonhuman world for human purposes. Life includes individuals, species, populations, habitats, and all human and nonhuman cultures. Like Deep Ecology, regional ecological design expresses concern and respect for cultures, as well as for the well-being and flourishing of human and nonhuman life.

There are different ways to maximize value, according to John B. Cobb, Jr. One can act to maximize value for yourself at all times (this is selfishness); one can act to maximize value for yourself in the future (also called prudence); or, you can act to maximize value for all humans for the indefinite future (the greatest good for the greatest number). Cobb points out that these three ways are unstable and unacceptable. That leaves the final principle, which he suggests is to act to maximize value in general (the process view). This implies that the value of ecosystems and regional cycles would also be maximized. But, should value be maximized? Would not that contradict a principle of limited good (that desired things only ever exist in limited quantities)? After all, nature contains good and bad (both human judgments, of course). Perhaps we should aim for satisficing value, rather than a maximum or an optimum.

2.6.5.2.4. *Principle of Preservation: Do not take everything for human use.* Focus on what to leave, not on what to take. Ecologically responsible design leaves fully functioning systems at all spatial scales through time. In other words, ecologically responsible design identifies the parts of systems, local, regional and global, that must be protected to maintain short- and long-term system functioning, and then determines what of the primary or net productivity can be safely removed for human uses.

These systems must include large wild systems, or wild areas, undominated by human processes, required to keep bioregional and global cycles operating, as well as for homes for ultrahuman species. This preservation of natural processes must transcend any economic, spiritual, or aesthetic needs. Preservation is essential for survival and self-preservation. Principles of preservation and protection suggest important standards, such as saving a satisfactory amount of habitat for the largest indicator species, limiting the use of species to a

percentage of regeneration, or reducing the use of materials to natural rates of production.

2.6.5.2.5. *Precautionary Principle: When Harm is Possible, take Appropriate Action.* We should adopt a precautionary principle, which asserts that, if harm is threatened, and if there is uncertainty about the seriousness of the harm, then precautionary actions must be taken. Since the 1970s, in fact, this principle has been incorporated into Swedish and German environmental laws. This principle means that not doing something, “benign neglect,” becomes a valid management option. Carl Walters suggests that inaction is an inappropriate alternative to gambling as a result of confusion, but inaction is a very appropriate alternative in the face of confusion—when in doubt about any large complex regional system, we should not interfere. As appropriate alternatives, both inaction and action can be suggested by theory.

2.6.5.3. Actions from Principles

Principles must be flexible to mirror the flexibility of open systems; flexibility is provided by diversity and redundancy. These principles also result in a further qualification of standards and behaviors.

2.6.5.3.1. Protect Diversity

Ensure that all plans and activities protect, maintain, and, where necessary, restore biological, ecological, and regional diversity (from genetic, species, and community diversity to large cycle and pattern diversity). Maintenance and, where necessary, restoration of all types of biological diversity is necessary to sustain life in wild ecosystems. Maintaining genetic diversity means ensuring that viable natural gene pools are restored to the site following human use. Maintaining species diversity means that viable natural populations of plants, animals, and microorganisms are maintained or restored, in previously degraded areas, throughout the various successional phases for each ecosystem type within a wild landscape. Maintaining community diversity means maintaining or restoring, in previously degraded areas, the variety of ecosystem types that result from natural disturbances at a variety of scales through short and long time frames in a landscape. Biological diversity must not be viewed as a frill or luxury. Ecologically responsible designers understand that maintaining natural biological diversity is an absolute requirement to ensure maintaining fully functioning ecosystems.

To protect diversity, we also need to protect, maintain, and, where necessary, restore ecosystem connectivity. Connectivity in ecosystems is maintained, in large part, by ensuring the protection of water movement patterns. This includes microscopic water movement patterns in the soil and in riparian ecosystems, from ephemeral streams and small wetlands to large river systems and wetland complexes. Connectivity is also maintained in ecosystems by protecting and, where necessary, restoring the full range of composition and structures from the large landscape level to the smallest patch.

2.6.5.3.2. Restore landscapes

Regional ecological design involves solving problems with finesse and ingenuity, rather than with force. Rather than use an approach that label some parts as valuable and other parts as worthless or harmful, regional ecological design uses a softer approach that keeps all the parts in balance. That approach means to:

Restore whole watersheds and large landscapes. For example, degraded stream channels and fish habitat are often the results of timber management activities that emphasize clearcuts

throughout a watershed. A stream channel cannot be restored simply by replacing missing structures in the stream channel. Instead, all parts of the landscape that contribute to the loss of structures in a stream channel must be restored along with the stream channel. Pursue the satisfactory (satisficing in H. Simon's words) instead of perfect maximum or even optimum.

Mimic natural ecological processes, particularly in time. People need to recognize that natural processes of ecosystem change are the way that wild ecosystem functioning is maintained, as well as the way that ecosystems rebound following disturbances. Wild design takes patience, since many ecosystems required hundreds and thousands of years to develop, and restoration will require hundreds and thousands of years to be effective.

Recognize the complexity of interrelationships. Not only is there a wide variety of plant and animal interrelationships, but also there are soil, water, atmospheric, and geological interrelationships. Each directly influences the others. Unique regional climates are related on a regional scale. Any change produces a chain of effects, many of which are unpredictable or unwanted. Small changes can be more easily corrected.

Plan and carry out restoration activities in local contexts with local inhabitants. Act from the bottom and restrain from the top (act locally in parallel, within the constraints from the top and design). Sometimes destructive land use activities have often been designed by specialists and accomplished by powerful tools, using unlimited amounts of fossil-fuel energy.

Respect traditional practices in place-based cultures. Effective restoration requires all kinds of people with different kinds of skills. People with shovels and ideas are as important as people with machines and plans. People who live and work in local communities are most likely to have both the commitment and the patience for effective forest restoration. Cultivate feedback from the participants. Work with errors, learn from, and allow them. Attempt to set up a transgenerational land tenure system to accommodate wild ecosystem time, which spans human generations.

2.6.6. Applied Regional Ecological Design As Lessons from Nature

Design can imitate nature on many levels, from structure and process to landscapes. We can imitate the structure of mature forests, for instance, by planting on every level of the forest hierarchy, from canopy to below ground. We can use native species. We can imitate the process of forests by allowing birds, bats, and other animals the opportunity to distribute seeds and energy to other areas or prey on "pests." We can create microclimates within the landscape that may shift the landscape in new directions. Planting trees, for instance, allows new species to become established under their protection. By doing these things within a regional design, we can effect the regional patterns that emerge from ecosystems. Ecosystem health is one of the goals of design.

Natural patterns can suggest a number of regularities that could help us to understand the design of regional or global ecosystems, according to Michael Soule. For instance, well-distributed species are less at risk than concentrated ones. Large blocks of habitat are safer from species extinctions. Blocks close together are more effective than those far apart. Contiguous blocks are better than fragmented blocks. Interconnected blocks are better than isolated blocks. Corridors can make functionally larger blocks functionally. Roadless blocks are better. Human disturbances similar to natural ones are more likely to be resisted or accommodated.

These rules work well with natural processes that operate in ecosystems, such as metalysis

(building up and breaking down), animal movement, interelement flows, human interactions, and shifting mosaics. For instance, forest fragmentation can be reduced through the design of forested areas, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects. The survival of organisms usually depends on factors in the web of relations. These factors can be modified by design.

Wild landscapes are affected by climate, soils, interactions, and disturbances. Domestic landscape is affected by land use as well. The greatest changes have been brought about by the destruction and creation of forests. With the predominance of artificial forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people. But, forests are also expected to look natural and renew themselves.

The values of the land and forest must be most carefully assessed. The characteristic qualities must be identified and measured for uniqueness. Comprehensive landscape plans should be required when planting or extensive felling is planned on a large scale. The patterns established at these times may persist for many years or centuries. Good regional design may be able to resolve conflicts between characteristic qualities of the landscape and the changes from use. Of course, the design should last as long as possible and should be self-sustaining.

2.6.6.1. Levels of Regional Ecological Design

As a design process includes planning of ecosystems, this means a fifth level of design (ignoring for a moment the planet as a sixth)—notice that after number four, all are properties of normal applications of design: (6) Planet as a whole, (5) Regions, landscapes, and watersheds (as well as airsheds), (4) The community, for instance forest, city, or corporation, (3) systems, such as ecosystems, traffic, or industrial areas, (2) products, as habitats, houses, roads, or plant sites, and (1) components, such as trees, fungus, bats, tools, rooms, cars, or land. Many problems occur at level three—more are to be expected at the new levels four and five. All levels of design need to be addressed (except the global, yet), from the conceptual to the political, and are involved in all stages of the process. This involves new challenges for ecological design, which has to:

5. Relate a project to its regional context (fifth level of design). This is the level of regional cycles relating to precipitation and waste recycling.
 4. Relate a project to its ecosystem context (fourth level of design); be concerned as much with cultural survival, justice, and wilderness preservation as with efficiency and aesthetics.
 3. Consider the whole perspective (ecocentric, perhaps); the proper vision is of the whole community in which we dwell. Apply ecological concepts, such as networks and carrying capacity.
 2. Make designs that are anticipatory, flexible, pluralistic, polyvalent, and polytechnic. Make open guidelines for long-term decisions.
 1. Essentially, work backwards from values and goals, and from the bottom up and inside out, drawing designs from the genius of place.
 0. Participate in place, care for all inhabitants, and assume responsibility for the designs.
- One of the shortcomings of design has been the lack of consideration of the higher levels, which can result in specific problems with safety or recycling.

2.6.6.2. Stages of Regional Ecological Design

Ecological designs, at the global, regional or local level, can be applied in eight stages. These stages should be typical of all designs:

- First, decide to design, then create a design/management matrix, then review the situation, evaluate the ecological history of the site, observing patterns of movement, interconnectedness, population change, land use, building and development, and boundaries. Conduct ecological and functional analyses.
- Then Inventory, record all of the resources, from physical to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system. Delineate patterns and balance components.
- Create a series of plans, from the site plans to value plans. Integrate with biosystem services. Kinds of integration include: Horizontal, vertical, and temporal. Consider aesthetic-perception factors.
- Start to design, which is a community process requiring the participation of all people, including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot voice their concerns. Synthesize simulations and models (conceptual, capability, and suitability). Make another series of plans, from landscape plans to policy plans, within a master design.
- Implement the design together. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Create new connections. Reduce unwanted effects, such as road effects or heat island effects. Integrate into context. Optimize passive mode; integrate water, biomass, and materials flows. Conserve water and energy.
- Maintain and manage design. Provide services for continuity and management. Monitor and improve constantly. Monitor, Reassess.
- Prepare undesign and disintegration

Ecological design must work within the components, structure, and function of ecosystems. Unless it does, it will not be long-lasting or satisfactory. Because design has to work with systems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the larger system, sometimes the global system.

Regional ecological design takes far more time than graphic or automobile design, due to the complexity, size and longevity of its subject. A number of factors have to be carefully assessed before design work starts. Wild systems require a lot of observation before activities can take place. Wild systems can be highly reactive to change. Some people value different characteristics of wild systems than others.

2.6.7. *Applying Regional Ecological Designs*

All design elements are related psychologically by designers, as focus or frame, as contrast or uniformity, as dominant or recessive, or in a number of other pairs. Good regional ecological design means not violating any of the aforementioned principles and ideas.

Geology, climate, disturbance, and stability all produce diversity. Landscape diversity is

linked to ecological diversity, which depends on diversity of the substrate. Different ecosystems introduce diversity into a landscape, but different ecosystems often can look similar. The sum of regional and local systems yields a global system with a few large patterns composed of many smaller ones. Excessive diversity on the global level could lead to confusion in a global landscape design. Increased diversity also has the effect of reducing scale, so adding diversity can be used to do reduce the scale. A high level of diversity is acceptable if one element is clearly dominant or if the differences cannot be recognized from a distance.

Process applied to components yields pattern. Nature is composed of patterns. Organisms have characteristic patterns, such as the branching of trees or the cloud forms of tree crowns. Lichens have lobes, wood grain under stress has spirals. The cracks in tree barks form nets. Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). The pattern should allow for surprises and discontinuities; it can do this if it is flexible. The design of continental forests, for example, is vulnerable to surprises because nature is chaotic (unpredictable) and science itself is uncertain (by definition) about patterns of change in forests.

2.6.7.1. Regional Ecological Design Management

Regional Ecological design is not finished with the design. The system has to be managed in some way as a result of the design. Noninterference matrix management is proposed as a technique for design management (see discussion under ecological design). An ecosystem exists as part of matrix that many interacting elements. Any activity in the matrix can have some effect on these elements. The whole matrix needs to be managed with the local ecosystems in mind.

Understanding of the principles of ecology can lead to better management. One critical message of ecology is that if we diminish variety in the natural world, we debase it—and our own—stability and wholeness. Many ecosystems have been simplified and degraded. Perhaps we do not have sufficient knowledge to manage a complex landscape because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction with minimal intervention. We must do all that we can to restore its richness and the natural processes that created the richness.

2.6.7.2. Principles of Regional Ecological Design Management

At the regional level, management principles will be broader than the ecological or traditional. Two sample principles are listed below.

- **Work at the Appropriate Scale of Space and Time.** Scale management to the size of the pattern. At the regional level, a manager will have to coordinate regional and local managers. This will involve putting limits on some regional or local actions. The design has to be a partnership at all levels. This will involve putting human wastes and human bodies back into the system. Work with regional time; do not try to do everything in the two-year (or five-year) industrial schedule. Be as slow as necessary to introduce system changes. Attempt to set up a transgenerational land tenure system to accommodate forest time, which spans human generations.
- **Accept Management Limits.** Management is limited, by costs mostly, to regulating animal and plant populations in a local system, rather than climate, geology, or water, soil, mineral cycles—that is, regional or global things. Manipulating plants and animals

to the environment is more likely to succeed than the opposite. Management limits are determined by the ecological characteristics of the resources and the scales, before any economic, technological, or political limits are applied. The use must be limited by the ecology before monetary considerations.

Principles, combined with common sense and good judgment, are necessary as guides in the absence of definite knowledge. And, definite knowledge is lacking in systems, such as large natural cycles, characterized by ambiguity, uncertainty and chaos. Principles give us a broad predictive ability. For each principle, we have to ask, how will it affect our objectives for that pattern, and how will standards vary?

2.6.7.3. Actions from Regional Ecological Design Management

Recognizing regional level problems is easier than deciding on appropriate regional level actions. Due to the complexity of interactions, many actions will have the opposite effects of the intended ones (similar to enantiodromia in tragic plays).

- Work backwards from known constraints. That will make sure that actions do not produce situations dominated by runaway positive feedback. At the regional level, most action involves some form of restraint on technological interference or landscape conversion.
- If in doubt, do nothing. It is better to not do a right thing than to decisively do a wrong thing. Natural processes have billions of years of experience recovering from small and large-scale disturbances. So, the worst possibility of doing nothing is that we will not be able to correct a situation within a human time scale, which means that we may suffer the consequences.

Cautious actions can nudge natural processes in directions that may benefit human needs. Other cautious actions can restore broken connections or empty niches. If the management actions are slow and small-scale, in terms of actions rather than ideas and designs, then the system can do most of the work and take most of the control itself.

2.6.8. *Summary of Regional Ecological Design*

Geology, climate, disturbance, and history all produce diversity. Landscape diversity is linked to ecological diversity, which depends on diversity of the substrates and historical developments. The earth itself is a complex total system.

Gyorgy Kepes compares a total system to the growth pattern of the human nervous system. The development of the brain increases the range and scope of perception, which leads to the need for a greater control within the brain to coordinate more information. The capital of perceptual knowledge offers a richer resonance to further perceptions. However, our social perceptions, with our tools of knowledge and power, are growing without any essential control. Our environmental crises occur because of the way things are made and used according to our simple, finite, isolated, noncontextual designs. Victor Papanek states that it is a design problem. Psychologists have recognized the need for diversity for people's quality of life and emotional well-being. An increase in ecological diversity would lead to an increase in diversity of the landscape. It would also tend to reduce the scale, but this would not be a problem in large landscapes.

Regional ecological design is a five-dimensional, six-level, eight-stage discipline in which we describe particular actions. This level of design can help us adapt to place; keep track of everything (using ecological accounting); design with nature; and make the designs visible as art. Regional ecological design has to exhibit diversity.

Regional ecological design has to particular attention to emergent regional phenomena, such as atmospheric gases (especially methane and CO₂), oceanic currents, and continental drift. It also has to pay attention to regional human effects, such as ship, plane and auto transportation lanes, as well as communications technology, from wires and spectra to transmission lines and satellites. And, it has to pay attention to large-scale conversion processes, such as agriculture and urbanization, which change entire landscapes.

Regional design can be a bottoms-up process within the limits of regional constraints. To use an analogy, architects can build buildings, but the most successful ones are built within the limits of gravity and entropy, as well as within human psychological and social limits. Design has to have the courage or influence to limit production, reduce use, or even reduce human populations and use rates if necessary. It has to do this to integrate the systems into a regional pattern.

In order to accomplish a regional ecological design, we have to include the spheres of human cultures and global processes. Without a modest redesign of cultures, any actions to balance regional designs may fail as cultures focus on immediate local needs, without regard for regional cycles, at the least. The totality of human experience and its institutional systems needs to be tweaked. Cultures need to become aware of specific purposes and meanings to become viable as participants in regional actions. Cultures have been a form of unconscious self-organization, a shared experiential system communicated between generations. But, they have to incorporate large forms of design, now.

We may not want to think of design as the conscious creation of regions or the planet, which is self-organizing, although design may contribute to the creation of a more encompassing image of a region. Perhaps that image would be of a 'garden,' as Bertrand de Jouvenel suggested. And, certainly human measure is important—it may be the only way we can measure—but the system is being built within a wild region that supports all human activities with aesthetics and services.

In designing the planet, it is important to design a frame that allows natural processes that are only integrated with artificial processes through larger natural cycles. In this sense we are not concerned with the design of a product or a structure, but a living constraint on natural and artificial systems. In this sense the design is to restore broken linkages, that is, to recreate what was interfered with, to restore the system with native parts or with equivalent niche-makers, and to reduce the interference of human activities.

2.7. Fitting Regional Design with Global & Local Design

Regional designs are not going to work unless there are hooks at the local and global scale to allow or encourage the designs to work. If a region, nation or international organization tries to enforce a top-down decision model for everything, then local decisions will be much more difficult. The challenge is to start with local decisions and try to constrain and coordinate them based on regional or global requirements necessary for the continued health of local systems.

2.7.1. Regions Emerge from & Constrain Local Systems

The planet originated as an aggregation of small pieces, within gravitational and electro-dynamic constraints. Any local system seemed to resemble any other local system. At a point in its growth, the scale of the aggregation changed its interior and exterior conditions. The interior heated sufficiently to change the state of iron and nickel. Regions divided into separate spheres characterized by specific temperatures and pressures.

The sphere that was the molten core of the planet kept the heavier, hotter matter in the core. That part of the planet was not free to interact with the surface. The types of regions constrain their local systems so that they no longer interact outside the system.

Regions emerge from and constrain local systems. Regional patterns emerge from local ecosystems, from their properties and constraints. Other principles either emerge at the planetary level or become more important at that level, such as the Principle of Wholeness, which states that a whole emerges from the interactions of parts and that whole is more than the total number of parts.

2.7.2. Regions Produce & are Constrained by a Global System

The emergence of water from rock and from volcanic action created a global pool of water. The emergence of gases from the surface created a global envelope of gases. These pools then acted as constraints on regional systems in the planet. The suboceanic realm permitted anaerobic bacteria to thrive, as well as plants that could exploit shallow zones for light and animals that could use dissolved oxygen. The atmosphere limited life to water, at first. As waste products, such as oxygen and methane, joined the atmosphere and built up, the scale of that change pushed the regional and global systems to change. Oxygen for instance, interacted with ultraviolet light, creating ozone molecules under those circumstances; this reduced the ultraviolet radiation reaching the surface of land and water, and allowed living forms to exploit the surfaces, especially terrestrial ones. Global phenomena, such as atmospheric gases, imposed restraints on regional systems, especially regarding carbon dioxide or fires.

2.7.3. Are Regional Designs Ever Independent of Global or Local Designs?

Because of the dynamics of the planet at least, local systems are not independent of the regional systems in which they are contained, as regional systems themselves are pushed by global flow patterns into distinct states with various degrees of temperature and moisture. Regional designs are never independent of global designs. Scale-linking occurs with processes at different levels, such as evaporation. In a sense, no regional system can ever be completely independent of the surrounding system, planet, or solar system.

2.7.4. *Leaving Hooks & Flexibility through Design*

Regional designs can leave hooks and have the flexibility to link to local and global levels. All the constraints of a system can influence or limit design. Harmony, of course, is a constraint on the whole system. The design imposes constraints on the system, but if it is flexible, it can be altered if the system is affected negatively. Some constraints, for instance, on technological interference, have to be top-down. Flexibility, defined as the unused capacity for change, can be designed into the system. The parts of a system have to maintain the potential for all possible behaviors that could flow from any other part of the system. Although there is quite a bit of flexibility for local orders, at the global scale, it would be better to keep flows in dynamic equilibria. Diversity at the ecosystem level promotes flexibility at higher regional levels.

No local life form has had to consider the regional or global effects of its accumulated exploitations and wastes. Changes in interactions or scale happened or did not happen. Some local forms, such as bacteria, became ubiquitous within the global system. Humanity, however, has slowly, as individuals and small groups, become aware of the regional and global consequences of its wide-spread habitation, transformations and waste generation. As human designs, especially of transportation networks, waste disposal and habitations, have grown larger, people have recognized that the consequences have become negative and damaging.

A dynamic system can often reach a threshold or tipping point, beyond which the system enters a new stable state or an unstable state. Threshold: entrance, beginning point, when perceived. Tipping point turning point. The action that precipitates change is often called a trigger. A trigger is a mechanism that activates a release of information or energy (or an immediate change in scale). A trigger is also a small impulse that can release the stored energy of a larger impulse; it is a form of energy amplification. The changes triggered can be much larger than the expected results. We can suggest past triggers. The extinctions of woolly mammoths, subarctic horses and other megaherbivores, as a result of factors from climate change to overhunting, triggered the shift to less palatable plant communities after cropping stopped renewing vegetation. Fire triggered land conversion. Domestication triggered differences in animal behaviors, shapes and requirements. Fossil fuel use triggered waste, speed and atmospheric changes. We have been transforming the planet for 12,000 years. We choose what plants grow where. We grab minerals, redirect water, and spread wastes.

External disturbances such as asteroid impacts or basalt eruptions could have triggered significant transitions between different states. However, most transitions appear to have been generated internally with evolutionary innovation playing a role. There are many further considerations: To what extent is the Earth system self-regulating? What is the contribution of life to maintaining habitable conditions? In what sense can the planet itself be said to evolve? Are there reasons to explain why regulatory feedback should predominate at the global scale?

There are many kinds of physical, biological, psychological or cultural triggers. A crisis can be triggered by a change in scale. A trigger can have connections to a global system. A trigger often creates positive feedback, causing dramatic amplification (See Section 17326 for a further discussion). The novelty and complexity of interactions of innovations can lead to thresholds that are tipping points, triggering punctuations in the functioning of the system with consequences that may surprise humans.

Is there a way that abrupt changes in the operation of the system can be anticipated and predicted? Can we identify the changes are most susceptible to triggering by human activity? Many aspects of system dynamics are believed to exhibit multiple equilibrium states, and

therefore may display abrupt transitions between equilibria. There is evidence for a transition from a green to an arid Sahara in the mid-Holocene, 5500 years ago.

We admit that design and its effects can have local, regional and global consequences from slums, to the destruction of regional forests to atmospheric change. That means that all designs are going to have to be studied for fitness with other scales. No global design to change atmospheric temperature should be tried without understanding the regional consequences of shifts in wind and moisture patterns that could destroy rainforests or agricultural designs. No design of pest control should be considered without understanding its consequences in poisons spreading through regional food chains. No design to restore the regional Sahara to forests should be considered without understanding the local consequences to endemic vegetation and local adapted cultures, as well as to global wind patterns.

Design has to leave sufficient hooks, in order to respond to triggers and changes. A hook catches something due to its design, or connect the parts. Regional designs can leave hooks for local design to respond to changes. All the constraints of a system can influence or limit design. Harmony, of course, is a constraint on the whole system. The design imposes constraints on the system, but if it is flexible, it can be altered if the system is affected negatively. Some constraints, for instance, on technological interference, have to be top-down. Flexibility, defined as the unused capacity for change, can be designed into the system. The parts of a system have to maintain the potential for all possible behaviors that could flow from any other part of the system. Although there is quite a bit of flexibility for local orders, at the global scale it would be better to keep flows in dynamic equilibria. Diversity at the ecosystem level promotes flexibility at higher landscape or regional levels.

Globalization as a general trend is triggering a profound shift in human consciousness. First by forcing us to realize we cannot do anything that we want, and next that cultural differences are less important than what is held in common. Human societies, like climate, are open systems that have chaotic and complex dynamics. Recognizing that our industrial civilization is a dynamic social system that can evolve or devolve may be the key to managing changes. At the same time our civilization has become unstable, we are acquiring the ability to design living systems. Buckminster Fuller said that to change something you have to build a new model that makes the existing model obsolete; do not bother fighting the existing reality.

Joseph Tainter notices that while converging stresses can result from disparate developments, such as a harvest failure at the same time as the invasion, they are often caused by cascading crises, for instance, when a harvest failure causes famine which then triggers a rebellion or the invasion of some other society. This whole idea of cascading stresses is very important in many collapses such as the Mayan or Ik.

Thus, there may be multiple triggers or cascading triggers. Autocatalytic loops keep self-organizing structures going. A trigger of one energy form sets off flow in another, which can trigger the release of another flow in the first, and possibly a chain of trigger/flow interactions.

Triggers can also be hot or cold, depending on the lag time between the trigger and the effect. Hot triggers offer immediate opportunity to respond. Some behavior requires a trigger, although it can part of the path also. Cold triggers require later action, after a lag time. Change, however, has to be a satisficing amount to be immediate and effective, not maximal or optimal, which even if possible would require longer lag times.

Ecological design needs to make hot triggers, that is, the actions have to be immediate: Saving kilowatts, planting grasses or food, or lowering the thermostat. We claim the ability

now to geoengineer the planet with large-scale ideas and projects. Even so, there are alternate ways of intentionally reforming the planet: An easy engineering way or a more difficult way of ecological design. If we experiment with engineering ways, we might want to localize the effects, by keeping the change to as few systems as possible, maybe in the southern or northern hemisphere only. For instance, gassing with SO_2 might have drawbacks: Acid rain, and shifting plant, animal and bird life. It might trigger uneven shifts. We rely on technology to 'change the game,' but we can change the game without involving more technology, or more than we have now, by choosing ecological designs that incorporate conservation and frugality.

Ecological design requires understanding of properties and principles that emerge from the local and regional levels; some regional properties cannot be understood without knowing global history. Like the global, regional ecological design also requires a sixth level of design, which relates everything into a global context; this is the level of global spheres, such as the lithosphere and atmosphere, which thread the regional.



Figure 481-1. Mountain stream, Severen Djendem, Stara Planina, Bulgaria 2000

2.8. Insurmountable Problems at the Regional Level

Civilizations have experienced problems that seem insurmountable—because those civilizations subsequently collapsed and disappeared. Many of the problems were structural, logistical, or spiritual. Economic decline can lead to stagnation, disease and collapse. Many have to do with political power distribution, especially if related to the desire to conquer, control, and make uniform other cultures through war (and now the threat of nuclear war with nuclear winter). Over-administration has its own seemingly limitless costs that can lead to collapse. Imbalance as a general condition can lead to collapse. Some of these problems could have been solved or have been solved for a time.

Urban problems, and some national problems, seem insurmountable. Some problems, the largest ones such as earthquakes and tsunamis, seem insurmountable. The dedication of the legal system to human activities seems insurmountable. The problems listed below, having to do with water, heat, crime and structural maintenance, seem to be insurmountable for any civilization, industrial or ecological.

2.8.1. Water & Drought

Water has been a problem in many civilizations, from Mesopotamian and Indian to Chinese and American. The changes in wind and rainfall patterns or river beds have resulted in drought. In Mesopotamia, for instance, cities compensated for declining rainfall by irrigating wheat and barley with canals. But that led to salt retention in the soils. By 3500 BCE wheat and barley crops were equal. Wheat can tolerate salt at only 0.5% in the soil, but barley can take twice that. By 2500 BCE wheat had fallen to 15% of the crop, although overall crop yields were still high, then to less than 2% by 2100 BCE. By 1700 BCE no wheat at all was grown. Overall yields fell 42% between 2400 and 2100 BCE, and by 65% by 1700 BCE. It was written that the earth was white with salt. After much intensification, the land collapsed. Many of these things are long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society that needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change. The only way to avoid the problems was to let the land be fallow for long periods until the water table fell. This alternative was impossible due to food demands.

When cities started to fail, as a result of attacks or droughts, people were able to emigrate. Many returned to herding, or when possible, hunting and gathering. For thousands of years, starting possibly 11,000 years before the present, people participated in a cycle of emigration to rural areas when time were bad and immigration back into cities when the ecosystems recovered and could be made productive again.

In complex, self-regulating systems very small changes have large consequences. In some cases, where conditions like drought, are cyclic, in the Sahel region of Africa, humans expand during the good times, only to perish when the drought returns. In other cases, human activities, such as deforestation or overgrazing of herds, can cause weather changes. The scale and rate of changes allows people to view the situation as natural, but once these catastrophes pass a threshold, the people and their cultures have been trapped by their demands, and only severe reduction or collapse can allow the system to regenerate.

Drought has been a major urban or rural problem. Even cities that have been located on

rivers have been destroyed by long droughts (usually over ten years). Fresh water has become an intractable problem in the past 50 years, as more aquifers have been drained and more water sources are used for industrial purposes, such as cooling or washing away wastes. Areas of the Americas and Asia still rely on irrigation, and people steadfastly ignore the warning signs of drought and collapse.

2.8.2. *Heat & Control*

Life can be described in terms of heat differences, as well as of order and disorder. The process of ordering is like a river that flows uphill, but it creates a more massive downhill flow. Heat is necessary for indoor comfort in cold climates, but it usually comes from burning fuel. When the entire environment enters a higher heat regime, then people either adapt or emigrate. Our current form of adaptation is cooling the air in buildings by burning fossil fuels.

Individuals and groups desire to control the environment or specific events in it. Personal control is not only integral to the concept of health, but it is crucial to health. People in dependent situations, such as the elderly in rest homes, live longer if they feel they have some control. However, when it comes to large-scale temperature changes, we do not seem to have control. Living in hot climates has always limited the number of plants and animals, as well as humans. Controlling climate has not been possible with spiritual or technological techniques. Control of the environment on any but the very smallest scales has not been possible.

Heuristics, habits and shared illusions become shortcuts for understanding data and making judgments, but they can lead to systematic errors and biases, according to L. Mlodinow. Biases play an important role in decision-making, especially when related to kin or groups. When we have an illusion or bias, then we regularly interpret data to support it, rather than disprove it, even actively seeking evidence to support it, for instance, whether it is for or against global warming.

We may be efficient at recognizing patterns, but we neglect our ability to assess them critically. We need to act critically on uncertainty and incomplete patterns. We can improve decision-making by understanding biases and illusions. And, by understanding that we cannot control every circumstance or avoid every unpredictable event or catastrophe. But, we can recognize negative patterns and plan for them, that is, have a framework for making decisions about them. We can recognize irrationality and unpredictability in our own behavior.

2.8.3. *Liberty & Crime*

People like being free to do whatever they want, but they also like being secure or protected. Usually the two conditions do not occur together in one political system. Even in a favored political system, crime and civic unrest do not disappear. Dangerous weapons, from automatic guns to tanks, and dangerous products, including nuclear reactors and biocides, are available to anyone to misuse. They are not strictly regulated. People choose to act badly sometimes. If a form of government is bad or ineffective, people can alter it. They can learn from mistakes or unintended effects. If the scale is small, then the catastrophe may be small. There will always be some injustice, inadequacy, and unpredictability. One law that Adolphe Quetelet described in his social physics was that vast inequities in wealth were responsible for social unrest and crime. Large political and economic institutions have only made inequities worse.

A United Nations report has identified the world's rapidly growing herds of cattle as

the greatest threat to the climate, forests and wildlife. And they are blamed for a host of other environmental crimes, from acid rain to the introduction of alien species, from producing deserts to creating dead zones in the oceans, from poisoning rivers and drinking water to destroying coral reefs. Cattle herds are the result of ignorance of the limits of local or global commons. Corporate cattle herds are worse. Corporations are especially bad at reacting to negative feedback from overshoot or drawdown—the lag time to consequences is too great, as is the lack of a distinct trail leading back to individual or group poor decisions.

Extreme political views are divisive in a society not bound by minimum standards of behavior, especially regarding honesty or responsibility. Too little liberty results in as many problems as too much liberty, which is often the absence of agreed-upon cultural limitations. Too much division in a society, especially as regards material goods or luxuries, can result in crime as the perceived way of leveling differences. There are social controls on crime, include shame, which requires a smaller community where all people are known, and threats of punishment through laws, but shame is scale dependent, and only effective in small scale communities, and laws are only effective if they are enforced at a large scale.

2.8.4. *The Maintenance of Civilization*

What is the relationship between amounts of complexity and amounts of design? Less is more, but so is more is more.

In an ecosystem, the energy required to maintain the ecosystem is inversely related to its complexity; succession decreases the flow of energy per unit biomass until the system reaches maturity (Margalef's concept of maturity). In a mature forest, for example, almost 100 percent of the energy is required to maintain the state of the forest. Any system formed by reproducing and interacting organisms must develop an assemblage in which production of entropy per unit of information is minimized, that is, waste is minimized in cycles.

The same relation seems to apply to cities or civilizations. The simplest economic transactions were between individuals who gathered food or made tools and then traded. The number of artifacts seems to increase as the populations increase. The number of artifacts seems to increase as the complexity of a culture increases. Materials can be used to express power. With the increase in specialization and complexity, came individual traders, then guilds, and finally corporations. A complex (or mature?) civilization tends to use 100 percent of its energy to maintain itself.

In every case where civilization has become more complex, according to Joseph Tainter, the cost of maintaining that structure has required an ever-higher percentage of income be set aside for maintenance; that income is no longer available to increase the standards of living. Modern civilizations have avoided collapse only by overusing fossil fuels to hide or override their true costs.

2.8.5. Design to Surmount

The ecological design of civilization has to address the true costs of maintaining levels of control and luxury. Ecological design has to be the creative modification of ecosystems to repair or enhance their ability at self-organization and the maintenance of their complexity and diversity. But, most of all, it has to become capable of reducing some forms of complexity and reducing improper uses of energy. Design has to fit human exploitation within the limits of a changing planet.

2.9. Architecture & Deep Ecology

By Arne Naess

Two areas of problems today require unusually long time perspectives: architecture and population. A slow but steady decrease of human population may perhaps start already in the twenty-second century, but an ethically and socially acceptable decrease to a significantly lower level must take many centuries. There must be action today, but desirable results may be in a distant future.

Architecture is today conceived as a sort of modification of Earth ecosystems and the good of both human and non-human living beings is taken seriously. Landscape architecture is already an old discipline, but has not often been studied within an ecological framework: seeing towns and cities as parts of landscapes, and landscapes as parts of ecosystems. Architecture, adapted to a population of 10 thousand million, or more, requires a lot of new ideas and procedures.

Supporters of the deep ecology movement insist that ecological sustainability is only realized globally or regionally when full richness and diversity of life forms (in a wide sense) is protected. Humans and human cultures are life forms, and their protection includes what is vital for them. But the present human domination is intolerable. Areas of tree-plantations, tree farms, gardens, parks (in cities), are areas of greatly diminished biodiversity. Tree plantations now occupy areas that are too vast.

Cities cannot, of course, contain areas of wilderness, but future cities, like many cities centuries ago, can contain areas of "free nature." Such an area is one without domination by humans but with scattered human population. They do not interfere with its flora and fauna and other life forms. One important difference from areas of wilderness is the size: an area of free nature may be very much smaller. In the Norwegian capital, Oslo, there were in the last century many areas of free nature, some less than 50 by 50 meters (2500m²). A difference from parks is of great educational importance: children were free to do what they liked in those areas (lökker) and access was not dangerous. If the ground was hilly, children made ski jumps. Small children could make use of any natural object in their play. Real estate prices in this century gradually made the free areas "much too valuable" (in dollars) to avoid "development."

From the point of view of ecological education, the spots of free nature are crucial because small children in cities and towns get intimately acquainted with the chaotic and infinitely diverse character of nature without being transported out of town or city. Growing up, children are gradually better equipped to reach larger areas of free nature, and many eventually are able to spend part of their time in wilderness.

Many of the most devoted supporters of the deep ecology movement have grown up either in cities or towns with small areas of free nature, or have, as children, enjoyed a home close to larger free areas. It is a long range problem of city planning to provide children with easy access to small areas of free nature.

The ecologically and technically cheap accessibility of the city population to large areas of free nature has steadily diminished in most places in Europe.

Before talking more about cities, I shall once more mention wilderness. For obvious reasons, it is common to see an antagonism between wilderness and human habitation. But Alaska was through many centuries a vast wilderness, but practically everywhere people, the

Indians, were present. The places have names that attest to their presence. It is likely that the land could have retained the status of wilderness for more centuries. The white man made that impossible. Sami people (Laplanders) inhabited Finnmarken, the northern-most part of Norway, for centuries and did not interfere seriously with the full richness and diversity of life forms. Now the excessive number of tame reindeer, and also other factors, has terminated the wilderness status of Finnmarken.

In short, the planet may be divided into three types of areas: wilderness, patches of free nature, and human dominated areas. Just as an idea to be mentioned in connection with a number of competing ones, consider the tripartition of the total habitable area of the planet, one-third wilderness, one-third free nature, and one-third human-dominated. The term *habitable* is inserted because the Antarctic and the extreme Arctic areas are kept out of the present discussion. (If part of the vast Soviet radioactive material stored in the extreme Arctic is not kept isolated from the ecosystems, the areas may have to be classified as man-dominated.)

But back to the cities!

Homes are increasingly built with close attention to minimize energy consumption and to other ecologically essential aspects. I shall not talk about building but rather about city planning.

It is a fairly common hypothesis that people brought up in cities without access to free nature will either be indifferent towards further elimination of wilderness and decrease of free nature or will have a low priority need and only spend a short vacation now and then in such areas. This means that, in the present intense conflicts of interest that are determining the rate and persistence of destruction, the indifference of inveterate city people will be on the “wrong side,” that is, among the passive or the “developers.”

It is difficult to assess the tenability of the above mentioned hypothesis. In any case, I think it of great importance that in the next century small children in the cities have *easy, safe* access to patches of free nature. Most of the very active supporters of protection of wilderness and free nature have enjoyed early experience in such areas. But there is still a too small minority of dedicated people to change present policies radically. At elections in Western democracies too few people support politicians who show courage in ecologically relevant conflicts. How can they propose responsible policies when it does not pay in elections, but presumably causes staggering losses?

In short, one of the important reasons for establishing access to free nature in cities, and not just parks, is that of maintaining and increasing the number of people who very early in life acquire respect and love for nature.

The 1990s seemed to be a time for environmental ethics to be taken seriously in schools and universities here in the West. In Norway, considerable sums have been earmarked for ethical research and teaching. This should be greeted with joy and appreciation, but I think that a major change of attitude towards nature and ecological systems as wholes largely depends on deep experience in nature, not so much on teaching that tells us to behave better. Presumably, our government agrees. But it costs so much more to prepare conditions such that everybody, or a substantial minority, can fairly easily change habits in the direction of a ecologically sustainable lifestyle. It still takes considerable personal initiative to do so. It costs so much less for governments to hand out money to science and ethics.

As it is, most cities grow concentrically and increase the average distance to big areas of free nature. Oslo is a tragic example. When I was a child, broad areas of free nature made

it enjoyable to ski all the way to the front door, or at least within easy walking distance from home. Then, gradually, the distance increased. Public transportation helped, but eventually people tended to go by car. So, after cross-country skiing one has to sit in a car driving through traffic instead of taking a shower and relaxing. A lot of problems arise every time people feel they need free nature.

As to transportation, Sweden may be the leader in making it possible to use bicycles, both in cities and outside, without risk of being hit by cars. In Canberra, Australia, and perhaps other cities, there was recently (1992) a stagnation in the development of bicycle paths. The argument used is the increasing rate of accidents. These are due mostly to bad construction: It was until recently assumed that people bicycled very slowly and that sharp 90 degrees turns were safe. But people often bicycle over 20 kph; then such turns are dangerous.

On a global scale, a major problem in the twenty-first century will be how to make cities livable: how to make it possible to live a healthy and decent life in Mexico City and dozens of other great cities in the less industrialized world. There is no space outside cities for the additional thousand million people. Somehow they must be contained in cities. Reforestation is necessary and the continual deforestation for the sake of subsistence agriculture must be stopped. The area of good soil for agriculture is decreasing. Even if it should be practical to change direction and get more square kilometers, there will not be soil for a thousand million more farmers. Clearly, the architects of the rich nations should cooperate with those of the less rich to work out plans as to how to solve the significant city problems ahead.

Helena Norberg-Hodge has won international fame for influencing architecture in Ladakh, but the power of irresponsible developers is staggering. It is an astonishing thought that she got to be world famous for doing something that so obviously must be done, and should already have been done in thousands of areas, not only in Ladakh and practically nowhere else. She has introduced solar energy in small homes and has otherwise been able to help the people of Ladakh proceed from premodern to postmodern, ecologically sane conditions. Or, to be more honest, she has gone a long way on that road, but is increasingly hampered by Indian "developers" of the conventional kind. It is lamentable how few architects are available in the less industrial societies. Not to improve the style anywhere, but to cooperate with the tiny minorities who are fully aware of the catastrophic developments in cities and even in the villages. The upper classes, including the politicians, are on the whole imitating the West, and the few who are in opposition for ecological or other reasons are not properly supported.

I shall end with a few words about what is called the deep ecology movement. It is distinguished from the reform or shallow movement, headed by people who trust that better technology, better scientific understanding of particular phenomena, such as ozone layer and climatic changes, and stricter rules for combating pollution will do the job. The supporters of the deep ecology movement think that changes of value priorities are necessary. They consider life on this planet to have a value in itself. The deep ecology economists are studying how to have ecologically sustainable economic progress during ages of slow population decrease, that is, progress in the satisfaction of vital needs of the populations. But there are two most essential points. The first is the grounding of ecological policies on philosophical or religious attitudes. In the last five years, the Christians, for instance, have with increasing strength announced that we have sinned against God's creation, and that everything directly created by God has inherent value, therefore all living beings and the untrampled landscapes have such value. But

most supporters have such a life philosophy, including value priorities, independent of any religious foundation. The second is that the supporters stress the need to be active politically in order to change society, especially the consumerism of industrial societies. Below is a useful condensed characterization of tenets fairly generally accepted by supporters of the deep ecology movement. Of course, they cooperate with the activists of the reform movement, and also with people active in the peace movement and the movements to fight desperate poverty and brutal tyranny. The eight points of the deep ecology movement are:

1. The welfare and flourishing of human and non-human living beings has value in itself.
The value of the non-humans is independent of their usefulness to humans.
2. Richness and diversity of living beings has value in itself.
3. Humans have no right to reduce this richness and diversity except to satisfy vital human needs.
4. The flourishing of human life and cultures is compatible with a substantial decrease of the human population. The flourishing of non-human life requires such a decrease.
5. Present human interference with the non-human world is excessive and the situation is rapidly worsening.
6. Policies must therefore be changed. These policies affect basic economic, technological, and ideological structures. The resulting state of affairs will be deeply different from the present.
7. The appreciation of a high quality of life will supersede that of a high standard of living.
8. Those who accept the foregoing points have an obligation to try to contribute directly or indirectly to the implementation of necessary changes.

Since the start of the international ecology movement in the 1960s, architects have been in the forefront, explaining hundreds of small and great ideas about how to make architecture ecologically responsible and progressive. But we need their voice increasingly clear and strong in the realm of local and global planning, solving the vast problems of responsible use and non-use of planetary space, never forgetting that we are small parts of the Earth. If we ever get in contact with living beings in comparable paradisiacal planets, they may be so far away that it will take a hundred thousand years for a Christmas or New Year telegram to reach them.



Figure 290-1. Arne Naess (left) at the Greenpeace Office opening in Oslo, 1988

3.0. Framing Nature for Design

Nature is a name we assign to a complex of things that occur in the dynamic planetary system. The system can be described as a set of interacting spheres—the geosphere, the atmosphere, the hydrosphere, and the biosphere, which interpenetrate and interact. The system has specific characteristics that have developed over billions of years: The atmosphere, for instance, has a unique composition, which is kept that way by the cycling processes driven by the sun and equally by a diversity of living forms living in complex, changing ecosystems. As a result of these activities and the composition, the planet has a relatively cool temperature.

The environment of the planet, that is the solar system and extrasolar space, is relatively isolated from local high gravitational influences as well as from intense radiation. However, it is also dynamic and provides many kinds of surprises and challenges, from the shifting of the planetary orbit to interstellar gas lanes and colliding space objects.

The biodiversity of species and living environments has to adapt to the planet and its larger system to survive. The very slow changes from plate tectonics or climate shifts are also challenges, as are medium and large collisions with planetesimals. We tend to call these events catastrophes if a large number of species or families of species are driven to extinction. We think of them as anastrophes (positive turnings) if the environment is stable for long periods of time. Thus, life suffers mass extinctions, but responds with equilibrium levels of diversity.

Energy from the sun, combined with material cycles and living ecosystems, keep the global system in a mature high-energy state. Can these cycles and ecosystems be designed? Can we design forested systems that keep the cycles going? Can we do that with animal patterns or wilderness patterns? We have to try, because we cannot invent wilderness from rock, nor can we drive global material cycles with a technology of nanobots and computers. The designs may have to be limited to anticipating large events and disrupting them, to limiting human use and restoring ecosystems, to shaping human impacts and managing in partnership with nature (with benign neglect as often as possible).

Natural materials have been created and broken down for millions of years. Exotic materials, from human industrial processes, are different. In most cases, there are no predators or recyclers that can eat or break down the materials.

Processes are responsible for distribution of elements. This results in renewal. Processes range from wind and fire to erosion and succession. Most all processes require energy acting on materials. The sun is the source of energy for most processes, but we have to recognize that the human use of energy has consequences to the natural systems, especially when too much energy is dumped into a the system in terms of waste heat.

Natural processes, such as fire, wind, or species explosions, would be allowed to operate freely, even if they altered the functioning of the system. After long periods without disturbance, a catastrophic disturbance is more likely—where wind and fire are absent, the probability of insect and disease outbreaks increases. Yet, even catastrophic disturbances like hurricanes rarely damage more than 5 percent of a forest. More than being agents of mortality, insects, diseases, and animals are native components of complex food webs in ecosystems that contribute to the selection of certain kinds (including healthy) and ages of trees (that determines the composition of the forest, which changes over time).

3.1. [Empty Topic; refer to *Redesigning the Planet: Foundations*]

3.2. [Empty Topic]

3.3. *Regional Design Factors: Ecosystems Communities & Organisms*

Why should we be considering these factors—ecosystems, communities, populations, and organisms? An ecosystem is a discrete unit consisting of interacting living and material components. An ecosystem is the unit of survival for living beings and communities. Organic structures, are building blocks for organisms for eating or nesting. They also nourish the soil. Ecology deals with the highest levels of biological integration, from organisms to the ecosphere. Autecology, for example, is the study of individual organisms in an environment. A group of individual organisms of the same species in a particular place is studied as a population. The assemblage of populations of different species in a habitat is studied as a community. The community in its biotic environment is studied as an ecosystem. Ecosystems comprise the ecosphere. There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes.

A living system is produced by living beings. A system is a set of things—such as people, cells, or molecules—according to Donella Meadows, interconnected in such a way that they produce their own pattern of behavior over time. The system may be buffeted, constricted, triggered, or driven by outside forces, but the response is characteristic of the system. A system is not just a collection. It is an interconnected set of elements that is coherently organized to achieve something. The system maintains its identity, despite the replacement of elements, molecules or organs.

Human perception of nature seems to be hierarchical, regardless of whether nature is. Several theorists distinguish levels of hierarchy in nature. G.T. Miller includes particles, atoms, molecules, organisms, societies, and nations. Mario Bunge extends the list to include processes and knowledge: Elementary particles (atoms, bodies); physical systems (organisms, ecosystems); physical processes (chemical, biological, social); material production (ritual, culture); and knowledges (physics, history). Ervin Laszlo makes a distinction between a macrohierarchy, comprised of a space-time field, particles, stars, galaxies, and various aggregations; and microhierarchies like the earth, composed of molecules, crystals, cells, organisms, ecosystems, and Gaia. Hierarchies can be regarded as vertically arborizing structures whose branches interlock with those of other hierarchies at a multiplicity of levels and form horizontal networks; arborization and reticulation are complementary principles in the architecture of organisms and communities.

3.3.1. *Ecosystems*

Some ecologists, like Arthur Tansley felt that the word community was too anthropomorphic, that plants did not voluntarily live together. So Tansley coined the word ecosystem to represent the interrelatedness of nature and to emphasize the flow of energy through a system, such as a forest or pond. The systems concept, however, is concerned with more than just a number of

elements or their kinds (species); it is concerned with relations between them. These relations are not explainable from the elements, hence, 'the whole is more than the sum of the parts.' The relations are emergent, that is, they are new 'things.' The theory of systems offers unique properties and principles, such as wholeness, novelty, growth, and openness.

A thing that grows, repairs, holds itself together, oscillates, and capture solar energy is an ecosystem, a system resulting from the integration of all the living and nonliving factors of the environment. An ecosystem is a community of organisms interacting with one another and their environment. Odum describes the ecosystem as a unit of organization undergoing an orderly process of development that is reasonably directional. Ecosystems, the essential unit of ecology, must be seen in dynamic and historical terms.

Ecosystems comprise the ecosphere. There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes. Ecosystems are the result of historical processes that are mathematically atypical. Furthermore, they are not randomly structured. A system drives to a nonequilibrium state as a mature ecosystem. The adaptively reorganized system is not necessarily more stable, but it is optimally resistant to the outside conditions that elicited the self-organization, a natural normalization process. The ecosystem learns the changes, periods, or seasons of the environment.

Ecosystems are ambiguous in a sense, since anything from a log to a watershed can be an ecosystem. Furthermore, ecosystems overlap and interact. It is possible to define close but not exact subsystems. The vast number of interrelationships between systems keeps them open. For example, grassland is affected by climates, soil conditions, fires, surrounding communities, and human agents. Ecotones between systems are usually shifting. Each ecosystem is unique and original. Each patch (locality) supports a segment of the total species population in a unique context, with a particular set of predators, competition, food, or physical habitat.

Ecosystems build up information. There are three different channels of information in an ecosystem: a genetic (in replicable individuals); an ecological based on interaction between cohabiting species (expressed in changes in their numbers); and the ethological or cultural, transmitted through individual learning based on experience.

Feedback within the interaction of a species is expensive memory with little storage capacity. Whenever succession starts again, after a volcano eruption for instance, old information in form of interactions has not been saved. Genetic memory has much larger capacity and is long-term. Cultural memory enlarged with higher vertebrates.

Ecosystems are described with a variety of terms: energy, matter, entropy and ektropy, productivity, cycles, diversity, complexity, stability, and trophic structure. Many terms in ecology, such as biomass, stability and diversity are inexact. It is almost impossible to estimate the amount of degraded energy in an ecosystem (that is, entropy from transpiration or mixing of water).

One problem with describing ecosystem attributes is that both quantitative (measurable) and qualitative (conceptual) factors are included. Resistance to external factors, for example, is a qualitative attribute. This may be more the result of succession than a factor producing an ecosystem. All ecosystem properties are not equally important. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. Behavior at any level is explained in terms of the level below, but its significance is found in the level above. Ecosystem behavior does not emerge from a set of organismic equations.

Properties (see Section 2.2.3.1.1.) of an ecosystem include: Wildness, Productivity, Diversity, Complexity, Stability, Change and extinction, Historicity, Wholeness and renewability, Multitude of parts, Structures, and Functions. Ecosystems can also be described by a series of principles:

- The ecosystem is the level of integration and the unit of organization undergoing a directional development (after Odum).
- Energy is bound into organic material, measurable as productivity.
- Energy/matter is transferred through individuals as a food chain.
- The interaction of individuals in a food chain results in trophic structures (pyramids).
- Chemical elements circulate in the biosphere in biogeochemical cycles.
- Energy and material no longer used by a system is the waste of that system (entropy)
- Life is limited by elements and physical factors, e.g., water or salt.
- Too little limits life (Liebig's law).
- Too much limits life (Shelford's law of tolerance).
- Energy required to maintain an ecosystem is related inversely to maturity (Margalef's concept of maturity).
- An ecosystem has a minimum size.
- An ecosystem has a distinct pattern, related to health.
- An ecosystem as a level of integration and organization undergoes directional development
- That quantity of energy and material no longer of use to the system is wasted.
- Chemical elements, especially those of life, circulate in the biosphere in characteristic paths known as biogeochemical cycles.
- Life is limited by elements and physical factors (light, water, gas, salt); too little of an element limits (Liebig's law); too much limits (Shelford's law of tolerance).
- The transfer of energy and materials through organisms is referred to as the food chain.
- The interaction of individuals in a food chain results in the trophic structure of communities (ecological pyramids).
- The energy required to maintain an ecosystem is inversely related to complexity; succession decreases the flow of energy per unit biomass (Margalef's concept of maturity).

To maintain ecosystems, we can create standards based on those properties and principles; these may be qualitative or quantitative. Sample standards (many of these based on Conservation Biology) include:

- Preserve the spirit of a forest place, e.g., leave places of special character
- Preserve minimum species and habitat for wholeness
- Preserve diversity at all levels
- Retain appropriate shapes and corridors for pattern unfolding
- Retain hierarchy of all levels
- Allow for limits, disturbances, processes, adaptation, evolution
- Leave snags and fallen trees, e.g., 4 snags per acre, 7 downed woody debris per acre
- Leave 2x buffers around riparian zones, e.g., 140 ft in coniferous forests
- Restrict roads/trails to appropriate terrain, e.g., to >10% grades on rocky soil
- Use appropriate equipment, e.g., cable yarding, in steep areas
- Take/leave trees of all ages
- Avoid damaging activities, e.g., slash burning

Based on these standards, we can describe practices of exploitation, which would allow limited exploitation of an ecosystem, to keep it wild and healthy. Samples of Practices include:

- Maintain size and completeness of forest
- Strengthen shapes and margins
- Keep density and openness in a balance
- Preserve the interior/protect riparian zones
- Plan paths to avoid sensitive areas and emphasize pleasing perspectives
- Bundle paths (power lines, utilities) to minimize intrusion
- Preserve the character and all aspects of the forest

Properties, principles, standards, and practices are then used to restore and maintain ecosystems, as well as landscapes and biomes.

3.4. Regional Design Factors: Landscapes & Biomes

A landscape is a heterogeneous area composed of a mosaic of interacting ecosystems of various sizes. A Biome is a large ecologically defined biotic community smaller than the planet, broadly corresponding to a climatic region and the physiognomic character of vegetation. The tundra biome is an example. How are these regional design factors like cycles and spheres? They recycle elements regionally. Biomes contribute to climate, not only by the types of landforms, but also by biological activities and densities. Landscapes contribute to cycles and flows as a result of their form and size. Transforming an entire landscape alters flows.

Landscape is a convenient idea that serves as a unit of analysis. Landscapes have a range of scales rather than an intrinsic spatial scale. As ecology undergoes a scalar shift, microecology, with ties to cellular biology and dominating the field, yields some attention to macroecology, the study of wildlife and landscape ecology. Macroecology has fewer practitioners. Russian scientists pioneered the concept and only recently have other scientists perceived the need for regional and global scale ecology. Ecology can mimic geology by working at multiple scales.

3.4.1. Landscapes

The patterns of ecosystems are addressed best at a landscape level. The word landscape was used by the geographer Alexander von Humboldt as a scientific term in the 19th century. A German biogeographer Carl Troll used the phrase “landscape ecology” about 1939 to describe land—and not just living organisms—as an integrated holistic entity to be studied in its totality by geographers and ecologists, geography providing a horizontal approach to the vertical one of ecology. F. E. Egler in 1942 emphasized the active role of humanity on the holistic nature of vegetation in the landscape. Later, Raymond Dansereau noted that landscape was the highest integrative level of environmental processes. Like G. P. Marsh, Dansereau described landscape modification by humans throughout history.

The modern science of landscape ecology was developed in Europe in the 1970s and formalized as a discipline during that time. Landscape planning is interwoven with the interdisciplinary aspects of urban and regional planning. Naveh and Lieberman list three factors that form a new science of landscape ecology: (1) Landscapes are recognized as

natural and cultural entities whose health and integrity are vital for human survival; (2) As an approach to the study of landscapes, the conventional reductionistic scientific paradigms are replaced by integrative and holistic methods based on a systems view; and (3) Technological advances in remote sensing and satellite images, combined with the capabilities of processing large quantities of data, support the possibility of dealing with landscapes holistically.

Landscape ecology is a goal-directed science for studying the complexity of landscapes, as well as for preserving their integrity and health and natural and cultural diversity. In order to manage complex landscapes, it has to develop better methods for study and management. Landscape ecology addresses the overall patterns of large-scale ecosystems, considering the biogeochemical, atmospheric, and hydrological cycles in relation to the shape and extent of individual landscapes. Landscape ecology can identify: Candidate ecosystems for restoration; candidate ecosystems for preservation, conservation, or reservation; and, patterns of forestry to preserve larger functional islands. Landscape ecology, with its holistic, cybernetic ecosystems approach, can address the emergent features of large systems and large cycles.

Landscape is the level lower than the biome and larger than the site or watershed. Landscapes include stable communities and fragile habitats. A landscape has to be large enough to offer diversity of resources for cycles, and small enough for exchange between organisms. It has to have sufficient time for development, that is, changes cannot be too fast. It has to incorporate a number and diversity of species, trends and patterns.

Before satellite data analyzed by GISs, ecologists and foresters did not have tools that could address the scale of landscapes. Regional and global data was hard and expensive to collect. The International Geosphere Biosphere Program (IGBP) coordinated by the U.N. uses GISs for global and regional issues, such as deforestation or desertification. The large images from satellites are exceptional for identifying landscape patterns, especially those related to the scale of species behavior, e.g., home range or breeding dispersion. Pattern can also be measured at the level of patch size and spatial relationships (that is, inter-patch distance), which is critical for relating the size of a habitat to the species in it—to apply the theory of island biogeography.

The data derived from satellite imagery and from field studies can be used to model the landscape at various levels. Some of these tools are used for specific problems in the classification of forest ecosystems and harvesting schedules.

3.4.1.1. Morphology History & Productivity

The morphology of a landscape has effects on nutrients and soil. For example, slope stability determines the potential migration of material into watercourses, the effects on landscape structure, changes in overland flow of materials and nutrients, and, changes in habitat conditions suitable to resident species. Soil erosion causes changes in physical properties of soil, such as structure, texture, bulk density, infiltration rate, depth for favorable root development, and available water-holding capacity. These flows determine the productivity of a landscape.

As humans began to settle permanently to exploit their surroundings continuously through agriculture and animal productivity, landscapes became more disturbance-dependent and became less resilient to climatic events. Human cultures attempted to cope with risks or to exploit opportunities, which required more management of the environment, although different parts of the environment operated at a range of scales, most of the natural dynamics and landscape occur slowly by comparison with human dynamics. As a result humans adapted themselves to a dynamics of the environment at the beginning, but over time cultures served

their own needs by modifying the environmental dynamics. Human cultures thus become dependent on colonized systems, which required certain social institutions, especially those involved in organized production and storage.

Descriptions of historic landscape disturbance regimes, e.g., fire magnitude and frequency, and the ecosystem component patterns they maintained, e.g., vegetation composition, provide an initial template for descriptions of ecosystem health. Some regimes result from economic needs, such as large timbers, as well as from cultural influences and human values, especially fads. In a way, the internal disturbances have as much effect on the dynamics of forest communities and forest landscapes as fire and blowdowns. Castello, Leopold, and Smallidge suggest that pathogens, by eliminating less vigorous or genetically unfit (filtering them out of the stream of life), control the direction and rate of succession. Tree mortality from pathogens occurs on various scales: gap phases (small scale), forest development (large scale), and landscape patterns (immense scale). Pathogens are one of the determinants of growth and development. Pathogens determine tree mortality, which drives forest and landscape patterns.

3.4.1.2. Human Uses & Impacts on Landscapes

Human use of fire, as mentioned, can shape landscapes. Geologists have noticed an increase in fossil ashes from the Pleistocene (1 million years BP—before present) that may indicate that early hominids used fire. Peking man (250,000-350,000 years) definitely had fire. Deliberate fires for clearing land and accidental fires from lightning strikes and drought have all destroyed forests. Before settlers arrived in the western America there were few large fires—although large fires periodically occur in certain kinds of forests, e.g., in lodgepole pine forests every 300 years or so. Since then, large fires have become a regular feature.

Environmental factors have shaped the course of human history to a greater extent than had been realized. The decline of Rome is a study in forest ecology. There were previous catastrophes in the Tigris and Euphrates valley, Greece, Khmer, Maya, Midwest United States, and the Australian outback. Many peoples could not solve their problems; many immigrated to new lands.

Only in the 19th century, beginning with G.P. Marsh, did people start to realize that humanity has done as much to change the environment as the environment has done to mold human history. Marsh, the first American ambassador to Italy, was one of the first to study the role of humans in changing the face of the earth. When he visited the near east in the middle of the 19th century, he was shocked to find deserted cities, silted harbors and wastelands instead of flourishing civilizations. He concluded that ecological errors had led to the deterioration of agriculture in Mediterranean countries. To avoid future deterioration, he advocated agricultural conservation practices.

Land continuously occupied by humans may form analogs of natural communities, guided by trial and error, by unconscious values, and by random changes. The American tall-grass prairie is a case of the creation and maintenance of an artificial but desirable ecosystem. Unfortunately, it was dependent on a multiplicity of unintended accidents. Ecosystems evolved through natural events, then as an effect of human activities, now through deliberate social choice in some places.

The archaic universe was regarded as the creation of order out of chaos, with humans contributing; nature and man are harmonious. Now, there is arrogance from Plato to Dubos,

that all human action improves the spontaneous course of nature. Dubos was disturbed that farms are overgrown and does not like to see vegetation revert. Dubos dreaded forest regrowth in New York as barren and uninteresting, but Leopold felt in Wisconsin it was a welcome prophecy of nature's second coming. This is the same Leopold who had once wanted to raise deer in a wolfless world, but later realized the necessary function of predators in a balanced community. Dubos and others have claimed that "nature knows best is wrong," that nature is inefficient and wasteful. But, ecosystems that seem inefficient and wasteful are many times extremely redundant, and therefore stable and flexible. Natural processes that seem destructive are cyclic and preservative also.

3.4.1.3. Landscape Management

Once a landscape has been exploited or modified, it has to be managed for as long as human use is considered. Of course, landscapes can be allowed to become wild again, but the process is lengthy. In the late 1970s, C. S. Holling described Adaptive Management as a response to natural disturbances at the landscape level. Matrix management (Noninterference) can be used to deal with designed landscapes, especially forested landscapes exploited with ecological techniques (Wittbecker, 1992). Shortly afterwards Alan Savory applied his ideas of Holistic Resource Management to preserve the quality of the landscape. The 1980s also saw a comprehensive Integrated Resource Management (Mitchell), Permaculture as the expression of a permanent responsibility for the landscape (Bill Mollison), and the Wholistic Timber management (Herb Hammond), which was dedicated to maintaining the structure and functions of diverse forests.

We must pay attention to the processes that make up the habitat, for example, the role of herbivores on trimming vegetation (and diversifying it by predation). The design of the forest and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved. The forest, however, cannot be considered outside of the context of the entire landscape, including human images and institutions.

3.4.1.4. Conclusion: Importance of Healthy Landscapes

Healthy landscapes reflect a balance of processes, including extinction, colonization, and connectence. Colonization is necessary to equalize local extinctions. The loss of colonization, for any reason, can allow species in a local system to be depleted. Island ecosystems, surrounded by poor areas, may lose species without colonization. If the matrix is rich enough, there should be successful colonization.

Wild landscapes are affected by climate, soils, interactions, and disturbances. Domestic landscape is affected by land use as well. The greatest changes have been brought about by the destruction and creation of forests. With the predominance of artificial or managed forests, it is important to consider the qualities of naturalness in the landscape. Forests are expected to meet the needs of society by producing timber, creating wildlife habitats, and providing recreational opportunities for people.

3.4.2. *Biomes*

A biome is an ecologically defined area spread over water and land that contains geographically distinct assemblies of ecosystems and communities (similar to a bioregion or ecoregion). The patterns of ecosystems within a biome are associated with characteristic combinations of soils

and landforms.

Biomes are larger scale than landscapes, which are often applied as a term only to human modified areas. At this scale things build up slowly. The system can absorb or loss many components and still stay relatively recognizable and stable. The system has momentum. The time it takes for change to become apparent lengthens, often beyond the longest human plans or consideration.

Many biomes have been altered tremendously by recent human impacts, especially grasslands and rainforests. Further landscape-level planning needs to be conducted over time and in cooperation with surrounding forestland owners/managers of both private and public forestlands. The negative effects of planning and nonmonetary effects are usually missing from such plans. Ecoregional context is also missing.

Except for the scale, and longer-term persistence, the design and management of biomes shares many similarities with ecosystems. The goals would have to be larger at this scale, and the designs would have to be less certain and more flexible.

3.4.3 Dealing with Change

How we treat large-scale communities is an important question. Deep ecology is one form for asking questions about landscapes, especially forested ones. For example: How can we design forests for neutral elements in interrelated processes in a landscape? What are we restoring when we restore an ecosystem without all the parts or good knowledge about the ones we have? These questions highlight the uncertainty we face in dealing with large, wild, complex, long-lived entities at the scale of landscapes. Managers have to live with uncertainty; this means that management decisions are essentially gambles. Gambling is a profession that acknowledges the operation of chance and makes conclusions in the absence of facts—few people are successful at it. This is an important admission, that we do not have facts to base our actions on, that nature is a stochastic process, and that landscapes and biomes always changing. Furthermore, we do not know for sure what effects our actions will have on landscapes, which live so long, in such diversity, in many places. Successful gambling suggests that the proper attitudes for gambling with nature are awareness, humility and courage, not arrogance and maximum use.

Perhaps we do not have sufficient knowledge to manage a complex landscape because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction with minimal intervention. Perhaps we lack sufficient courage or willpower to manage large-scale forms. According to Garrett Hardin, many of the ideas necessary to fit humanity into the pattern of nature are known but not yet popular. For instance, exponential population growth or exponential economic growth cannot be maintained very long. Human communities cannot grow 4 percent per year without disastrous consequences to the infrastructure and the quality of life. Growth cannot be continued because the landscape is limited, in terms of productivity, energy, and resilience. Thus, we need to fit our population into the limits of a landscape or biome, although some limits can be expanded by technology or by lowered expectations. Redundancy at this scale, with regional self-sufficiency, keeps global limits less critical. The carrying capacity of the area is not only a function of the limits of the community, but it is equal to the number of people multiplied by the level of comfort (quality of life style). Changing the scale of concern does not solve any problems relating to overconsumption or drawdown; it just displays the regional limits sooner.

3.5. Regional Design Factors: Regional & Planetary Cycles

Many elements, materials and nutrients are moved in cycles that can have local, regional or global pathways. A cycle is defined as a pathway along which an element moves through biotic and abiotic compartments. All the chemicals, nutrients, or elements—such as carbon, nitrogen, oxygen, phosphorus—used in local ecosystems by living organisms stay in a relatively closed system, which means that these chemicals are recycled instead of being deposited or lost. Virtually every material cycles through an ecosystem: Phosphorus, potassium, calcium, sulfur, magnesium, and water. Nutrient cycles change with the development of ecosystems.

Energy and materials can be traced through transfers through compartments in an ecosystem. For example in the nitrogen cycle in a forest, the compartments are the atmosphere, vegetation, forest floor, and mineral soil, while the transfers are precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification. Each compartment keeps the nitrogen for a certain time, termed the residence time; for a hardwood forest floor, for example, residence time is about 17 years. If the compartment keeps the element for a long time in large quantities, it is called a reservoir, like the ocean; if the residence is short, the compartment is called an exchange pool, like a cloud.

Some reservoirs, such as the atmosphere, allow rapid movement. For example, almost any gas or fine particulate matter released into the atmosphere can spread across the planet in days. And, because of the movement the atmosphere stays in a pattern of dynamic equilibrium. Some cycles move at higher speeds than others. Some speed up seasonally or daily. Microbial activity speeds up an iron cycle. Tectonic activity can renew some cycles, such as the phosphorus cycle.

Some nutrients cycle between other ecosystems or in larger patterns around the planet. These regional and global cycles keep nutrients moving. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are centuries or millennia long. Human beings do not pay much attention to very long cycles or to those we perceive as not affecting us. Sometimes we deliberately or inadvertently interfere with cycles. An excessive concentration of carbon dioxide in the atmosphere is an example of a disrupted cycle. The nitrogen cycle is being disrupted by runoff of fertilizers. Nitrogen fixation has doubled on the global scale. Sulfur emissions to the atmosphere have doubled, also. Human interference in one cycle can affect other cycles.

Cycles are nonlinear systems, with limits and thresholds of which we are relatively ignorant. They allow unstable and improbable reactions to keep taking place. These cycles are not only interesting, but necessary. Consider the oxygen cycle, for instance: Without cycling, all reactions would take place, and the atmosphere would reach an equilibrium (as on Mars).

Cycles are connected; for instance, the water cycle contributes to the operation of the carbon cycle; in fact, both meet in the photosynthetic activity of plants. Carbon dioxide is part of the carbon cycle, which is tied to the heat cycle of the atmosphere. Carbon dioxide is the source of carbon for plants and it plays a role in the weathering of rock. In addition to being a part of living organisms, these chemical elements also cycle through abiotic factors of ecosystems such as water (hydrosphere), land (geosphere), and the air (atmosphere); the living factors of the planet can be referred to collectively as the biosphere. These cycles drive the metabolism of the planet.

3.6. Regional Design Factors: Regional & Planetary Spheres

As a whole system with global processes, the planet can be reduced to various spheres for analytical purposes. The planet is composed of interacting spheres that interpenetrate and overlap. We tend to think sometimes of the planet as a rock decorated with a few fluids and gases, but the ocean and atmosphere emerged early from the denser elements as a result of the formation of the planet. The energy from the sun and the formation produced complex chemicals that learned to replicate their patterns. As these patterns reproduced on the scale of regions and the planet, their activities and wastes influenced and drove cycles that promoted more complex forms, which further modified global states and cycles. Although we identify major spheres on the planet—the geosphere, hydrosphere, atmosphere, and biosphere—they are very much interactive and their boundaries are open and shifting. These spheres intersect and interpenetrate. The biosphere produces certain kinds of rock, and the oceans produce atmospheric effects, so that we cannot say that each sphere does only one thing. Regions function as subsets of the spheres, with unique patterns and rates of movement and exchange.

3.6.1. Geosphere

The growth of the earth was impacted by several giant impacts, one of which most likely resulted in the formation of the moon. The planet continued to grow as a result of planetesimal impacts and cold dust accretion. Impacts made the earth very hot. Metals formed a protocore. A solid inner iron-dominated core formed with a fluid overcore. As a result of these processes, a silicate mantle and then a light, floating crust formed. The mantle is a thick, flowing solid on which the oceanic and continental plates float. Terrestrial regions occur on continents, but may reach across two plates.

3.6.1.1. Lithosphere

Heat is conducted from the core of the planet to the mantle and then through the lithosphere. Radioactive isotopes produce heat in all the levels. The planet produces different kinds of rock. Igneous is produced by volcanic action or intense heat; gabbro is formed deep in the crust, while basalt and pumice are formed at the surface. Under water, granite and obsidian are formed. As these basic rocks weather, they become sedimentary, such as sandstone, shale or gypsum. Mixed with the content of living organisms, they become limestone, chert, or coal. When these rocks are pulled under by tectonic action, they become metamorphic, like slate, schist, gneiss, quartzite, or marble. Minerals are limited artifacts from formation, but many of them are nutrients for life.

The crust of the planet is dynamic. Mountains are limited in height by the thickness of the crust (which is not a problem with Hawaii which rests below the crust). The action of the ocean and atmosphere tends to level the surface through erosion, but crust movements tend to build mountains. The division of earth into water, land and air determines directions of evolution, or rather limits the possibilities. Plate tectonics keep a significant portion of the planet surface above water, permitting the evolution of land-air based life. The changing locations and sizes of continents, from the supercontinents of Rodinia, Gondwana, and Pangea, to smaller continents like Australia and Antarctica, produce different patterns of oceanic and atmospheric circulation, and thus changing environments, that push the

emergence and diversification of terrestrial plants and animals.

Intensive plate tectonic processes continue today and recycle the crust, along with organic material that has not been recycled by living organisms. This organic material is slowly transformed into petrochemicals containing high-quality energy.

3.6.1.2. Pedosphere

Radiant energy from the sun flows around the surface of the planet, contributing to the heating and cooling, and eventual breakdown, the disintegration and alteration called weathering, of rock. Water also flows over rock, getting absorbed, trapped, stored and released. Plant roots find purchase in the rock and absorb water. Dead plant matter forms a layer on the rock, a loose assemblage of animate and inanimate particles, where other organisms recycle residues from plants and animals. The remaining water follows the gravitational gradient to streams, aquifers and the oceans. Soil accumulates depending on conditions, e.g., temperate climates retard organic uptake, allowing the material to form much deeper soils.

The soil acts as a buffer to keep water in the system longer for the use of plants and animals. This slows down erosion and flooding, and sustains the gradual constant release of water into streams. Many nutrients in the water also move downstream. Water increases the mix of mineral particles, gases and nutrients that make up the soil substrate. The soil is a medium where recycling of nutrients takes place. The soil is a living filter that mixes nutrients, dilutes pathogens and toxins, and purifies water. It is very porous and has an active surface thousands of times larger where biophysicochemical processes continuously take place.

A small amount of soil contains the living roots of plants, as well as a large community of organisms of various sizes, from microscopic to macroscopic—in fact, billions of organisms, from viruses fragments and bacteria to worms and insects. Although the soil forms a relatively thin layer, possibly less than one meter averaged across the planet, it is exceptionally active. It is strongly interconnected to the ocean and atmosphere through water. These interactions allow soil processes, such as sequestration of carbon, to contribute to the composition and properties of the atmosphere.

Humanity inherited incalculable soil resources that allowed the entire enterprise of agriculture. Unfortunately, agriculture tends to simplify the soil ecosystems and allow increased erosion. Erosion is amplified and accelerated by the scale of agriculture, which converts entire grasslands and forests to ‘smiling fields’ by removing vegetative cover for long periods, altering the biotic community, and changing the topography and microclimates. Regions may be characterized by a suite of soil types that result from climate and processes.

3.6.2. Hydrosphere (on Planet Ocean)

Water is formed under conditions where molecules of hydrogen and molecules of oxygen react (that is, their elemental bonds are broken in a chemical reaction and recombine as water, releasing energy in the process). Water has some extraordinary properties: A high boiling point, high specific heat, and high heat capacity (due to its high heat of vaporization and low viscosity). Low viscosity makes it a good medium for swimming. The heat of vaporization allows evaporation to carry large volumes of water with a large thermal energy.

There is a vertical heat exchange in the ocean, as cold dense water sinks and is replaced by warmer water flowing poleward. This happens basically in two partially independent cells in the Atlantic and Pacific. Minor changes in ocean surface temperature can affect the expansion

of surface waters (such as with El Nino).

The ocean stores over 96 percent of water on earth; it is the source of most evaporation (86%) and receives most of the precipitation (78%—the difference is that much precipitation is caused by mountain ranges and falls to earth, and there are regions such as the north Pacific that have surplus precipitation). Every other reservoir of water is limited to below two percent of the total storage, including ground water (1.688%), atmospheric (0.0009%) and biota (0.0001%). These small reservoirs are important. For instance, water vapor in clouds covers about 60% of the planet in clouds at all times, which reduces solar radiation reaching the ground. And, living organisms pump water through their leaves, which evapotranspire it to the air. Much of the fresh water (65%) on earth is in underground reservoirs and aquifers.

Water is necessary for life; it is the medium for life. It is essential for metabolism. It makes up most of living biomass by weight. Water cycles between oceans and pools to the atmosphere and through the land. This cycling allows photosynthesis to occur in land and air as well as in pools. The sun drives the cycle, but the ocean dominates it. A small amount is stored in living beings, although evapotranspiration pushes more water vapor into the atmosphere (~10%).

The basic elements of life, especially carbon, oxygen, nitrogen, and sulfur, can be transported in water in solution. The cycling of these and other nutrients keeps the biosphere functioning. These cycles are carried to some extent by the water cycle, although they are driven by plant and microbial metabolisms rather than by the sun. Mineral cycles participate in the water cycle, although they are pushed by a tectonic cycle that binds or liberates them.

Although the overall productivity of the oceans is about the same levels as deserts, some areas of the ocean are as diverse and productive as tropical forests or temperate wetlands. Life in the ocean is limited by physical factors, from the abundance of nutrients to light, gas, and salt. The ocean has effects on the erosion of land as well as on the amount of water in air and the circulation of the atmosphere.

3.6.3. *Atmosphere*

The atmosphere is composed of gases, mostly nitrogen and oxygen, with argon and traces of others gases and particles. The first atmosphere was thought to be Argon and other inert elements. Continued development added CO₂, H₂O and N₂, which created a weak reducing atmosphere. After life formed, it added more ammonia and methane (from the anaerobic decay of biomass), which contributed to a strongly reducing atmosphere. CO₂ would have been reduced from 1000 times to 100 times current levels by 2.5 billion years ago. At the same time, there was burial of organic carbon as a result of tectonic movements. After that the oxygen content rose from the activities of phytoplankton. The rise in atmospheric oxygen to 5-18% of current level is considered to have triggered the evolution of animals.

The atmosphere is the place of gaseous cycles, such as water vapor, oxygen, and nitrogen. Changes in the atmosphere is driven by solar energy. This is one reason why the atmosphere is so dynamic; The distribution of heat drives very rapid circulation patterns, much faster than oceanic or terrestrial ones. The composition of the atmosphere creates a greenhouse effect that traps solar energy.

Nitrogen comprises the bulk of the atmosphere (approximately 78%). Nitrogen is the one element found almost entirely in the atmosphere—there's very little on land or in the sea. Nitrogen cycles slowly through the earth's system. Nitrogen is a key element in proteins and

nucleic acids and so is essential to life. But, if nitrogen is not available in a usable form, living beings and ecosystems would fail to thrive. There are bacterial species that specialize in taking nitrogen from the air and converting nitrogen into different usable forms. This conversion is difficult due to the high stability of gaseous nitrogen. These bacteria also release nitrogen from organic material back into the atmosphere. This process, denitrification, makes nitrogen available again for fixation. Some bacteria carry out denitrification under anaerobic conditions.

Oxygen is found in the atmosphere at a stable concentration (approximately 21%). Because it is a very reactive element, it can quickly combine with other elements and disappear from the atmosphere. Yet it persists, and in high concentration. It is the cycling of oxygen through photosynthesis and respiration that accounts for its presence and stability. A world without cycles, without life, would retain little if any oxygen in its atmosphere. Oxygen is a direct product of the metabolism of living forms.

Some atmospheric oxygen is bumped high into the upper reaches of the atmosphere, the stratosphere, where, it is converted into a new compound, ozone, in a series of reactions powered by solar radiation. Ozone absorbs ultraviolet (UV) radiation from the sun, which has the effect of protecting many life forms from damage. Ozone molecules unform and reform, as they are carried around the upper atmosphere. The formation and destruction of ozone by various reactions have been in equilibrium for hundreds of millions of years.

Oceanic processes contribute to massive landforms as well as to the composition of the atmosphere. For instance, sedimentation of a small fraction of the biomass removed carbon from and released oxygen to the atmosphere. This biomass formed large deposits of hydrocarbons that were cooked and distilled to forms of gas, coal, and oil. The process of biomineralization put volumes of carbon, calcium and phosphorus into sediments that were elevated by tectonics to form large mountain ranges.

The atmosphere, through reflection, can limit the amount of solar radiation received. Living organisms can change the content of the atmosphere, especially in terms of water vapor, nitrogen, and oxygen. Microorganisms can be lofted high into the atmosphere, beyond the troposphere. They can exist on their own or in aggregations. Viruses, bacteria, fungi, spores, and pollens may be carried far in the atmosphere, before returning to lower and more comfortable levels to reproduce. Many do not survive the temperatures or the UV radiation. Some forms are resistant to UV-rays, X-rays, and gamma rays. Birds and insects frequent the atmosphere for movement and hunting. Most travel and hunting occurs at low altitudes. Migratory birds, and a few insects, find higher altitudes, which allow higher flight speeds.

3.6.4. *Biosphere*

Vladimir Vernadsky developed the idea of the biosphere, expanding and refining the term from Eduard Suess. Vernadsky pointed out that none of the works in geology treated the biosphere as a whole. He defined the biosphere as the network of living organisms as they live in groups and patterns. Vaclav Smil notes that the atmosphere, hydrosphere and planetary crust are defined by obvious physical discontinuities, but that living organisms have invaded all three. He also notes that the boundaries are moveable and interpenetrating. In the atmosphere, microorganisms can be found throughout the troposphere and in the stratosphere (50 km in vertical distance). Birds can also fly to impressive heights (5-9 km). In the oceans, the entire water column (to over 10 km) has eukaryotic organisms, such as fish and whales, as well as viruses and prokaryotes. Hydrothermal vents host ecosystems on the ocean floor, where

some organisms can tolerate high water temperatures. Some microorganisms and insects can be active in temperatures below freezing. In the land surface, soil-forming organisms work in the first 20-30 meters; Smil suggests that the extent might be as far in as 7 kilometers. Viruses extend the reach of the biosphere, as do cryobiotic forms. And, autotrophic ecosystems near thermic vents, without sunlight or chlorophyll, are energized by the oxidization of sulfides.

In general, without following an exact path, life seemed to have risen out of self-defining processes. Christian de Duve suggests that life began from a 'protometabolism,' after short polypeptides were formed from thioesters of amino acids in more acidic water (in volcanic lakes or near hydrothermal vents). A high-energy thioester bond may have cycled to form cells or RNA. Perhaps the origin was cold, however, and life formed on a metallic substrate under different conditions, based on inorganic nutrition and progressing to photosynthesis and organic matter. Smil notes that we know that the earliest organisms were prokaryotic, anaerobic, and tolerant of ultraviolet fluxes and planetesimal collisions. Many early living forms were cyanobacteria, which survived in extremes of salinity, acidity, temperatures, desiccation, radiation, and low oxygen. Other Archean microorganisms were methanogens and sulfate-reducing bacteria.

Bacteria dominated the planet up to 1.8 billion years ago, when the first eukaryotic micro-algae formed. Bacteria still dominates it in terms of biomass. Eukaryotes became short-lived specialists, rather than slowly-evolving generalists. Life converts solar energy into foods. Vernadsky concluded that life forms in an indivisible and indissoluble whole, where the parts are interconnected with living beings as well as the environment. The total of life is the biomass, which grows and shrinks, depending on the global environment, on seasonal cycles, and on long-term cycles and changes. This biomass has energy flows. Living organisms drive global cycles of nutrients and elements. These cycles provide elements and nutrients to other living organisms, including humans. Furthermore, atmospheric gases are biogenically formed, especially oxygen. Life produces sulfides and binds calcium. The movements of the chemical elements necessary for life are referred to as nutrient cycles.

Human beings have started to evaluate these 'free' services' of cycles and biomass in monetary terms. Regarding ecological services, the biosphere can supply resources, as well as absorb wastes (materials and emissions), however, it is limited by amounts and rates. As George Woodwell (1976) put it, humans live as "one species in a biosphere whose essential qualities are determined by other species." Humans metamorphosed with a technosphere. Perhaps a biosphere reproduces at the end of a chain of metamorphoses.



Figure 35-1. A. Wittbecker, R. Hart & M. Barnes consider Forests for the Future 1999

3.7. Regional Design Factors: Intricate Patterns

What are the big patterns in regions? At various times, ice has covered a medium to high percentage of the land and water area. The continents move over deep time and will continue to do so until the energy of the planet core is exhausted. At some time during the development of the earth, natural processes created a pattern that guaranteed the maintenance and reproduction of a system of processes. These processes were considered living. Large patterns are formed by continents and the ocean. Mid-range patterns include vegetative cover, from oceanic algae to terrestrial forests. Small patterns include food webs and worm tunnels.

3.7.1. Distribution & Density

The biosphere varies considerably in its density, from deserts and tropical seas to marshlands and tropical forests. In a forest, for example, trees penetrate the soil to get water and nutrients to grow. The nature of soil determines the kind of vegetation on a site and the distribution of vegetation between sites. Thus, soil limits the occurrence of a species within the range allowed by climate. Soil moisture, even in a homogenous stand of trees, has a mosaic pattern, due to species and individual differences in water distribution. Thus, a diversity of microsites can govern the pattern of future tree establishment.

The distribution of forests is influenced by climatic, edaphic (soil), and physiological factors. The first two are also affected by the third, which creates microclimates and soil particularities. Physiological factors include configuration (such as valleys), altitude, slope, and exposure. The amount of water influences the occurrence, growth, development, and the distribution of forests. Wildlife that inhabit the soil environment are sensitive to contamination. Air emission can cause reductions in soil organisms and shifts in trophic structures, such as insectivorous bird species. A reduction in decomposers can result in a decrease in litter decomposition and nutrient cycling. The distribution and abundance of frogs, toads and salamanders may be influenced by soil pH and ephemeral forest ponds.

In their studies of biogeography (biogeography is simply the distribution of life over an area of the earth), MacArthur and Wilson hypothesized a general theory of island biogeography based on the observation that the number of species (species richness) on true ocean islands is lower than it is on the mainland. The theory states that, assuming all other factors are equal, large islands have more species than small islands (according to a species/area equation). The number of species on an island reaches an equilibrium between the extinction of existing species and the immigration of new species from other areas. The rates, however, are a function of island size and remoteness. MacArthur and Wilson suggest that small islands have a reduced habitat variety, reduced immigration of species, and higher extinction rates; furthermore, the climatic variability affects the stability and longevity of populations.

It would be difficult to develop strategies to prevent the depletion of genetic information, especially with intense public and industry demands on forests, without knowledge of the diversity and distribution of genes in the tree population. Although a study of gene flow and genetic recombination is needed, a lot of this knowledge can come from careful observation of the forest, the mating systems of trees—e.g., pine species require pollination as a mechanism for outcrossing—and the shape and size of a forest area. Smaller organisms with limited distributions tend to become extinct faster.

3.7.2. *Surprise & Joy at Diversity*

There are emergent properties at each level of organization, such as the diversity of species and the structure of a food web. Furthermore, each level of integration has distinct attributes. A community has 'species diversity,' which is meaningless at the population level.

The concept of maturity, as an attribute of a community, is related to structural complexity and organization. Maturity increases with time in an undisturbed community. The species diversity, that is, the information content, of a community also increases with maturity, leading to a more complex spatial structure. Diversity incorporates species richness (how many different kinds are present) as well as a measure of abundance—how many of each, as individuals or biomass. Other aspects of diversity, such as life cycles, are less often considered. The energy in a mature system goes to the maintenance of order and less for the production of new materials. In general, diversity is higher, and life cycles are more complex; symbiosis between species increases, and nutrients are conserved. Complexity and diversity offer advantages for living forms. Complexity allows increases in size, which allows the colonization of harsh environments. Diversity allows more effective behavior through specialization; for example, a specialized organelle may digest less common molecules.

Diversity can be related to the increase or decrease in ecosystem measures, such as productivity, biomass, and stability. Diversity can be related to genetic information as well as to relationships of species, such as predation or mutualism. In fact species number may increase depending on interactions, resources, niche overlap, redundancy, or exploitation efficiency in a community. For example, deciduous forests in Europe typically have fewer species than deciduous forests in Asia or North America (from ice-age effects).

Using information theory, Margalef claims that higher information content and increased interactions promote stability. Margalef was the first to propose that diverse systems were more stable than less diverse. Robert May suggests that communities are more stable if they are compartmentalized (as holons, perhaps), that is, where subunits within a unit have stronger interactions than those between units.

Diversity is an expression of the dynamic properties of a complex system. A complex of circumstances allowing a high diversity also permits high stability or constancy in taxonomic composition: "nature tends to become baroque in situations permitting high maturity, with little energy left for large changes," according to Ramon Margalef. Stability and diversity are not a matter of definition for Margalef, but reflect crude impressions of the behavior of physical systems.

Humanity is part of the whole process of succession and maturity. We are actors in a tremendous presentation. This metaphor once formed part of the basis of a worldview where nature was a theater of violent competition. The frame where a metaphor originates carries the conceptual baggage of the time. So, over time the play supported the idea of superiority of "favoured" races in the struggle for existence and emphasized the role of competition in biological and cultural situations, at the expense of other interactions.

Alas, the metaphor needs to be expanded. All species play a temporary role in the local stage in the ecological theater. Herb Hammond notes that all the actors and acts are essential. We are foolish to think some species are more important than others—that is ignorance or wishful thinking. All species and things contribute to the functioning of the whole, including rocks and gaseous elements. But, some are invisible to us because of their size or longevity.

Some play their roles in a clump of soil, others in continental landscapes. Some acts last less than a second; others take millions of years. Even if an actor seems to leave the stage or the act is over, they continue to influence the play with their corpses and elements.

There are many stages playing simultaneously in the theater, and it is not a one-act play. The human play has converted some of the stages, subverted and converted others. The human actors are ridiculously egotistical and ignorant, pretending that the stages and theater is for them only, and all others are support characters. They pretend that the less important people and freaks are in the audience, but the only audience is other stages with partial perspectives.

And, some plays are embedded in others. One play is the evolutionary play, where autopoietic beings drift through filters in the morphogenetic landscape. Another play is the human conversion of ecosystems and the urbanization of human communities (with some companions, familiars and pests).

We have trouble understanding the theater or the plays because of our physical, temporal, psychological, and cultural limits. We see species and ecosystems as individuals, when most of them are in fact communities. We see walls and barriers, and not permeable filters. We see philosophical constructs of classes in isolated locales. We have problems dealing with motion, indeterminacy, ambiguity, and vagueness. We are seduced by logic and fallacies to believe that we can understand and control the play.

Although the scales involved in a planetary theater are linked by processes, in fact the scale of the planet and its evolving life forms is significantly larger and longer. As important as human changes are to us, and to the ecosystems from which we emerged and on which we depend, those changes may only bump the global system to another stable state, well within the range of those from the past 2 billion years. We are the stewards only of ourselves and companion forms, not of the planet.

On the other hand, Francis Bacon noted that we faced four major obstacles in understanding nature: The idols of the tribe, cave, marketplace, and theater. The perspective of the tribe is our inherent tendency to interpret and measure nature through our human senses, with their limits and scale. The idols of the cave refer to our personal peculiarities. Those of the marketplace refer to errors from language and culture. Most of the errors of the theater have to do with the fallacies of our philosophies, even those based on good metaphors.

Where does joy come in? We feel joy that things are always new and different, that there is enough to continue to provide and to inspire. We are actors in a process, but we are genealogical actors in ecological roles in the evolutionary play in the global theater. As long as we realize that we are not everything or the center of existence, but participate in larger patterns, we can continue to feel joy.

3.7.3. Patterns in Regions

Process applied to components yields pattern. Nature is composed of patterns. Organisms have characteristic patterns, such as the branching of trees or the cloud forms of tree crowns. Lichens have lobes, wood grain under stress has spirals. The cracks in tree barks form nets.

Regularities in systems are patterns. Patterns can be seen in things or even cultures. For instance, laws of genetics are natural patterns; human customs are artificial patterns. Where the natural ratios of females to males are altered by female infanticide or other action, the pattern is semi-natural.

Mario Bunge distinguishes four kinds of real patterns: Laws, trends, correlations,

and rules. A law is a stable pattern inherent in things; it is discovered; laws like gravity are boundless; biological laws are bounded, he says. After the 'Big Bang,' gravity was bounded. There are examples of social or cultural laws: "The inertia of a social system is directly proportional to the number of components and inversely proportional to its cohesiveness." or: "Higher culture does not emerge in society until the basic needs of some of its members have been satisfied."

A trend is a temporary pattern, such as the globalization of capital or fertility. Trends can be reversed. A correlation, usually statistical, is a covariation of two properties, e.g., a correlation of sickness and education—but this correlation is problematic, due to fact that the educated are wealthier and report their sickness more than the poor; the real correlation could be reversed. A better correlation is: Single-species forest stands can be correlated with standing armies in the northern hemisphere; standing armies were thought to be characteristic of people in tougher climates, which encourage large stands of trees. A rule (or norm) is a social convention set up by people, in force in a social system. The analysis of patterns is the strength of systems analysis.

Paul Shepard describes living natural 'objects' in terms of events that constitute a 'field pattern.' Relations are not prior to objects; they arise together. The wasp and the yucca coevolve; they are not co-linked by prior relations. Furthermore, a specimen is more than the sum of its species' relationships to an environment; it is an intentional being that, with other members of the species, can create niches, as well as adapt to them. Because the STEM field produces life, the qualities of life cannot be separated from its physical qualities. While it is true that living subjects are at a different level of description than events in field patterns, they should not be treated as ontologically subordinate. All of the aspects of the field have equal status. The ecosystem model, as a reaction to 'superorganismic' metaphors of early ecologists, attempted to be a field theory, but has been limited by its parentage and thermodynamics.

Patterns are not still. A circular pattern through time can be recognized as a spiral (the earth's orbit for example). These patterns can be analyzed into events. Everything that exists has its place in the order of nature. This does not mean that reality is an organism or that everything is reduced to biological terms. It does mean that every thing resembles a living organism since its essence depends on the pattern in which it occurs, and not on its components. In some ways, patterns are prior to things, in helixes, light, fields, and ecology. The science of ecology attends the overall pattern of relationships, beyond the details. The pattern should allow for surprises and discontinuities; it can do this if it is flexible.

3.7.3.1. Natural Patterns

Organisms are material patterns in space as well as energy moments. Even if energy is considered primary metaphysically, organisms are still composed of the atoms and molecules that energy forms under certain conditions of temperature and pressure, and they act differently than just 'energy vortices' or 'patterns of energy.' Furthermore, the organism must adapt to the environment, which implies having a memory and being capable of learning, and must reproduce, that is, duplicate its pattern in a separate being. Organisms are goal-seeking, and often stability is sought above change or complexity. Nor is the gene a permanent entity, although Dawkins argues that it is. The pattern lives longer than the molecule, and even the pattern changes with mating.

Nature consists of moving patterns whose movement is essential to their being. As a rope

makes the knot visible, so the body is a pattern made visible. The body is a movement that maintains a topologically stable pattern; it is a vortex but not the water. The thing, the pattern, is a cross section cut through the movement. The mind is an invisible knot that is capable of recognizing both visible and invisible patterns, that is to say, a rope is not always necessary for the demonstration of a knot. An ecosystem has a distinct pattern, related to health. According to E.C. Pielou, species diversity decreases and pattern diversity increases during succession. Very small changes in complex, self-regulating systems, such as forests, that have large and important consequences, as when rainfall patterns shift after a forest is removed. Weather patterns on North America, for instance, have created 'nation states' (see Paul Colinvaux) of trees that surprised the first European naturalists because they were so different from the European forests. The large sulfur cycle is beneficial to marine and land organisms, and important to the general pattern of production and composition. The life-form communities and physical elements are related in a definite pattern, which is a real but untouchable property (structure). In general, this structure becomes more complex as time passes, as long as the environment is stable or predictable. The structure acquires a historical character.

History creates unique patterns, especially in forests. Each forest is unique in its parts and structure, in its matter, energy, forms, information, and in its dynamics and history. Some patterns in forests are scale-dependent; for instance, hemlock trees may dominate small clusters, but be scattered all across the entire forested landscape. Pathogens determine tree mortality, which drives forest and landscape patterns. That is to say, the pattern changes with the scale. This is true of processes in forests as well. A typical forest is composed of many patterns, including vertical layering (stratification), horizontal segregation (zonation), activity patterns (periodicity), food web patterns, social patterns (including reproductive), interactional patterns (from competition or mutualism), and stochastic patterns (from random events).

There are long-term trends in ecosystems, that is, patterns of: Primary productivity, organic matter accumulation, inorganic inputs and movements through soils and water, disturbances, and populations in a trophic structure. The actual substance of which the forest environment is made consists of patterns rather than things or individual species. The forest ecosystem is a large-scale pattern of millions of minute events. The environment requires an enormous amount of minuscule local adaptations between the environment and its users. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one.

The patterns of ecosystems are addressed best at a landscape level. Landscape ecology addresses the overall patterns of large-scale ecosystems (biota), thus considering the biogeochemical, atmospheric, and hydrological cycles in relation to the shape and extent of individual landscapes. The large images from satellites are exceptional for identifying landscape patterns, especially those related to the scale of species behavior, e.g., home range or breeding dispersion. Pattern can also be measured at the level of patch size and spatial relationships (that is, inter-patch distance), which is critical for relating the size of a habitat to the species in it—to apply the theory of island biogeography.

As Richard Hart mentions, patterns are the key to understanding the nature of ecosystems. Nature, for Alfred North Whitehead—this is one philosophical foundation for considering patterns—consists of patterns whose movement is essential to their being. These patterns are analyzed into events. Everything that exists has its place in the order of nature.

This does not mean that reality is an organism or that everything is reduced to biological terms. It does mean that every thing resembles a living organism since its essence depends on the pattern in which it occurs, and not on its components. In some ways, patterns are prior to things, in helixes, light, fields, and ecology. Paul Shepard has written that relationships are as real as the objects that result from them. Ecology attends the overall pattern of relationships, beyond the details.

3.7.5.2. Cultural Patterns

Culture is also this kind of pattern, a cross-section. Culture can be analyzed into smaller blocks; the pattern of the whole organization is reflected at every division in differences of organization on either side of boundary. The wholeness of the character of a culture is reflected at every level. Patterning relates symbolic meanings in the context of a cultural system as a whole. The patterns form another level of meaning that has to be addressed in understanding it. Although physical environment imposes limits and sometimes determines patterns and rates of change, the community controls the development of the system.

Human beings create patterns, for food, places, events, and histories. Cultures create different patterns of living, from eating to building. Of language, relating, and changing. Many of the patterns are adaptive; some are not. Many patterns modify natural patterns. Humans have modified animal and plant associations in a different way, simplifying patterns of energy and chemical exchange, solidifying themselves at the end of many food chains as a dominant species. Patterns of eating have influenced the constitution of species and the very contours of the earth. Throughout their history, humans have used animals and plants for food and clothing. Animals were followed, herded, corralled, tamed, and finally bred. Plants were domesticated later. As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances.

The general patterns of living landscapes— Patches, Corridors, Matrix, Connectivity, Extension, and Geometrization—have been duplicated in some extent by humans in agricultural fields and cities. Places are patterns of things and webs of relations that can be understood by observing and participating. Human cultures have other big cultural patterns as well, such as: Overshoot, reproductive success, ecosystem conversion, stupidity and violence, stagnation, and the asymmetry of sex and handedness.

The problems of cultures, of natural ecosystems, and of modern, industrial, corporate, urban civilization, have been documented quite thoroughly. We have identified most of the problems in the problematique, from erosion, pests, and fertility loss, to population migration and diseases, and we have addressed them separately, using technological innovations or political adjustments. But, we have not dealt with them in a whole pattern. We have not understood them as complex large dynamic systems.

The intent of describing large-scale trends or patterns is to have human patterns fit with observed patterns in nature; patterns have a form, sometimes repetition, and sometimes regularity, but each of these is caused by some limiting factor. Fitting the pattern can lead to continuity and predictability; both are needed to adapt human activities to natural limits.

3.8. *Defining Regional Places Ecologically*

What makes a place good? Can we define good places? Are there qualities that can be distinguished in places so that we can describe good places? We live in places, that is, in place. We are embedded in places. We can examine places using the concept of ecosystems. Ecosystems, as a device for understanding, have advantages, in that they can be applied to various sizes and shapes of places. Defining good places is not simply listing a set of biological or ecological characteristics; because they are defined by people there have to be psychological and cultural dimensions. All or most of these dimensions are required if places are to be defined as good for human use. We can define places as ecosystems in a specific locality. Within the concept of ecosystems, a number of properties, principles, and standards are evident. These are defined for clarity.

- Properties are qualities common to all members of a class. A property is an attribute proper to a thing or characteristic quality.
- Characteristics are qualities that distinguish unique individuals, systems, or patterns. Gregory Bateson calls them differences that make a difference.
- Principles are fundamental rules that we can use to create images or models.
- Variables are qualities with no fixed value, changeable
- Components are elements or ingredients of a whole; constituent parts.
- Attributes are characteristics or qualities of a thing.
- Qualities refer to a basic nature or characteristic element.
- Standards are established for comparison to determine quality or value.

Ecosystems are described with a variety of terms: Energy, matter, entropy and ekropy, productivity, cycles, diversity, complexity, stability, and trophic structure. Many terms in ecology, such as biomass, stability and diversity, however, are inexact. For instance, it is almost impossible to estimate the amount of degraded energy in an ecosystem—from transpiration, mixing of water, and many other factors. So, only qualitative descriptions will be used to define good places.

3.8.1. *Places as Healthy Ecosystems*

A place can be understood as an ecosystem, a unit of organization undergoing an orderly process of development. Ecosystem principles can be derived from the study of ecosystems and applied to places:

- The ecosystem is the level of integration and the unit of organization undergoing a directional development (after E. Odum)
- In an ecosystem, energy is bound into organic matter, measurable as productivity
- That quantity of matter and energy no longer of use to the ecosystem is wasted
- Chemical elements, especially those used by living organisms, circulate in the ecosphere in characteristic paths known as biogeochemical cycles
- Living organisms are limited by elements and physical factors, e.g., light, water, gas, salt; too little of an element limits an organism (Liebig's law); and too much of an element also limits an organism (Shelford's law of tolerance)
- The transfer of energy and materials through organisms is referred to as a food chain. The transfer of energy and materials through organisms is referred to as the food chain. It is

of various lengths, depending on the system but is rarely more than 7 or 8 layers deep. Mature forests have longer food chains.

- The interaction of individuals in a food chain results in the trophic structure of communities (as ecological pyramids)
- The energy required to maintain an ecosystem is inversely related to the complexity of the system (Margalef's concept of maturity).

Understanding and applying these principles, human beings can make good places. Because human beings live in ecosystems, the description of good places as healthy ecosystems has a human psychological dimension. Humans have definite psychological needs, as well as physical and social ones. Abraham Maslow described these human needs on five levels: Physical, e.g., food, shelter, clothing; safety, e.g., law, order, security; psychological, e.g., belongingness, love; esteem, e.g., strength, self-sufficiency, competence, freedom, attention, prestige; and self-actualization, e.g., achievement, creativity. These needs will be related to the health and goodness of place.

Human cultures also have specific needs to remain active and viable. These needs include: To be grounded in place, to be secure or partly isolated (too much isolation, for instance in the mountains of New Guinea, can lead to insulation and becoming static; too little isolation, for instance in the crossroads of western Asia, can result in destruction by aggressive conflicts); to have a dynamic order for human health—in some places, east Africa, for instance, humans have been kept out of ecosystems for centuries by noxious pests, such as flies or mosquitoes—perhaps design could compartmentalize those systems, so that humans and mosquitoes could share the same region but not the same place; to be complex and sophisticated, with checks and balances; to be comprehensive, yet open, to allow change and diversity; and, to have and to manage adequate resources—a middle order of organic productivity seems to provide a good balance of innovation and plenitude. These needs are addressed specifically in the following sections.

Good places are set in ecosystems. To understand place, we must discuss the properties of working ecosystems. One problem with describing ecosystem attributes is that both quantitative (measurable) and qualitative (conceptual) factors are included. Resistance to external factors is a qualitative attribute. This may be more the result of succession than a factor producing an ecosystem. There is no whole system without an interconnection of its parts, and there is no whole system without an environment. The properties of good places—dynamic change, self-making, uniqueness, investment, regularity and renewal—contribute to and inform the properties that are characteristic of good places (Table 381-1).

Table 381-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
<i>Field</i>	<i>Ecosystems</i>	<i>Place</i>	<i>Culture</i>	<i>Good Places</i>	<i>Good Society</i>
Process	Course	Dynamicism	Conduct	<i>Action</i>	Method
Autopoiesis	Self-making	Identity	Wholeness	<i>Individuality</i>	Extension
Differentiation	Diversity	Uniqueness	Flexibility	<i>Richness</i>	Variety
Integration	Construction	Investment	Adaptation	<i>Conviviality</i>	Cooperation
Constancy	Stability	Regularity	Endurance	<i>Consistency</i>	Loyalty
Development	Productivity	Renewal	Vitality	<i>Health</i>	Harmony

3.8.1.1. Action

An ecosystem with a dynamic order is open to modification by human activities. The ecosystem is open to natural processes as well. It develops diversity and variability on many levels. It tolerates fluctuation, irregularities, uncertainty, and disturbance, which are characteristics of open systems. Human action—finding or growing food and making habitations, for instance—can increase the diversity without increasing irregularities and disturbances. This can allow a place to be self-ordering and self-renewing.

3.8.1.2. Individuality

Ecosystems with human beings change and turn. As ecosystems mature, so do human beings. Human maturity allows the development of the narrow ego of a child into the comprehensive structure of an adult. Adults can develop a deep identification with all life forms; this concept is known in the history of philosophy under various names: the universal self, the Atman, or the absolute. Maturity is linked to the increase of identification with, and care for, others. Albert Schweitzer noticed the expanding circle of care from family to humanity to animals, although different cultures have different emphases. This leads to investment in other beings and their places. Paradoxically, it can lead to an expansion of self to include place.

3.8.1.3. Richness

Reality for an amoeba is less than for a fish and much less than for a human. The richness of experience seems to be in proportion to an organism's capacity to receive, decipher and influence the proximate environment. But the organism receives from reality what it puts in, that is, it enriches reality. What is impaired in the absence of a rich ecology is the individual's knowledge of herself, not only as a individual, but also as a member of a species. A deep relationship with a place is necessary. Without it, existence loses much of its significance. The richness of life forms contributes to the realization of human values and is also a value in itself (the Deep Ecology movement emphasizes this). Simple species contribute to richness and diversity of life. In designing good places one has to consider all aspects and levels of richness to cocreate and allow good places.

3.8.1.4. Conviviality

Basically, conviviality means living together (from the Latin words), embedded in places. The making of places by living beings is an ordering of a distinct structure and center. The organization of perception, meaning, and thought is intimately related to specific places. Place becomes a focus of meaningful events and a platform for ordering a world. The individual image of a place is modified by memory, experience, emotion, imagination, and intention. Living in place orders experience (an aesthetic function). Living together results in an ethos, the moral and aesthetic aspects of a culture. It is the tone, quality, style, feel, mood, and character of their life. A place is a part of the environment claimed by feeling. Emotion binds together motion and perception. Emotion can transcend distance. Emotion creates an 'in-place'. A place, however, must be found and made; it cannot exist without inhabitants.

3.8.1.5. Consistency

A place exhibits consistency or regularity in terms of stability or rhythm of changes. Cultures learn that regularity and anticipate the changes. Cultures endure the negative aspects of change, because they are committed to their places. The commitment to a place implies acceptance of its limits. We need to trust a place. One cannot trust by overusing resources, hoarding or spending. A place must be trusted, like all life support systems, to find its way to balance and compensation. Too much control is detrimental to all relationships. Control and surrender must complement each other. Simplicity and surrender are high values only in a world one trusts, to which one feels attuned at the deepest levels.

3.8.1.6. Health (Renewal)

Health is a dynamic measure of ecosystem organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Too much stress, for example, leads to unsustainable patterns of behavior; continuous stress leads to a breakdown of processes that becomes irreversible—the system collapses and dies. In a middle order of productivity, human productivity can focus on mature ecosystems or on perpetual pioneer systems—modern civilization almost always limits itself to fast-growing pioneer ecosystems, from wheat fields to weeds.

3.8.2. *Place Health at the Watershed or Regional Level*

The successful development of places has to be rooted in the watershed or region, in the shape of the land, its character, and its ecologies. The watershed is the unit of renewal (called a 'rene' in Section 7.8) at the regional level. All these places are the result of natural and cultural processes. Traditionally the watershed or region has shaped the patterns of building, helping to make places locally or regionally distinctive.

Development designed to fit the spirit and limits of its setting in the landscape is likely to avoid the industrial homogenization of places. Understanding the watershed is the basis for knowing essential details about what plant species will flourish, how drainage systems work, and how buildings can best be sited. Places that are designed with an understanding of watershed processes, and created with the participation of the residents, are likely to be enjoyed, cared for and valued.

Watershed design can create places in harmony with changing natural processes. Design is a strategy for directing a process of continuous change; its success depends on carefully managing what has been created and recreated. Design also has to consider whether uses are realistic in view of legal, economic and market conditions and limits. The market, however, should not be limited to the development of past forms and designs. Good design can have positive feedback on what is produced. The ultimate limit on good design is system health.

One of the most important responsibilities of a regional culture is to maintain the health of the natural communities—because environmental health is the basis for human community health, and community health is the basis for economic health and worker health, which determine cultural health. The quality of life depends on the quality of the environment. If the environment is degraded to raise the quality of life, the effect will be very limited and never be self-sustaining. Fitting economic costs and needs to the limits of ecosystems, and monitoring the economic process, would reduce wastes and pressures on natural processes.

The conscious restoration of degraded systems would contribute to the health of ecosystems. The health of the system would be guaranteed better if groups were accountable for ecological impacts, avoided interference with natural processes, by not dumping wastes for example, and integrated their buildings into the sites.

Perhaps health should be related to economic value. How much is a watershed worth? It is fairly simple to calculate the loss of potential crop income if a buffer is created. It is more difficult to calculate and contrast the costs of erosion if a buffer is not created. It is almost impossible to attribute a cash value to the enjoyment or displeasure of people living in or traveling through the area. When economic systems consider health first, many forms of productivity may become less important. For example, when biofuels concerns are raised, the health of the ecosystems may make their use impractical.

On a local project on Whitaker Bayou at Ringling College, the importance of boat access was weighed against the health of water. Students suggested denying boat access until water quality was restored using rafts of trees and shrubs; only afterwards would some boating be considered. Understanding of the principles of ecology can lead to better management. One critical message of ecology is that if we diminish variety in a system, we debase its—and our own—stability and wholeness. The Bayou ecosystem is simplified and degraded in its current state. Perhaps we do not have sufficient knowledge to manage a complex wetland because it is too complex to understand scientifically. But we can understand the pattern and drive it in a healthy direction. We can restore its richness and the processes that created it.

3.8.3. *Summary: Details & Framework*

Good places already exist, on every continent and in most every culture. There do not seem to be enough, however. They can be described. Some of the traits that make them good can be understood and repeated. It is possible to make a formal compilation of the general characteristics of good places. Perhaps the number of good places can be increased with understanding of traditional ways and with more effective metaphors. Many archaic societies employ a set of principles, different from industrial cultures, that may be more adaptive.

3.8.3.1. Details & Dangers

Places can be simplified by removing species. Places can also be simplified by making them smaller, that is, drawing in the boundaries, such that cycling cannot take place after connections have been severed. An ecosystem is multi-dimensional and pluralistic, with many necessary and redundant connections. Places are being diminished.

Balanced development, rather than growth, is emphasized, so that the elements of the system work in harmony. Good places are characterized by harmony, the kind of harmony that comes from adaptive history. It is not the musical kind exactly, but more like the mutual restraint of groups of organisms. The details of how these organisms and elements interact are the subject of ecology. Ecology relates to dwelling, to the frame that contains us as we live. The desire to refine a focus on our problems has allowed the frame of reference to be neglected. This metaphor has the capacity to turn our attention to the whole, but even that is limited. A region, ecosystem or planet is not a house any more than it is a spaceship. And, there is not just one house; there are many unique systems with individual characteristics and connections.

Humans have the ability to extend the diversity and richness of places. They can do this by respecting the limits of the ecosystems, and also by moving at rates respectful of the limits

of renewal of places. This means being conscious of the ecological dimensions of place.

3.8.3.2. A Design Framework for Good Places

Design can combine the essences of ecosystems and places in a cultural context to make and maintain good places. Good place allows us to rediscover a participating consciousness and a symbiotic connection to the living region. Design can reduce the destruction of places and perhaps even bind people to, that is, reattach them to places. Design can accommodate the regularity to form a consistent approach that results in the creation of good places. Designs can allow a culture to endure droughts and disturbances. With appropriate design, both mature ecosystems and domestic pioneer systems can remain healthy with exploitation.

Design can balance the renewal of places with the vitality of cultures in the context of productive ecosystems. Design can provide the balance of exploitation and preservation. The poet Gary Snyder questioned whether complete compartmentalization is healthy. He suggested that some land is saved like a virgin priestess, while other is overworked like a wife, and some is brutally reshaped like a girl declared promiscuous. This distinction could be avoided with ecological design. The landscape needs to be zoned (compartmentalized), however, to provide a safe balance between protected ecosystems and used ones. Restrictions on land and water are one means of avoiding overpopulation or overexploitation. Compartmentalization avoids the need to compromise every ecosystem for human use. Some wilderness or archaic areas should have extremely limited access. Multiple use systems should only be part of the picture—after a protected environment of mature ecosystems, then productive systems, and urban areas. No land should be brutally destroyed.

The ideal landscape at one time became the middle region, the garden between the complete order of the city and complete chaos of the wilderness. The garden was cultivated from the wilderness as a middle landscape, but now the city expands at the expense of gardens. The garden is a human order, but not usually sacred. Design can balance these ideas.

Design needs to first preserve the health of systems—the health that can lead to productivity and renewal—and not just physical renewal but emotional and spiritual as well. A place is spiritually alive. Spirituality is a state of mind, of being, in which we experience a place as if it were endowed with grace, a mysterious, wonderful place to be.

We need an ecological and political framework for design. Eutopias, as a general framework, uses a root metaphor of many places (on the local and regional levels). This Eutopias is a framework for cultures, to preserve the unique image that a society needs to guide it and to make it different from others. To be effective, in contrast with the ideal characteristics of ideal designs, a Eutopian framework embodies attributes of designs that are compatible to the values and norms of living cultures.



Figure 3832-1. Johnson Forest Farm
in Oregon 1997

3.9. *Designing Regional Patterns: Elements to Bioregions*

We could actually place landforms of various heights and shapes to precipitate or channel water, but we rarely consider those things. We could create forms to channel wind and noise, as well as change shade patterns and water flow—in fact, we have already done this in cities with blocks of large buildings. We could set up conditions where natural processes modify the structures over long periods of time (in fact, this is what happens when we restore streams and forests). Natural processes, such as building up and breaking down structures, development, disturbance, animal movement, inter-element flows, human interaction, and shifting mosaics, need to operate freely in landscapes.

3.9.1. *Designing Elements and Processes*

Most stable elements have been around for billions of years. These elements have been incorporated in biogeochemical cycles that are crucial for life. Although we can create new elements physically or chemically, they have limited lifetimes and limited use. Molecules have been combined chemically to replace many resources that were rare or located elsewhere. Many of these molecules are exotic and have not been incorporated into diets or cycles. They tend to behave like inorganic molecules, even those based on carbon. We need to try to design molecules that can be used as nutrients or resources, yet can be broken down into elements by natural processes such as wave action or digestion. Plastic nurdles is a good example of a molecule that needs to be rebuilt (See Section 6.8). Many processes do not need to be designed, but we need to design human behavior around them, so they can continue to operate. Surprisingly, this would include: Decay, soil production, litterfall, temperature or precipitation changes, which are highly variable, tectonic flow, climate change, fires, and earthquakes. Would should design monitoring and warning systems to avoid catastrophes. Other catastrophes could be avoided by not building on unstable or dangerous areas, such as floodplains or the sides of volcanoes.

3.9.2. *Designing Ecosystems and Landscapes*

Design itself has many dimensions. The size and scale of reserves have already been mentioned. The shape of a reserve is also of critical importance. Edge effects started out being considered as centers for diversity. Now, many edge effects are considered to be destructive. In the 1940s, it was thought that edges should be increased to provide bountiful game crops. Edges have proven to be good for both game and weed species. Edge effects, however, are detrimental to populations adapted to forest interiors. Too many edges reduces forest diversity at local and regional scales. Different species perceive edges differently. So, how deeply should edges penetrate forest stands? Overall, within 50 meters—but this may be too general.

The pattern of a design is also important to control patchiness and fragmentation and to allow for future change. For example, for a Palouse grasslands preserve, a spider-shaped area was recommended to incorporate many north-facing slopes and to allow for possible greenhouse effects (Wittbecker, ICE 1986, and *Wild Earth* 1994). A good pattern should also anticipate temporal change. Conservation biology suggests some general principles of reserve design:

- Species that are well distributed across their native range are less susceptible to extinction

than those confined to small areas.

- Large blocks of habitat, containing large populations of each species, are superior to small blocks with small populations
- Blocks of habitat close together are better than blocks spaced far apart.
- Habitat in contiguous blocks is better than fragmented habitat.
- Interconnected blocks are better than isolated blocks.
- Corridors can function to make small blocks function as large blocks, although some corridors may be too narrow for many species.
- Roadless blocks are better than accessible roaded blocks.
- Human disturbances that are similar in scale and timing to natural disturbances are less likely to threaten species than those that are radically different from a natural regime.

Naming the elements of a landscape, such as ridge, hollow, or river, helps to identify the priorities of design. Less dominant features can be unobtrusively changed or emphasized with good design. Forest fragmentation, for instance, can be reduced through the design of forested areas, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects. The survival of organisms usually depends on one of two factors in the web of relations. These factors can be modified by design. Conservation biology can make several specific recommended practices that would preserve diversity and complexity in forests (and avoid numerous extinctions) and in ecosystems in general.

- Stop logging old growth and mature natural forests. Grant timber leases that are contingent on the maintenance of productivity and diversity of the land.
- Promote cutting practices that respect the productivity and complexity, leaving snags, logs, and many-aged forests.
- Maintain natural habitat structures in a surrounding wild matrix.
- Reduce fragmentation through the design, taking into account the genetic diversity of the trees, catastrophic conditions, minimum viable populations, corridors, and edge effects.
- Maintain and restore natural connections. Avoid artificial connections. Stop constructing new roads; close and revegetate old roads; integrate new roads.
- Retain the structures and processes (which produce the complexity and diversity) of the system, including legacies and special areas. Soil is an important structure.
- Restore clearcut areas; replant with native species.
- Restore damaged streams and wetlands.
- Recommend that reserves be made large enough for minimum viable populations and minimum viable ecosystem areas.

Because current reserves are usually too small to hold viable populations, corridors must be planned to intersect with larger set-asides; highway routes and underpasses must be modified. According to Larry Harris, highways are a major force in fragmenting habitats. Conservation biology recognizes the need for planning at a landscape level. The design of forests is vulnerable to surprises because nature is chaotic, and science itself is uncertain about patterns of change in forests. Social and economic activities that complement and enhance, rather than oppose and degrade, ecological processes are to be preferred and encouraged (Norton, 1992).

3.9.3. *Designing Patterns & Biomes*

The word 'design' means 'marking off a pattern.' Our effort should be to make sure that we are using the whole patterns. Characteristics are qualities that distinguish unique individuals, systems, or patterns; Gregory Bateson calls them differences that make a difference. Principles are fundamental rules or laws. Standards are models or examples of quality or value established by authority or consent. Practices are behaviors in line with the aforementioned. A sample practice would be: Retaining appropriate shapes and corridors for pattern unfolding. Designs can be applied in five stages (Wittbecker 1988):

- First, review the situation, observing patterns of movement, population change, land use, building and development, boundaries, limits, and life. Conduct ecological analyses.
- Then record all of the resources, from physical resources to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system and create a series of plans, from the site plans to value plans.
- Start to design, which is a community process requiring the participation of all people (including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot voice their concerns). Synthesize simulations and models. Make another series of plans, from landscape plans to policy plans, within a master design.
- Finally, implement the design together and start to maintain it. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Provide services for continuity and management.

In appraising the landscape, design must work within the components, structure, and function of the ecosystems. Unless it does, it will not be long-lasting or satisfactory. Because design has to work with ecosystems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the larger system.

Designs provide a framework for natural and artificial processes to work in. The patterns in design can mimic patterns in nature. Good designs learn to embrace error and failure, so necessary in open systems. The intent of describing such patterns is to have the human patterns fit with observed patterns in nature; patterns have a form, sometimes repetition, and sometimes regularity, but each of these is caused by some limiting factor. Fitting the pattern to limits can lead to both continuity and predictability, and both of these are needed to adapt human activities to natural limits. A model is a pattern or object representing another object; it is a tool that permits thought to be extended.

3.9.3.1. Preserving a Predominantly Wild Region: North Slope of Alaska

The pattern of a design is also important to provide minimum viable areas and to allow for future change. For example, for the North Slope of Alaska, a large amoeboid shape was recommended to contain as much area as possible within the limits of the range of caribou (Wittbecker, 1992). A good pattern should also anticipate temporal change.

3.9.3.2. Restoring Wildness in a Predominantly Domestic Region: Central Europe

The early settlement of Europe resulted in overkill of favored animal species, causing ripples of extinctions; fire was used to drive animals or shift habitats towards grasses. The heavy

human population of Europe resulted in habitat destruction, and fragmentation. Favored exotic species were brought in. Soil, water and air were polluted, contributing to hydrological and climate shifts. Larger populations, increased poverty, ignorance and greed contributed to destruction (and human misery in a positive feedback cycle). Agriculture and cities spread 'wildly' converting billions of hectares of ecosystems into agricultural fields, cities and thoroughfares between them. Now, with greater efficiency of manufacturing and intensification of cities and agriculture, millions of hectares have been abandoned—this pattern is being repeated in many nations on other continents.

Dave Foreman, Reed Noss, and Michael Soule have suggested rewilding the Great Plains in North America. This idea has a great possibilities for other continents, such as Europe, South America, Asia, and Australia. In Europe, native mammals included aurochs, bison, boar, chamois, red deer (elk), horse, ibex, moose, and reindeer (caribou). Poland has reintroduced European Bison in Białowieża forest. Spain has some wild horses and wolves. Italy and France have ibex and wolves. Scandinavia has Sami herds of reindeer. The aurochs and other unknown animals are extinct (and possible candidates for genetic reconstruction).

These abandoned areas are 'available' for the reintroduction of wild animals who could shape the systems into a more natural configuration. Even small single hectare lots could be left for smaller mammals who are gradually making their way into cities on their own. Larger expanses could be made into more formal parks. Large mammals would be introduced from remaining stocks. Mammals from other continents, as functional equivalents, such as African rhinos to replace the extinct variety in Eastern Europe, would be added to the mix. This would require management until the system sorted out the fitness and interactions. Cattle could be run in large numbers as equivalents, until wild species could be introduced. Eventually the system would be more balanced and self-renewing (and self-managing, of course). In some areas, rewilding would begin with trees, then beavers, lynx, and wolves. In others, storks, pigeons, falcons and bats. As these areas were left by benign neglect or set into motion with sophisticated management, they could be connected by corridors, probably abandoned railway lines or decommissioned roads and highways, which would link the rewilded patches and allow migrations (and genetic flows) in the whole matrix. A balance between edge and interior in an overall wild matrix is important for large species and for interior species. Cities would become more permeable and dangerous, but that might be welcome.

No doubt working, volunteer tourists and citizen scientists would become useful in helping establish some areas. Even the more artificial efforts, which would take decades or centuries to become fully functioning ecosystems, would be valuable, and would likely attract more traditional tourists, who would contribute to the local communities. The increase in ecological value would support everything from carbon fixation to clean water (the now inappropriately but popularly called 'ecosystem services'). The ecological complexity and diversity that forms in wild systems with large populations increases the health of those systems and the neighboring artificial human systems. The shape and pattern of these renewed areas is important for their self-making and renewal.

By consciously creating meaningful ordered patterns, we can develop ways of producing widespread community wealth while positioning the community for a long, sustainable future in a healthy environment. Designs and computer-based models can permit complex explorations, as well as suggest new patterns and further hypotheses. Through thought experiments, many of the dangers and expenses of our activities can be avoided.

3.9.4. *Designing Landscapes & Fitting Humanity Inside*

Design is needed to create natural spatial patterns and temporal phases across watersheds and entire landscapes. Ecological design considers the whole context. Large-scale ecological design is based on principles specific to the scale and extent of landscapes and ecoregions, for instance: The scale of an ecosystem should reflect the landscape. Optimum diversity in a landscape should be valued. Landscape is unified when scale and diversity are optimum. Any one sense, even smell or touch, can dominate a landscape, so careful balance is a consideration. Ecological and evolutionary processes should be maintained in healthy landscapes.

Design can imitate nature on many levels, from structure and process to landscapes. We can imitate the structure of mature systems by planting on every level of the hierarchy, from canopy to below ground. We can use native species. We can imitate the processes of forests by allowing birds, bats, and other animals the opportunity to distribute seeds and energy to other areas or prey on 'pests.' We can create microclimates within the landscape that may shift the landscape in new directions. Planting trees, for instance, allows new species to become established in forming soil. We can mimic processes such as small fires. The design of the forest and its management must ensure that the processes operate to maintain a dynamic state. Furthermore, the context must be conserved.

Landscape design depends upon an appreciation of six key design principles: Shape, scale, diversity, visual force, unity, and 'spirit of the place.' These elements have been expanded and related for ecological design. The specific properties can be described in more detail. For instance, diversity is the number of differences in a framework. Geology, climate, disturbance, and stability all produce different kinds of diversity. Landscape diversity is linked to ecological diversity, which depends on diversity of the substrate.

Different ecosystems introduce diversity into a landscape, but different ecosystems often can look similar. Excessive diversity can lead to confusion in a landscape design. Increased diversity also has the effect of reducing scale, so adding diversity can be used to do reduce the scale. A high level of diversity is acceptable if one element is clearly dominant or if the differences cannot be recognized from a distance.

Scale is a contrast of relative and absolute size. Scale is also determined to some extent by perception. The scale of a forest should reflect the scale of the landscape. But, since scale depends on human perception, which depends on perspective, it is difficult to keep scale for all perspectives. The scale of a landscape increases with the distance and width of the horizon and with elevation. The scale of a landscape is greater from mountaintops than from valleys.

As the scale of the landscape changes, the scale of various ecosystems should change accordingly. Change between areas should be gradual. When a landscape seems to be composed of two kinds of texture, the ratio between them should be a golden mean (also, the ratio of a rectangle in Renaissance paintings), which is judged as most satisfying. The golden mean produces a pleasant symmetry, unlike an equally divided landscape. The scale of agriculture and development should be related to the scale of the landscape.

Unity is a fundamental objective of landscape design. Unity is the way the elements, including shape and scale, of a landscape are combined. Visually, a forest usually dominates the landscape. Each place expresses a unique combination of elements, including contrasts, dramatic features, and the presence of water. Design can work to be consistent with the recognized spirit of place. If the design recognizes this aspect of the landscape, it may be

stimulated by spirit and it may further enhance it—what it should not do is degrade it. Forest design can emphasize some features above others.

Character is partially determined by a distinct pattern of elements in a landscape. The character may be desirable, or not, to different groups of people. Character develops out of the interactions of the elements over a period of time, usually a long time. Some of the character is derived from human perception and values, from color to balance.

When we change landforms, we have to consider how the climate and water flow will change, and then how the communities will change. We have to consider changes in cycle and spheres also. Goals of good designs include: Relinking people with genius of their places, revivifying images and identity with places, and developing and maintaining identity of places. All the elements of design can be combined in an image.

Every organism creates an image of its place from what is meaningful to it. This image is what fits the organism to its place. Boulding (1956) notes that the image as a cognitive construct of the world has several aspects: Spatial, temporal, personal, relational, value, and affectional (emotional) for each individual. Landscapes abound in nostalgic or consumptive trends on many levels of explication—some iconic, some invisible. We originally perceive the landscape symbolically, but the landscape has other functional dimensions that increase according to use. Usually, the landscape itself can suggest a unifying image. The landscape provides its own metaphor for design. The landscape is a unique individual, a community, a dynamic system of interacting patterns—the human pattern is a part of it now and should be preserved as part of the whole pattern, but not necessarily as the only pattern or a completely dominant one.



Figure 68-1. On the way to Colfax in the Palouse 1975

4.0. Designing Nature

On the assumption that nature might be amenable to large ecological designs, we can start by addressing water problems and water flows. Water is a molecule, a perfect solvent, a medium for dispersal, a resource, a commodity, and a habitat. Our planet is a water planet. Life is water; water is life. Living beings average 75-90 percent water by weight. Trees are standing water. Water defines a sense of place; its state and form can measure seasons and time. It can be a solid, a liquid, or a gas. Water as a critical element; it is a means of renewal and regeneration. Water is a link to other ecological issues. Water is a useful metaphor for designing.

4.1. *Regional Problems: Water*

Water defines and shapes habitats. The quality, quantity, form and fluctuation of water significantly influences the species and population of a watershed. The interaction of air, water and energy shape the weather and storm patterns of the planet. Water is critical for survival. Water is a crucial, although little-understood, resource. Human economic survival depends on water and its interconnections of place. Water ways and water sources have historically defined the locations of cities, communities and cultures—and been a limit of their prosperity. Water furnishes recreation, enjoyment and awe.

There is an uneven distribution of water on the planet. Water occurs in lakes, pond, streams, rivers, rapids, pools, currents, bayous, bays, oceans, estuaries, glaciers, snow, ice, frost, clouds, mist, fog, humidity, tides, floods, storms, springs, aquifers and ground water. It impacts the physical and ecological environments. It defines and connects ecological systems. It is collected and ingested by every living being.

Humans require water. In Abraham Maslow's 'needs pyramid,' water is a basic physiological need, although it can contribute to safety and esteem needs in various ways. Water has to be in the connections at all levels for people and systems, that is, people have to be connected to the source of their water, and have some stability and control, in order to thrive within the limits of water flows.

Human beings may have developed as a semi-aquatic species, according to Elaine Morgan. We may have used it for birthing as well as protection. We have used water for transportation, from swimming to boats and ships. We have used it for drinking and washing food. Most environmental issues are water issues. Like land, water can be owned in a legal system; rights can be assigned, fair use can be allowed. There are issues with salt water intrusion, storm water runoff, yard and agricultural run off, non point source pollution issues, waste water treatment, freshwater and marine habitat loss, aquifer recharge, ground water protection, ground water contamination, desalinization, water diversion projects (dams and conduits), causes and impacts of changing water table heights, world wide water supply issues and projections, water demand issues, changing water use patterns, alternative water treatment options, alternative water catchment options, alternative irrigation techniques, watercourse restoration, aquatic habitats and watershed management. All of these issues and problems have economic and political dimensions.

4.1.1. *The Water Cycle Restated*

The water cycle is mostly driven by climate, meteorology, and geology—from evaporation to movement down hills. The sun drives climate and meteorology. The sun provides the energy that drives the weather systems which move the water vapor (clouds) from one place to another—otherwise, it would only rain over the ocean or plant communities. Precipitation occurs when water condenses from a gaseous state in the atmosphere and falls to earth. Evaporation is the reverse process in which liquid water becomes gaseous. Once water condenses, gravity takes over and the water is pulled to the ground. Gravity continues to operate, either pulling the water underground (groundwater) or across the surface (runoff). In either event, gravity continues to pull water lower and lower until it reaches the ocean or the lowest land basins. Geology and topography influence the cycle, by slowing or accelerating it.

Frozen water may be trapped in cooler regions of the Earth, e.g., the poles or glaciers on mountaintops, as snow or ice, and may remain as such for very long periods of time. Lakes, ponds, and wetlands form where water is temporarily trapped. The oceans are salty because any weathering of minerals that occurs as the water runs to the ocean will add to the mineral content of the water, but water cannot leave the oceans except by evaporation, and evaporation leaves the minerals behind. Thus, rainfall and snowfall are comprised of relatively clean water, with the exception of pollutants (such as acids) picked up as water falls through air.

Organisms play an important role in the water cycle. Water moves out of organisms quickly in most cases. Animals and plants lose water through evaporation from body surfaces, and through evaporation from gas exchange structures, such as lungs. In plants, water is drawn in at the roots and moves to the gas exchange organs, the leaves, where it evaporates to the atmosphere. In both plants and animals, the breakdown of carbohydrates (sugars) to produce energy (respiration) produces both carbon dioxide and water as waste products. Photosynthesis reverses this reaction, and water and carbon dioxide are combined to form carbohydrates.

The amount of water on the planet is relatively constant. Juvenile water, which originates deep in crust, does not add much to the biospheric water cycle. Little water is lost to the reduction of the water molecules.

4.1.2. *Interactions of Cycles*

In addition to water, many other substances such as nitrogen, oxygen, and carbon cycle through the earth and atmosphere. These cycles are important to individual animals and plants and even to entire ecosystems. But we're less familiar with the notion that these cycles fundamentally influence the planet as a whole, dramatically and unmistakably altering the earth's atmosphere. When you think about it, this influence only makes sense. The atmosphere is the greatest, fastest, and most reliable global transport system we have.

The carbon cycle and heat cycle of atmosphere are limits, as are heat and water evaporation. The ability of carbon sequestration by plants is limited by water and nutrients. The health of a water system is more important than access or use. Water and phosphorus intersect in the water cycle at various times.

4.1.3. *Problems with Disrupted Cycles*

The biogeochemical cycles of oxygen, carbon, nitrogen, phosphorus, sulfur, water have stayed within certain limits, and the environment has been constant enough for organic evolution, but variable enough for natural selection to be challenged. The key term is limits. The carrying

capacity of the ecosystem can sustain only a given amount of life, and there are other limiting factors that may not have a short time scale.

Humans are modifying the cycles. We are changing the rates of nitrogen fixation, which skews the plants, especially due to leakages, applications and losses. We are increasing phosphorus 12-fold in systems. Waterborne phosphorus and nitrates cause eutrophication of streams and lakes, and even some estuaries and seas. We are changing the albedo of regions and the planet, draining aquifers, diverting rivers (with dams and canals), and changing evapotranspiration (from deforestation). Water withdrawals, globally, have increased 15-fold, although the population only increased by 6-fold (the same kind of increase holds true with energy use, also). These actions affect the integrity of the biosphere and global cycles. And, they do so rapidly. They may alter the course of biosphere development, away from the human comfort zones. How can we appraise the possibility or probability of change?

There are problems with water scarcity and water stress, not just in Africa but in Europe. Some of these scarcities are hidden under national reasons. The demand for water increases as population grows. Cities may become more vulnerable to drought and heat waves. Water reservoirs are being drained. Water reservoirs are a significant feature of the planet. Water reservoirs take up an area of 0.5 million km² (less than 1% of ice-free land area). Stocks of water are part of systems. They usually change slowly. They can act as drags, delays, lags, buffers, ballasts, and sources of momentum. Changes in stocks can set the pace of the dynamics of a system. The stock is a source that has in inflow and an outflow. A reservoir is a stock that lets farmers get water in dry times. Systems can have more than one stock.

The temperature or shape of water is important. Could the Gulf stream stop after a temperature change or fresh water dilution? Vaclav Smil states that the Gulf is not driven by thermohaline circulation. Like the Kuroshio and the Agulhas, it is a wind-driven (due to solar radiation) and torque-exerted (from the rotation of the planet) flow. He further says climate does not require a dynamic ocean. However, local weather does. The average may be the same but the details determine habitability and crops.

4.1.4. *Valuing Water*

Donella Meadows notes that any growing system runs into some kind of constraint, in the outflow or inflow or in the stocks. The higher and faster a population or system grows, the farther and faster it can fall. With exponential growth of a nonrenewable resource, even a doubling or quadrupling of finds of the resource, such as water, offers little added time for developing alternatives. Also the more the growth loops evade the control loops, the worse the fall after production.

In any commons system, there is a resource commonly shared. If it is eroded, then it can become a tragedy. The tragedy of the commons arises from missing, or long-delayed, feedback from the resource to the users of the resource. Some systems are thus allowed to get worse; this is a drift to low performance. Rivers get dirtier, the tragedy slows, and we adapt to it. All of the ways to avoid the tragedy are cultural ways, whether through education or privatizing to regulation. Rich countries transfer technology and capital to poor, never questioning that capital or technology might not be the limiting factors. It may be clean water and ecosystems.

We need to learn to value water. There are three use values for water. Direct use value refers to goods that are consumed or enjoyed, such as water, food, or views. Indirect use value refers to environmental services, from ecosystems rather than individual animals or resources,

such as climate or river flow. Option value has to do with the possibility or potential of getting benefits later. Nonuse values—there are three also—derive from the benefits of ecosystem services without using them in any way. Bequest value means passing on ecosystems to future generations of humans. Existence value is what people derive from knowing that something exists regardless of potential use. A final category of value, self-value is the value of nonhuman beings for themselves and their needs.

Simple conservation makes the most sense, as we just reduce the flow and have less to bury or deep-place in the ocean, or avoid with solar screens or aerosols. Efficiency alone promotes more consumption. Conservation may include additional rules on the size and efficiency of vehicles, no different than other restrictions on speed or driving laws.

We can identify nontrivial risks with water. We can identify areas of ignorance and fill a few in. But, we have to be willing to live within certain ecosystemic and biospheric limits. We also have to accept precedence of the health of the whole system. We have to accept multigenerational equality and commitment to general dynamic goals for health and fitness of the whole system. And, of course, have to deal with current inequities between groups and nations, as part of the program to fit in the planet.

Cheating is a trap; it is avoiding the rules. The solution for cheating is to redesign rules in the direction of achieving the purpose of rules. The trap also is seeking the wrong goal. The way out is to identify goals that reflect real wealth, that focus on leverage points, where and when. Meadows cites Forrester's leverage points of growth, economic and population.

Systems goals are parameters, which can be leverage points, and can make big differences. Buffers are leverage points. Buffers are large stabilizing stocks. Delay length is a high leverage point. Balancing feedback loops is a leveraging point. Governments and corporations are drawn to a price leverage point, but sometimes push it in the wrong direction, according to Meadows, so the direction has to be understood.

Meadows suggests that strengthening market signals, such as full-cost accounting, does not go far due to the weakening of another set of balancing feedback loops—those of democracy. The self-correcting feedback has been disrupted by leaders who control information. Designing alternative forms and rules of government might help. Taking away the power of the persuaders to influence representatives with money might work.

4.1.5. *Designing Water Flows*

In Mesopotamia, farmers dug canals from the rivers to irrigate their wheat. In many places around the world, farmers built up terraces to control the flow of water downhill. In Bali, temple systems controlled the complex allocation of water. Some civilizations dug canals between rivers. Others created reservoirs to hold water; lately industrial civilization has created huge, automatic dams to hold drinking and irrigating water, as well as to generate electricity. Some cities, like Colfax, Washington, built concrete river beds through the city. Other cities, like Providence, Rhode Island, covered the rivers with concrete roads and plazas.

Can we save the water of a river system, like the Colorado, by assigning ownerships at each reach? Then, in each ownership, allocate 50% to the river, 30% to the first owner, then smaller percentages down stream. Can we save the ocean with zoning or national ownership?

An artistic approach to designing water courses and water systems might help to express the sense of water in a community, as well as its role in reminding us of our individual

connections and responsibilities with this resource and its continuity. When it comes to water, we consume it and discard it; droughts remind us that water is never guaranteed. Pollution shows us that water carries the history of its passage. Art can display the world as a whole.

All places are linked by global cycles. Of course each place has unique species and sets of species that function as parts in the whole planet. The whole matrix needs to be managed with water in mind. Matrix management weaves people back into the fabric that supports them and in a sense makes them subject to the constraints of ecosystem processes.

A noninterference approach to water management—the essence of a Taoist way—is to let water take its own course with plenty of room to spread. Therefore, once the temporary constructs were in place, the path of water would be allowed to develop without interference. Since flood control would be accomplished by a healthy watershed, artificial constructs such as dams and concrete channels, recommended in earlier studies, would be unnecessary.

People can overestimate the power of systems thinking and think that it is a way to predict and control problems. But, self-organizing, nonlinear, feedback systems are inherently unpredictable. They can be understood generally, especially with knowledge of the goals, but sometimes need overwhelms knowledge and sense. This kind of need is a good illustration of why chickens cannot walk to the end of a fence and go around it, even when they can see the grain on the ground and have the end of the fence in sight.

Water is the kind of thing we should not try to control completely, perhaps just encourage it in other directions or prepare for its misbehavior with landscape designs that seem designed by the flow and overflow of water. Meadows says we cannot control systems or even figure them out completely, but we can dance with them. And the secret of good dancing is awareness of the music and matching the motions of the partner.

4.1.6. *Seawater Agriculture: A Brief Summary*

The Seawater Foundation is using seawater to grow plants in an agricultural setting, based on the belief that environmental efforts have to be economic successes, and successful businesses have to incorporate environmental enhancement as part of their ‘bottom line.’

The foundation has many years in research and basic implementation of seawater agriculture and aquaculture technologies. They continue to use seawater to plant forests of mangroves and other appropriate halophytes for carbon sequestration, and to communicate the idea of seawater agriculture. These practices should alleviate some of the complex ecological problems facing human civilization, from drought to global climate chaos.

The atmospheric physicist Carl Hodges founded the Seawater Foundation in 1977 with a unique approach to draw seawater inland, irrigating barren coastal desert regions to revegetate them. The use of saltwater-tolerant plants (including the biofuel crop *salicornia*) would provide homes for wildlife as well as creating food, jobs and prosperity for previously poverty-stricken areas. In Eritrea Africa, the Seawater Foundation has created the world’s first integrated sea farm for shrimp, fish and halophytes covering over 1000 hectares. Manmade rivers would be cut so that seawater flows inland and irrigates crops and contributes to small ecosystems of animals and fish, perhaps eventually to whole forests or larger ecosystems.

If global climate chaos causes glaciers to melt and sea levels to rise, it might be easier to bring seawater inland. And, this might slow climate change, by sequestering carbon in fields and forests of plants. Instead of building sea walls to cope with rising water, the effort would

be directed to rerouting the water inland. Money is spent for these new production systems, creating jobs, creating wealth, and taking big steps in solving global warming.

Salicornia, one of the plants investigated, produces a high quality vegetable oil on seawater. On land it is not competitive for food production. But, on seawater it produces at a rate that is probably one of the most economical biofuels on the planet, states Hodges.

Hodges envisions seawater rivers around the world. There are 34 countries where could have 50 rivers of the scale of their project in Mexico. They would come inland and they would irrigate a quantity of desert coast in an ecologically sound fashion. It would be on a scale that takes so much water inland that it could stop sea level rises in about ten years.

Nations would continue to build these rivers over the next 40-60 years. They would make a significant contribution to taking enough carbon out of the air to slow planetary warming. Creating halophytic systems would be better than trying to take the salt out of the water and then use the water for purely freshwater systems.

But, what would be the long-term effects of these proposed changes? How would they affect wild desert systems, which would likely be replaced entirely. How different are halophyte ecosystems and how well to they interlace with other systems? Are these systems going to require labor or capital-intensive investments or management? Will those systems disrupt other systems? How much atmospheric carbon would be produced through the movement of water, as well as planting?



Figure4823-1. Dryland farming in Turkey

4.2. *Designing a Regional Watershed: Rethinking the Amazon River System*

The Amazon River, with twenty percent of freshwater in its flow, drains the largest tropical rainforest, home to ten percent of the species in the planet. The cyclical replenishment of nutrients carried in by the annual floods of the Amazon River Basin creates an ecologically rich area unrivalled on the planet. Its topography is as diverse as the continent. The health of this river, which is threatened by deforestation, drought, hydroelectric dams, resource extraction, and industrial transportation on waterways, is connected to the health of the global system. Clearly, the river has to be addressed on a regional scale. Local and national actions have to be coordinated at a regional level. The 30 million people, some of whom live in 350 indigenous groups and the rest of whom are housed in urban areas, depend on Amazonian ecosystems for food, shelter and livelihoods.

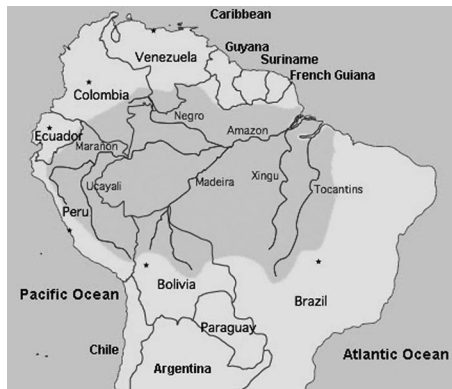


Figure 420-1. Amazon River dominates South America

The key to conserving the Amazon is its size. A substantial percentage of the forest, possibly over 70 percent needs to be reserved. This is required to maintain the volume of rain needed by the river. The vast stores of carbon in the forests need to be kept sequestered. Development has to be limited by the characteristics and properties of the river. The direct and indirect impacts from large-scale human activities have to be minimized. Keeping the Amazon River functional is important for keeping the forest complete and functional; it may require rethinking the process of industrialization and urbanization in that region.

4.2.1. *Rethinking Energy*

Dams, such as the Belo Monte Dam, have to be stopped from diverting 80 percent of the river. The Paquiçamba and Arara territories of the Juruna and Arara indigenous peoples will be affected. The forests flooded by Belo Monte's reservoirs will generate enormous quantities of methane (a greenhouse gas that 25 times more potent than CO₂) according to Philip Fearnside of the National Amazon Research Institute (INPA). The project would attract far more people than would be employed, who would then depend on a weak social infrastructure and the weakened ecosystems.

Other hydroelectric projects, such as the Madeira River Complex, have to be rethought and modified. These kinds of megaprojects foster disease, loss of food and clean water sources, and cultural disintegration and human rights abuses by illegal loggers, migrant workers and land speculators in indigenous communities. The potential impacts and damages are too

great when the scale is so large. Single dams would be energy inefficient, and run below their nominal capacity, but to guarantee a constant flow, the rest of the Xingo River would have to be dammed with five other dams by the government. The dams would also attract unsustainable industries, such as aluminum smelting and metal refineries, and mining. Almost one third of the energy generated would be for these industries and the rest would be for housing needs.

Investing in energy efficiency for existing dams would save the amount of energy from 14 new dams equivalent to Belo Monte. This would include replacing old generators and reducing transmission losses. Some additional energy could be generated in small-scale wind and solar power farms.

Public consultation needs to be increased for these large projects. Environmental Impact Assessments (EIA) have to contain comprehensive and adequate data on water quality and many other indicators.

4.2.2. *Rethinking Forestry*

Formerly forested lands need to be rehabilitated and restored. Since 1978, over 500,000 square kilometers of Amazon rainforest have been destroyed. In one year (May 2002-03) 24,000 square kilometers of forest were lost.

The use of reduced impact logging might keep the rainforest healthier. Reduced impact logging practices including: 1) cutting climbers and lianas well prior to felling; 2) directional tree felling to inflict the smallest impact on the surrounding forest; 3) establishing stream buffer zones and watershed protection areas; 4) using improved technologies to reduce damage to the soil cause by log extraction; 5) careful planning to prevent excess roads which give access to transient settlers; 6) reducing wood waste for cut areas (anywhere from 25-50% of the wood from a given cleared patch is wasted); and 7) limiting the gradient of roads to prevent excess erosion. Landowners could establish plantations on degraded lands. Forest plantations are essentially tree crops planted for the particular purpose of providing a specific source for wood products. If they were harvested only partially, the remainder might acquire the characteristics of a mature forest. Lands that have already been converted to farms, cattle pastures, scrublands, and tree plantations need to have their productivity increased if they cannot be restored.

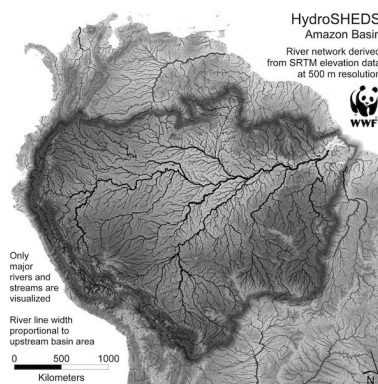


Figure 422-1. Watersheds of the Amazon (World Wildlife Fund)

4.2.3. *Rethinking Agriculture*

Traditional agricultural techniques, applied to tropical forests with lateritic soils, have failed, resulting in desert-like conditions, suitable only for short-term grazing, before the land becomes completely stripped. Swidden agriculture (also called slash and burn) is a functional form of agriculture developed by tribal peoples adapted to the conditions of the ecosystems; it works by mimicking natural small openings in the forest. When the soil starts to fail the small plot is abandoned, the people start a new plot, and the cover forest reclaims it with little damage (although it may take 200-300 years for the emergent dominant trees to return). Several groups have tried to create commercial applications of Swidden, usually with disappointing results.

Agriculture around the Amazon River would have to be a different kind of agriculture. Some earlier cultural groups did practice a different kind of tropical agriculture at a larger scale (the archaeological evidence of these groups has been discovered and examined recently). Much like the Aztecs and Mayans, these groups created large, raised fields with deep soil and wild tree margins. Since these peoples used the fields for thousands of years, the practices could be sustainable in modern times. Certainly, new fields could be designed in similar ways. The crops would have to be rainforest adapted. Farming could have to be no-plow farming. Harvesting would likely be much more labor-intensive, as would planting.

4.2.4. *Rethinking Grazing*

Cattle are an attractive investment for Amazonian farmers because they are a highly liquid capital asset with low marginal costs once forest has been cleared. Cattle are used to establish land claims on otherwise “unoccupied” rainforest land. Smaller herds of cattle could be used to create productive grasslands. Poor rainforest soils could be enriched with charcoal and animal bones (the “terra preta” soil could be used to absorb carbon dioxide). With improved soil quality, large areas that have been deforested could be used to support agriculture. This could help reduce pressure on rainforest areas for agricultural land. For thousands of years, human populations have exploited the Amazon productively (possibly sustainably) with agriculture.

The restoration of entire ecosystems is most possible in regions where parts or at least remnants of the original forest still remain and there are few human population pressures. Small clearings surrounded by forest recover quickly and large sections may recover in time especially if we provide some assistance in the reforestation process. After several years, a once barren field can once again support vegetation in the form of pioneer species and secondary growth. Although the secondary forest will be low in diversity and poorly developed, the forest cover will be adequate for some species to return (assuming they still exist). In addition, the newly forested patch can be used for the sustainable harvest of forest products and low intensity logging.

Tracts of replanted forest may have ecological returns in addition to economic ones. In the short term, forests absorb large amounts of atmospheric carbon and the more trees that are replanted, the more atmospheric carbon will be sequestered. Replanting and rehabilitating secondary forests around the world has tremendous potential for offsetting greenhouse gas emissions. Furthermore, rehabilitated forest lands can attract ecotourists and sustain some native forest wildlife.

The number of protected areas needs to be expanded. Biological hotspots need to be protected first. Protected areas need to be funded and maintained by local or national

enforcement agencies. Local management needs to include indigenous peoples.

Incorporate the techniques of indigenous Amazonians into agricultural projects in the rainforest to increase the productivity of degraded forest lands and promote sustainable use of forest resources. Through agroforestry, polycultural fields, and floodplain orchards outright destruction of rainforests can be avoided, while improving economic efficiency and providing a source of income for rural poor.

4.2.5. *Rethinking Policies*

No application of these forms of rethinking would work without changes in current land policies, which encourage and reward wasteful, short-term exploitation. New policies would have to reward self-sufficient, local ownership and ecological techniques. The land and animals would have to be conserved. Land policies would have to be reformed, with an end to special subsidies. Laws would have to be enforced. Sustainable products would have to be planted and sold. Tourism would have to be ecological or severely limited.

4.2.5.1. Ending subsidies

End subsidies granted to large landowners, as well as to mining, sawmills, road construction, and logging. Also for ecosystem conversion.

4.2.5.2. Reforming Land Policies

Under Brazilian law, much of the Amazon is essentially an open access resource so there little incentive for squatters, farmers, or developers to use forest lands or resources in a sustainable manner. Simply clear some land then move on to another area when the land is no longer viable. Developers can also acquire rights to unoccupied forest land simply by “using” it for at least one year and a day -- typically by burning the native forest and establishing some cattle on the land.

To remedy this wasteful use of land, lawmakers in Brazil should consider laws that restrict these practices. Or maybe lawmakers could enforce some of the existing laws like the 1996 law that forbade Amazon landowners from cutting more than 20% of the forest on their land. For whatever reason the laws on the books are not that effective—deforestation has increased dramatically in the past couple of years.

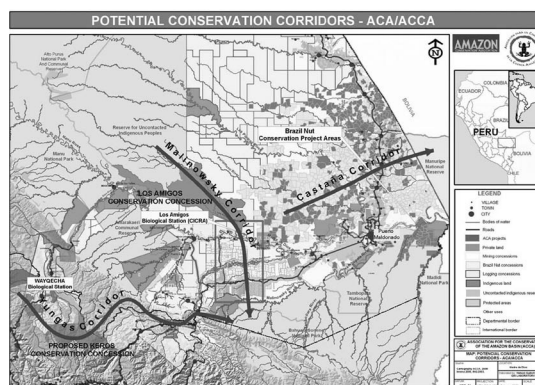


Figure 4252-1. Conservation of the Amazon in Peru

4.2.5.3. Enforcing laws

Brazil has a number of laws on the books that theoretically should slow Amazon deforestation and encourage sustainable use of forest resources. The problem is, IBAMA, Brazil's Environmental Protection Agency, is woefully under funded. IBAMA is going to need more resources. Maybe lawmakers could enforce some of the existing laws like the 1996 law that forbade Amazon landowners from cutting more than 20% of the forest on their land. For whatever reason the laws on the books are not that effective; deforestation has increased dramatically in the past couple of years.

4.2.5.4. Conserving Animals

Keystone species, such as the peccary, have to be conserved so that the ecosystem does not collapse to a simpler and poorer configuration. The peccary, for instance, is a vital species for the Amazon rainforest—they act as seed dispersers and destroyers, as they consume seeds and fruits, engineering freshwater habitats and forest gaps. Peccaries have the highest density and biomass of any Neotropical mammal species. Specialized jaws allow them to crush very hard seeds. Searching for insects, frogs, seeds, and fruits, herds of noisy peccaries bulldoze through the leaf litter, trampling many seedlings and saplings, leaving areas of bare ground.

4.2.5.5. Buying sustainable products

Trees such as the virola are being harvested and exported as tropical timber to North America and Europe. The Forest Stewardship Council (FSC) logo certifies that the product comes from a company that has made a commitment to managing forests in ways that help protect biodiversity and respect the rights of indigenous peoples whose livelihoods depend on the sustainability of the forest. FSC is a decent guide to buying wood products. Similar needed certification is also being planned for coffee, fruits and fish. No matter how good the certification, consumers have to limit their demand by being informed of availability.

4.2.5.6. Supporting Ecotourism or Limiting Tourism

Tourism to wilderness regions like the flooded forests of the Amazon can sometimes harm the natural environment that draws visitors in the first place. To prevent possible damage, the state has to limit tourism. For the tourism to be truly ecological, the state has to enforce standards for the tour operators, such as recycling and cleanup. Organized tours and local facilities that are ecologically sensitive can also boost the local economy, creating demand for accommodations, food, and local guides while minimizing the impact on the local ecosystem. Furthermore, operations can help protect biodiversity by creating incentives to protect it. Tourists have responsibilities, also. They should research and support ecotourism.

4.2.6. Conclusion: Saving the Amazon System

The extinction event that is occurring now may be as extensive and critical as extinctions caused by natural disasters of global ice ages, planetary collisions, atmospheric poisoning, and variations in solar radiation. The difference is that this extinction event is the result of human decisions based on ignorance or greed—and it can be ended with informed decisions based on better values and knowledge. Past extinctions indicate that it takes at least 5 million years to restore biodiversity to the level equal to that prior of the extinction event. Emergency plans and actions undertaken now will determine whether this area will be biologically impoverished for the next 5 million years.

Deforestation could be slowed or halted with funds generated under a U.S. cap-and-trade or a broader U.N. scheme to reduce greenhouse gas emissions from deforestation and degradation (REDD, as reported recently in the journal *Science*). The rate of destruction means that the window of opportunity is short. Amazonian deforestation within a decade would mean dramatic changes in climate and productivity. Brazil accounts for roughly half of tropical deforestation between 2000 and 2005. Instead of advocating a market-based approach to REDD, where credits generated from forest conservation would be traded between countries, Brazil expects to benefit from a fund financed with donations from industrialized nations, even though contributors would not be eligible for carbon credits that could be used to meet emission reduction obligations under a binding climate treaty.

For almost 50 years, environmentalists have been voicing concern over the vanishing Amazon rainforest, but their voices and efforts have not been effective at slowing forest loss. Even later, with the popular support of celebrities and millions of informed citizens, with millions of dollars of funding, and the establishment of millions of acres of protected areas for tribal peoples and forests, deforestation rates have increased. Average annual deforestation rates have increased peaked at 28,488 square miles of forest loss between 2002 and 2004. As land prices appreciated, cattle ranching and industrial soy farms expanded, with new infrastructure. Development pressure on the Amazon is accelerating faster than conservation efforts.

Market measures, which value forests for the ecosystem services they provide as well as reward developers for environmental performance, may alter the trend and save some areas from destruction. But, the real drivers of a permanent solution will have to be social and cultural changes in values and ownership.

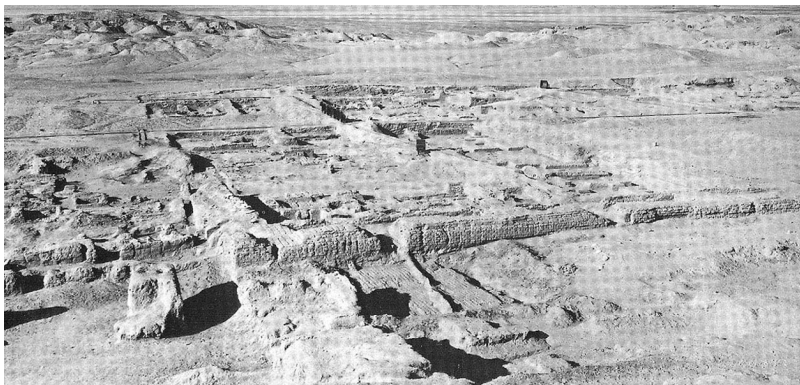


Figure 433-1. City of Uruk in Iraq (Long after climate changes & droughts)

4.3. Regional Problems: Atmospheric Change

Due to its rotation around the sun, and to imperfections in mass distribution, the earth tilts on its axis. The moon stabilizes this tilt. This obliquity of the ecliptic creates seasonal variations, to which most plants and animals have adapted. Any changes, even relatively small ones, could be catastrophic for climate. Furthermore, plate tectonics can contribute to changes in regional climate change, ocean circulation, and ecosystem disturbance. Climate change is controlled primarily by cyclical eccentricities in Earth's rotation and orbit, as well as variations in the sun's energy output. 'Greenhouse gases' the atmosphere also influence Earth's temperature, but in a much smaller way.

The atmospheric effects on temperature changes include heat retention due to atmospheric gases, mostly gaseous water vapor (not droplets), and also carbon dioxide, methane, and a few other gases—referred to as the “greenhouse effect.” The atmosphere also controls solar reflectivity due to white clouds, volcanic dust, and white polar ice caps.

Regional climate and temperature cycles are the result of a complex interplay between a variety of causes. These cycles and events overlap, sometimes enhancing one another, and sometimes interfering with one another. Therefore it is difficult to identify a statistically significant trend in climate or temperature patterns from just a few years, decades or centuries of data. At the extreme of cycles, the variation in sunlight received is less than a tenth of percent, but that difference can change atmospheric temperature by 9 degrees F (12.7 C).

4.3.1. Atmospheric Heating

At what point does atmospheric heating become global warming or climate chaos? Is it a symptom, problem, or nothing? Are green houses gases increasing? Is the average annual temperature increasing? Is it a positive feedback system? Is it too complex for us to understand? Is global warming a problem for the planet? The planet has been much warmer before, during the Jurassic for instance, when there was no snow, ice packs or glaciers, and when dinosaurs were suppressing mammals and expressing heroic size to exploit their environments. Of course the pattern of continents was quite different then and less spread out.

Is global warming bad? For us? For our companions plants and animals? For the Planet? Should we try to control it? Will it reverse on its own and head towards another Ice Age? Can we control green house changes? How could we try? How do we know if we can? Should we try anyway? What kind of behavioral changes could we make? What kind of technical things could we do? Mirrors? Ocean Doping? How would they work? What other effects would they cause? What is the worst that could happen?

Warming now is pushing rainforest animals from the canopy to the understory, and from lowlands up the mountains, and from the equator towards the poles. Other problems associated with warming are ocean levels, and the nonsynchronous timing of plants, birds and insects. It will shift whole habitats polewards. It might get warm enough to push arctic specialists, like polar bears or penguins, out of existence.

The warming Ocean and melting land glaciers are expected to result in sealevel rises that will flood many towns—and over 50% of human dwellings are within 10 miles of the ocean. To save coastal cities, island cultures, and lowland agriculture, we could move inland, but that would be a major transition, disruptive and expensive.

4.3.2. *Greenhouse Gases*

Carbon dioxide is very long-lived, over 100 years, and 56% of it from industrial processes is still in the atmosphere. CO₂ interacts with water vapor, methane, and sulfur, affecting how those gases retain heat or contribute to cloud formation. CO₂ is good for some plants, mostly trees. But, plants in extra CO₂ have tougher leaves, less nutritional value, and higher amounts of defensive chemicals. One species that will benefit from changes will be parasites. Mosquitoes will spread malaria in some places.

The CO₂ is already in the air. We have no easy way of getting it out. So, the course of climate change is set for next several decades, or 15 thousand years, depending. Significant CO₂ is removed through natural processes, which also generate quantities of CO₂. We could remove quantities, but it would be expensive, and may not be at a scale large enough to be effective. We do not know the threshold for anthropogenic change, but it could only be 2.3 degrees F according to Steven Schneider.

We could also try to reverse anthropogenic inputs into the atmosphere and ocean. Most importantly carbon dioxide, methane and nitrogen. A team of scientists has established target thresholds for 9 planetary life support systems. The planetary boundaries mark a safe operating space for the development of humanity. Three boundaries have already been crossed: Biodiversity loss, biogeochemical flows, and climate change. The target for carbon dioxide is 350 parts per million, which we have exceeded already at 400. Several groups, such as 350.org, are working to educate people about the threshold and to pressure congress to act to require industries to reduce emissions. Given the excess and momentum of population and industry, it might be wise to aim for 240 instead of 350. So that we would reach a number below 350 as fast as possible, perhaps 275, the number after the Ice Age. Other greater threats may be methane from agricultural and industrial sources as well as permafrost melting, ocean clathrates release, and wild land conversion.

Changing so much, reducing so much will take fundamental changes in industry as well as agriculture. Large areas of the planet will have to be restored to more native conditions, although that should not affect cities, as much as roads and support lands (ghost acreage).

4.3.3. *Drought as a Serious Recurring Problem: A Brief History of Mesopotamia*

Water is perfect solvent, gathering up minerals and living cells. Water systems are large assemblages with many links and complementary relationships between soils, plants, animals, and decomposers, as well as within the atmosphere, geosphere, and ocean. Fresh water ecosystems tend to depend on solar energy, photosynthesis, biogeochemical cycles, stability and movement of the atmosphere, and the services of nonhuman organisms. The cycles of nutrients and water tend to be closed, which allows recycling. Plants and others tend to stay in their ranges, feeding in their niches. The system tends to be stable over a long time due to flow, cycling, and diversity.

Most water is held in the ocean or in aquifers. The water in the atmosphere and the surface of land tends to move quickly. Streams are an open system that export energy to land. Velocity of a stream is determined by gradient, as well as roughness and depth of bed. Slower currents drop more sediment, which can cause backups and changes in flow. Sudden drainage can lower the water table and dries out land. Streams have more oxygen than lakes, which are more susceptible to organic pollution.

Humans sometimes speed up or shift geological processes for their benefit. The water cycle is an example of this. In arid regions, such as Mesopotamia, rainfall fluctuates. The soil is an arid soil type, best suited for pastoral nomadism, due to drought caused by fluctuations. Only 10 percent of the area is suitable for dry farming.

About 12,000 years BP, the winds shifted north and brought moisture from the Mediterranean to this region, making it a Fertile Crescent (in James Breasted's words), taking it from North Africa and Egypt. The woodland belt of the Zagros mountains benefited directly. The climate became milder; summers were warm and dry, and winters were cool, and wet. Rainfall may have reached a meter per year. Oak (acorns), maple, juniper, hawthorn, pistachio, almonds, grapes, apples, and wild pear grew on slopes, as did einkorn and emmer wheat (*Triticum dicoccoides*), barley (*Hordeum spp.*), and oats (*Avena spp.*). The wild einkorn wheat grew so thick and tall that a family of six with a stone sickle could gather enough in 3 weeks to last a year. People learned the principles of gathering seeds and planting them. Then, they started to make permanent settlements. Different plants would be available at different times, and people could move up slope to take advantage of those times. People exploited these environments for thousands of years.

Goats, sheep, pigs, cattle, deer, gazelle, and wild asses used the grasses, like the elephants, rhinos, and hippos before them. Men hunted the ungulates; most meat came from gazelle or deer. Goat-grazing may have intensified before 10,500 BP. Animals were closely watched, then herded and eventually controlled for desired characteristics, such as meat or hair. The young or elderly collected snails, turtles, clams, crabs, and seeds.

The first settlements in the North, like Jarmo, were in fertile areas and produced abundant crops, but, there was limited land. Only a small part could be irrigated. The population rose. The settlement grew to 4 acres overlooking a stream, near an oak forest. Possibly 150 people lived in permanent mud-walled houses with courtyards and ovens. There were separate herding villages within trade range. Wild emmer could produce 2500-4000 pounds per acre of seed (as good a yield as in Britain in 1400). Stone sickles could be used to harvest a lot of wild stands. Because no sowing, weeding, or tending was necessary with wild crops, the effort was less. By 10,000 BP einkorn, emmer wheat, and barley were domesticated. Cereal wheats required 400-750 mm of rain (15-30 inches of rain or water), although the water came in winter and the height of heat was in summer before harvest. Later lentils, chickpeas, and peas were used. They grew just as well in kitchen middens as on rocky slopes. Agriculture was vital, but hunting and gathering were still important.

The other two ecological zones, the steppe-land of Assyria, and the Alluvial plain, benefited from the river flows. There were no trees and few minerals. The people in these areas benefited from trade, exchanging natural asphalt and reeds for the nonnative seeds, grains and young animals (possibly by 6500 BP). The grasses grew well in the alluvial soils, which had no roots, stumps, or large rocks; the soil was renewed by floods. Because of sun and abundant river water, which could be relocated through canals, crops grew well, and settlements, especially with seed storage buildings, were built by the rivers. These settlements grew to hold 200 people, then 2000.

The plants tended to be weedy at first, living in poor soils subject to dry and wet seasons. They also produced large seeds, were able to germinate easily, grow quickly and survive drought. These characteristics would be attractive to people cultivating them.

Over 40% of grain production went for ale production (no beer until hops were used

4000 years later). Ale was brewed in the homes and sold from there. Beyond domesticating intoxication and letting people feel good, the ale fermentation increased the amino acid content of grain, making up for a narrower diet. Cattle and goats were kept for milk; few people ate meat regularly. The date palm provided 100 pounds per tree per year of sweet fruit.

New cities, such as Uruk, were founded, each being dedicated to a Goddess for protection. The people of Uruk built a huge temple. By 5000 BP, the city had 50,000 residents, although local settlements declined from 146 to 24, perhaps due to forced relocations. The surplus grain had to be transported, stored, reallocated, which required organization. Early temples may have claimed all of the land as well as 10,000 donkeys as the first organizing body. Farmers would have worked the land for pay in form of food. Irrigation allowed water control, and thus multiple harvests of one crop. At first people near swamps simply captured or diverted water from runoff. Irrigation proper refers to transporting the water to fields and managing the drainage. In Mesopotamia, complex systems can be managed locally by farmers, although there may be conflict by upstream users. But, cooperation is necessary, especially in villages and between villages later. As a result large-scale water systems were first managed by religious leaders, then later by secular leaders. Irrigation became necessary when the rainfall was scarce or unpredictable.

By 3000 BCE a stratified class society had developed, with slaves at the bottom, peasant farmers and craftsmen in the middle, and then the elites of administrators, religious and military. As problems developed, temporary military leaders became permanent hereditary kings. Palaces were built and staffs numbered thousands.

By 3000 BCE over 12 cities had over 2000 inhabitants. Ur, Lagash, Kish, and Umma had populations of 10-20,000 people. By 2500 BCE the total population of Sumer exceeded 500,000, eighty percent of whom lived in cities. City states on the Tigris and Euphrates flourished around 2800 BCE. Sargon of Akkad developed the first Empire by 2350. Irrigation systems and arts developed. Two hundred years later the city-states rebelled.

Shortly afterwards the Third Dynasty of Ur set up a larger bureaucracy to collect taxes and tribute. They rapidly expanded the irrigation system, settlements and the population. This led to a more rapid and more complete collapse. In the following hundreds of years there was a 40 percent reduction in settlements and a 77 percent reduction in area. The size of the bureaucracy and army fell rapidly. The city-states weakened and were conquered from outside. Sargon conquered them in 2370 BCE and established the Akkadian Empire.

These city states also weakened and were invaded. Political power shifted north to Babylon and Hammurabi. But, that empire only lasted 80 years to the death of Samsuiluna, his son, in 1712 BCE. Succeeding kings ruled smaller realms. The last resurgence of Babylon was ended by Cyrus the Great. There was another large-scale collapse between 1300-900 BCE. Arabian Baghdad flourished in 600-700 CE, as new canals were dug and soil was renewed.

Mesopotamia was incorporated into successive empires. Under these empires, agriculture and city-building was expanded. Then after the 7th century CE the river systems changed courses and alluvial deposits. By 1100 CE the total area was only 6 percent of what it was 500 years earlier. Population was at its lowest point. Tax revenue was down 90 percent. People rebelled. The only remaining irrigation weirs were in the vicinity of Baghdad. With the Mongol conquest in the 1200s, a massive collapse reduced the population from 1.5 million (in Mesopotamia) to 150,000 by 1500 CE. Nomadism returned to the area until modern times.

Unfortunately, irrigation built up salt in the soils. Droughts occurred for long periods or

in series of years. The collapse of cities and empires follows periods of drought as faithfully as predators follow prey, or Canadian lynx populations follow Snowshoe hares (See Table 433-1). During periods of collapse, the rivers washed away the salt and the soil became fertile, waiting only someone to clear out the canals and start again.

Table 433-1. Big Weather

15,000 BP	Storm tracks shifts north by hundreds of miles over 3000 years
12,800 BP	Younger Dryas brings 1300-year drought in Mesopotamia
11,000 BP	Climate becomes warmer
8470 BP	Moisture shifts due to melting of ice wall at Lake Agassiz; drought
8200 BP	The hydrological cycle (world wide water-circulation system) slows down, stops and starts again resulting in wide spread drought in western North America, western Asia and Africa
8000 BP	Climate becomes hotter and dryer
6500 BP	Sahara starts to be desert
6200 BP	Tremendous droughts from slowed hydrological cycle again
5300 BP	Mesopotamian soil salinization; drought
3100 BP	Winds fail; drought

The Tigris-Euphrates alluvium has been farmed continuously for 7000 years, except for periods of drought and salinization. The only way to avoid the problems from salinization was to let the land be fallow for long periods until the water table fell, but this was impossible due to food demands. So, the land collapsed. At 3500 BCE wheat and barley crops were equal. Wheat can tolerate salt at only 0.5% in the soil, but barley can take twice that. By 2500 BCE wheat had fallen to 15% of the crop, although overall crop yields were still high. To less than 2% by 2100 BCE. By 1700 BCE no wheat at all was grown. Overall yields fell 42% between 2400 and 2100 BCE, and by 65% by 1700 BCE. The earth was described as white.

In general, agriculture selects species for use, and then removes unwanted species, especially, predators and pests, from the system. This reduces diversity and exposes the soil to erosion. People have to take over the maintenance of the system. In low rainfall areas, they have to use irrigation for water management, which slows water flow and increases evaporation. This changes water tables; water levels may rise until soil becomes waterlogged. Water alters mineral content of soil, increasing the amount of salts. In areas hot with high evaporation, salt forms a thick layer on the fields. The soil at the river heads had low permeability. Drainage was also slow because the land was flat. Many of these things are slow, Invisible, long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society than needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change.

In the Middle East now, 200 million people are supported on 10 percent of the land by intensive agriculture and intensive imports from trading oil. The force of drought has been reduced through regional and global trading, especially after oil became more valuable.

People learned to adapt to drought, first by moving, but then by bring water through irrigation. One problem of agriculture was the uncertainty of yields due to drought. Agriculture acted as an ecological trap, removing and simplifying the ecosystem, but tying the burgeoning number of residents to that system. With permanence and the changes in

neighboring systems, it would be impossible to return to foraging. But, agriculture was also a population trap: Not being limited by having to move or carry children; also, being sedentary, farmers had more kids. More kids required more food, which could be provided by agriculture, which was helped by working kids. But, because of the surplus, farmers could out-compete foragers on a smaller territory. Perhaps the trap was also a material trap. Things required storage or transportation. Storage was cheaper and easier. But, it tied people to the settlement.

The transition to farming was gradual and slow, but the spread of farming by out-marriages was rapid. Farming allows intense food production in a minimum area. Farming increases the carrying capacity. But, this, and many other regions, are best suited for pastoral nomadism or foraging cultures. The food-producing revolution was along process of changing ecological relationships between groups using different strategies. The grains were shielded from natural selection by humans. The successful cultivation then intensified trading of cultivars and resources between groups. Village specialization may have been the best adaptation. Dry-land crops were sometimes chosen to be drought-resistant or drought-evasive; special varieties of crops such as wheat, barley, corn, sorghum, and rye were often used. Then the economy of redistribution created regional temple and market towns that regulated the trading in goods.

In its early stages, agriculture is constrained to the early stages of succession. That is, it uses nutrients and energy for quick growth and reproduction, rather than invest in efficiency, durability or maturity. Fossil fuels have allowed this artificial condition to continue. But, eventually, agriculture will have to become more mature. Wes Jackson and the Land Institute are working on this.

Before agriculture, cultures were able to adapt to dynamic changes in the environment, including drought and vegetative changes. They were able to work out appropriate solutions in harmony with their environment. Their traditional forms of restraint, such as prescriptions for marriages and births or restrictions on hunts, ensured that tribes would not interfere with local animal and plant populations, much less with ecosystem cycles. Population density was controlled by the traditional approaches to resources. Cooperation and consensus, as opposed to competition and individual exaltation, permitted planning to remain informal. But, cities removed some constraints, especially among specialists.

Drought can create a positive feedback loop, leading to fires, then air heating and pollution, which increases the system vulnerability to long-term changes in precipitation patterns, which could lead to inadequate rainfall that leads to greater drought. Drought has often contributed to the collapses of cultures, such as the Mycenaean in the Mediterranean. Now, the Ik of Northern Uganda, a foraging society living in a dry area, are threatened by a disruption of their cycles by new national boundaries, as well as by droughts; their society is collapsing. Other areas are regularly threatened with drought. East Africa has a tropical savanna ecosystem, with few trees and shrubs. Fire and grazing maintain the grasses in drought cycles.

Cities themselves may have been good adaptations to drought, as long as no drought lasted over 5-7 years, and as long as drought cycles did not occur closely connected over a hundred year span. Cities, and civilization, may also be a trap. Through specialization, the habits of luxury and power are refined and inflated. The promise of redesigning cities has to consider drought as a catastrophic threat, but perhaps it can be reduced by designing new flows and cycles of water within the cities.

4.4. Designing Regional Spheres and Cycles

A region is a set of fractal ecologies that are linked by cycles in nested spheres. The larger spheres and cycle developed over billions of years. Land and ocean areas change over millions of years, as part of tectonic cycles driven by the internal heat of the planet. Is it reasonable to talk about designing continents, spheres or cycles? Certainly it is a fertile science fiction topic and within the realm of possibility. What we might be able to do, instead, is to design human artifacts and behaviors that influence cycles and spheres.

The term global has been used to mean ubiquitous, that is, appearing everywhere in a widespread distribution, whether of potholes, soil erosion, aquifer depletion, smog, or emissions. These have little impact on other local systems. Yet, because they are part of a whole system, their very ubiquitousness can influence that system. So, local generation of carbon dioxide can have global changes, such as affecting the radiation balance (from greenhouse gases) and ozone.

We are not sure of regional change in phytomass in deep history. It might be only a half of the preagricultural amount. Vaclav Smil concludes that our understanding of the larger scale remains poor. We could start by planning regional extents of forests; this would require setting aside large areas and restoring large areas, so that regions would have an optimum tree cover, based on largely native ecosystems. We could design paths and preserves for many species of animals and plants. Many of these areas would have limited human access or use, since they would provide 'services' to regions and the planet and animals, as well as to humanity. This is a different kind of design, based on natural processes, but aided by human operations. It may be a more taoistic approach, characterized by benign neglect and minimal intervention in natural flows.

4.4.1. Designing Regional Spheres

How can we design emergent, complexly interconnected phenomena like atmosphere, the geosphere, hydrosphere, and biosphere—or even the regional parts of them? Design has to recognize that the biophysical particulars are whole system-emergent, and the system proceeds with feedback, making, demaking, and remaking patterns that we recognize as places that offer many possibilities for living and exploitation. The whole system has nested levels that are linked with levels of cycles in a planet-base. Many alternative patterns are tried by chaotic development, evolution and maturation. Failure is allowed, as novelty is generated by historical, constrained processes. Design has to mimic the health, but display courageous neglect of reciprocal, receptive processes. Recognizing that natural order is capital creating and no-costing, design has to create its own economic forms and patterns with minimal disruption of that order—it has to interweave them within that order. It has to integrate its own processes with natural processes at the appropriate energetic and material scales. To achieve holonomic value, design has to refrain from interfering with living cycles. It has to respect geological and ecological time that is needed for ecological health and geological change. Danger and uncertainty are unavoidable aspects of change. The goals for design value have to be holistic, concerned with the whole ecological order. Finally, design has to display the characteristics of respect and wisdom to bind itself to the ecological order.

4.4.1.1. Regional Atmospheres

We have the technology to manufacture and put in orbit some kind of physical sunscreens to reduce the input of solar radiation to some continents or regions. They might work by reflecting light energy away from the planet. How would we get them down if we needed more light? That would be part of the system of feedbacks and we cannot predict the feedbacks.

It would be better to enhance the regional and local levels by planting trees. Local systems do affect regional and global systems. Cutting down local forests may contribute to the discharge of greenhouse gases, such as carbon dioxide, into the local atmosphere. This may have the effect of increasing quantities in the global atmosphere, creating a global change, possibly a runaway increase in atmospheric temperature.

We have identified things that potentially cool the earth: Growing trees take up CO_2 ; sedimentation of plants in water or soil; DMS (dimethylsulfide) released to the atmosphere from ocean algae; dust; and, jet contrails. DMS is the most abundant single biological sulfur compound emitted to the atmosphere. Emission occurs over the oceans by phytoplankton. These atmospheric DMS aerosol particles or droplets are oxidized to sulfuric acid and act as cloud condensation nuclei. Through this interaction with cloud formation, the massive production of atmospheric DMS over the oceans may have a significant impact on the Earth's climate.

Some people have proposed possible technical solutions to the human addition of carbon dioxide into the atmosphere. These include: Iron doping of regions of the ocean, to allow algal blossoms that would release more DMS, although if they died, the situation would be worse, and pumping liquid CO_2 in oceans so it would stay inert at the bottom—this could also be dangerous, if the material were disturbed by volcanic action or some other source of heat.

4.4.1.2. Regional Geosphere

Regarding the geosphere and design, it is not likely that we can or would want to try to anchor continents in place or try to modify their effects by adding rivers or grinding down mountains, especially due to the long-term effects and nature of plate movement. Although we mine the lithosphere, our effects have more to do with ecosystems than that sphere itself. The pedosphere, however, we have been plowing up or ripping up for millennia. After restoring much of it to some form of health, we could design those areas where soil would be sacrificed for crops, or perhaps we could redesign agriculture and just use less dramatic techniques such as seed drills.

4.4.1.3. Regional Hydrosphere

Possibly the best thing to design ocean processes is to stop the dumping of wastes, especially plastics, which are gruesomely dangerous to microscopic life. Although we have the technology to separate many peninsulas from a mainland, such as Florida from North America, that would change the course and characteristics of the Gulf Stream. Although we have the technology to separate North and South America, that change would have immense consequences on the Gulf Stream as well as on Atlantic and Pacific species. The Panama Canal caused numerous problems with competing species, not to mention exotic species carried by the vessels.

4.4.1.4. Regional Biosphere

We have already altered the biosphere most effectively, starting with the use of fire, continuing with the hunting of all large charismatic species, and finally with the massive conversion of grasslands to host a few domestic grasses, supplemented with biocides and fertilizers, and disturbed annually with plows and planting equipment. Converting forests and grasslands to fields resulted in massive deforestation, with changes in land cover, soil, biodiversity loss, species invasions, water cycles, element cycles, and mineral patterns.

Allenby and others (2000) argue that the biosphere itself is a human artifact. And, because of this, we need to manage it and engineer it. Adaptive management might help, if it is based on understanding of uncertainty, ignorance and the wild processes of change. Ignorance is a problem. We are ignorant of the chemical processes that formed life. We are ignorant of the current processes. The biosphere is unpredictable. Changing some regions might have far-reaching effects on local and global systems.

4.4.1.5. Restoring Animal Volumes & Patterns: Whales

Instead of trying to create certain patterns in the ocean and regional biosphere, it would be more prudent to restore animal populations and let the animals recreate the desired patterns. For instance, whales could geoengineer parts of the ocean. And, this would have effects on carbon dioxide as well.

In some coastal areas, such as Norway, whales could be reintroduced to their historical ranges. Minke, Humpback, Sei and Orca were native to the North Sea. Algae blooms provide nutrition for zooplankton and pelagic crustaceans—copepods, amphipods, and shrimp, which supported whales, as well as seals and birds. The Norwegians hunted whales for thousands of years. By restoring whales to their waters, after so many decades, Norway could take pride in restoring a healthy ecosystem that people, including tourists, could really see and admire. And, the resulting richness might allow some small amount of exploitation of many other species, especially of fish. Some species, such as whales, might not be used at all, but that was an ethical decision that only the Norwegian people could make.

Whale populations could do more than any artificial geoengineering scheme to respond to carbon dioxide increase. When Antarctica's great whales were nearly wiped out by the 1960s, the krill population plunged instead of swelled. Whales produced the conditions for krill to survive; their excreta supported the plankton that krill ate. Furthermore, whales excrete iron-rich plumes near the surface, where the plankton fix CO_2 in large quantities. The plumes sink downwards; the iron filters through the food chain. Other whales like Sperm whales eat iron-rich prey like squid and drive a similar cycle.

This natural cycle of predation anticipates a geoengineering suggestion for fertilizing the ocean with iron, so diatom plankton would take up the iron and carbon dioxide, bloom, and die and sink to the bottom, sequestering 1 billion dollars of carbon trading, but with geoengineering costing \$2-500 per ton of CO_2 .

The current 12000 sperm whales draw 50 tons of iron to the surface, J.B. MacKinnon calculates, and in a year remove 260,000 tons of carbon. When many whales die they sink to the bottom, and are fed on by scavengers in a bottom cycle, keeping the carbon out of the upper cycle for hundreds or thousands of years. There are ten more species of great whale, including right, humpback, and grey. Depending on accurate numbers they could fix possibly

30 million tons of carbon. Adding large fish like whale shark and sunfish, and predatory fish like shark, cod, and tuna, many of which also sink at death, greatly increases the amount of carbon fixed.

Prewhaling numbers were roughly 120,000 Sperm whales, which would have removed 2.4 million tons of carbon (worth \$20 million MacKinnon figures). Prewhaling numbers of Blue whales were possibly over a million; they would have captured tons of carbon. Precatch numbers for the other whales and large fish are estimates, but the numbers are very high. All of these animals would be fixing carbon, and many would be returning it to the sea bottom, although the actual numbers are fuzzy, due to beachings and human takes. In carbon trading terms, a rough guess is \$13 billion per year (at a much lower cost than geoengineering and a much higher return).

Obviously, we should rewild the oceans and hire the whales and fish to fix carbon. It would be cheaper, although a ban on most fishing for 20 years could cost (out of a gross of \$85 billion, estimated by the Pew Group), \$60 billion a year in temporarily lost income—a heroic sacrifice to be sure, but then our industrial vacuuming caused the problem. Eventually a healthy renewed ocean could easily support an estimated 1.75-2 billion people on an indefinite basis (this is a calculation for an optimum, not a maximum of 3.45 billion). It would be impossible to support the current population of 7 billion or even 3.5 billion at a minimum survival, much less a generous level of luxury. The value of the fishing in a healthy system should go above \$50 billion per year, although that could be higher with more valuable fish in an ecological economic system.

It is also more ecologically sane and naturally renewable for the long-term. The aesthetic value of whales and fish is apparently much higher than the ecological value. Tourist interest translates into additional billions of dollars for community economies. Total tourism dollars for 2009-2013 was over \$1.3 trillion USD (World Bank numbers); Since the bulk of human population lives within 135 kilometers of the ocean, a healthier ocean could generate conservatively over \$200 billion USD per year. We need more whales!

By reintroducing whales, we can bring back some of the functions and some of the colors of the ocean, but it will involve sacrifice. We will have to change our diets. We will have to restrain our appetites. We may go hungry sometimes and live on less wholesome and reduced varieties of food.

Because, in order to rewild the ocean, we will have to stop 90% of our fishing. That means no factory ships. It means no ocean aquaculture or mega-engineering of ocean fisheries. It will be hard on cultures that depend on the ocean, but if we don't do this now, the oceans themselves will be harder on those cultures; there will be nothing to catch!

We have almost ruined the ocean, as we used our finder technology and mining techniques to strip entire fish and bottom communities. At one time, Grey whales swam in Vancouver Harbor; within 40 years they had all been killed. Eighty species of fish are absent from the New York area. The first species to disappear from the Wadden Sea were whales. Grey whales in Atlantic were wiped out. Then northern right whale. When Antarctica's great whales were nearly wiped out by the 1960s, the krill population plunged instead of swelled. Whales had created a good environment for the krill. In the North Atlantic, biomass has declined by 97 percent. As stocks collapse, fishing collapses.

Paul Watson says we are eating the ocean alive, although fish harvests are not growing anymore. We are polluting it with toxic chemicals and wastes, that also cause acidification,

which is hard on shelled animals and plankton. In the 'Economics of Extinction,' it pays to kill everything to justify the technology investment. Furthermore, fish like Bluefin Tuna become more valuable as they become rare. The last fish will likely fetch a million dollars. The concern is profit, not a living sustainable resource.

The damage is so immoral that denial of our slaughters is useful for us to retain our sanity. We are innocent of recognizing the truth. The sense of loss from destructions and extinctions would be hard to bear. But, the knowledge seeps into consciousness slowly. And, the only way to assuage it, is to allow the ocean to rebuild by removing our catastrophic interference. Unlike the land, we do not need to live in the ocean and we do not need build new ecosystems. All we have to do is let it repair itself. We could, and should, restore most of the reefs and shorelines. This is only intelligent self-interest.

No one has developed a model of the historical abundance of the entire world ocean. No way to guess how many fish could be taken below limits of decline. Perhaps in the future, we could inventory the oceans and determine how to exploit a percentage of a population without destroying it or its habitat. In this case we have to conserve the entire ocean ecosystem by withdrawing. Moreover, rivers play an important part in regional and global biogeochemical cycles, by transporting materials to the ocean. Ninety percent of the landmass drained by rivers. Since river systems discharge nutrients, we would have to restore the rivers, many of which barely reach the ocean. This means increasing the water flow to previous levels, by allocating use and if necessary rationing water use.

In ten or a hundred or more years, depending on the ages of some fish and aquatic mammals, we might start taking fish carefully, noting which populations are stimulated or depressed by the percentage of harvest. The catch over the entire ocean may be less than half of the current mass vacuuming. We will have to reduce our waste and value the fish that are eaten. Perhaps, we have to deny fish to domestic animals as a food supplement.

4.4.2. *Designing Cycles*

A pattern is a regular array of similar units. The units do not have to be exactly the same shape or size, and the regularity does not have to be perfect. Many of the laws of physics are nondeterministic laws (or stochastic) and they influence natural and human systems. Our ignorance of them lets us get caught by surprises. These laws create patterns in space, as well as in human history. There are simple kinds of patterns. A linear pattern tends to be interpreted as progress or regress. This is the dominant concept of modern history, unending progress. Despite the chaos of individual events, there seems to be a direction.

The circular pattern, suggested by the myth of eternal recurrence, depends on regular repetition, as with the seasons. It allowed disintegration to be replaced by regeneration. The helical pattern is innovatively cyclic, and the cycle is additive and seems to each reach a higher stage. Finally, there are nonlinear patterns. These seem to have more surprises due to the acceptance of complex nonequilibrium systems. They may evolve in a definite direction, but move by leaps and turns.

The definition of stability is related to linkages, especially flows and cycles at different scales, with other species and patterns. This is why human improvements are often not stable. Nothing is fixed or static. Everything is changing and flowing. But that is not the result of design. That is bottom-up flowing and forming in nature. Nature has no design or intent.

Humans are increasingly perturbing biogeochemical cycles. In addition to impacting

the carbon cycle, humans have doubled the natural global sulfur emissions to the atmosphere, doubled the global rate of nitrogen fixation, enhanced levels of phosphorus loading to the ocean, altered the silica cycle, and perhaps, most critically, altered the hydrological cycle. Relative to many natural perturbations, the effects of human activities have been extremely rapid. We can design cycles by mimicking natural cycles and reducing the anthropogenic flows of many elements, such as nitrogen and carbon.

4.4.2.1. Atmospheric Cycles

Vaclav Smil notes cycles that we probably cannot alter. They include the evaporation-precipitation cycle dominated by the ocean or the nitrogen cycle in the atmosphere. Nitrogen used to be fixed by lightning and natural biofixation, but now synthetic fertilizers and the combustion of fuels adds another 100% of reactive nitrogen to the biosphere. This creates tremendous interference in the global nitrogen cycle. Can we wean ourselves of fertilizers? We can decarbonize energy, but cannot denitrogenize organisms and ecosystems.

Carbon dioxide is an atmospheric constituent that plays several vital roles in the environment. It is a greenhouse gas that traps infrared radiation heat in the atmosphere. It plays a crucial role in the weathering of rocks. It is the carbon source for plants. It is stored in biomass, organic matter in sediments, and in carbonate rocks like limestone. The primary source of carbon/CO₂ is outgassing from the Earth's interior at midocean ridges, hotspot volcanoes, and subduction-related volcanic arcs. Much of the CO₂ released at subduction zones is derived from the metamorphism of carbonate rocks subducting with the ocean crust. Much of the overall outgassing CO₂, especially at midocean ridges and hotspot volcanoes, was stored in the mantle when the Earth formed. Some of the outgassed carbon remains as CO₂ in the atmosphere, some is dissolved in the oceans, some carbon is held as biomass in living or dead and decaying organisms, and some is bound in carbonate rocks. Carbon is removed into long term storage by the burial of sedimentary strata, especially coal and black shales that store organic carbon from undecayed biomass and carbonate rocks like limestone.

We do have the ability to influence carbon sequestration or carbon emissions in carbon dioxide. To stabilize carbon dioxide concentrations in the atmosphere to 450 ppm, various models suggest they must be reduced by 50 percent by 2050 and 80 percent by 2100. Is global climatic chaos something that can be changed on a human level? Will a warmer world be worse? Yes, for cold species most likely. Yes, for many human companion species. Should we give up and let it happen? Should we do the best we can with the least waste? We need to make changes to avoid human and other suffering, rather than try to balance the planet. Do we know enough about how the planet moderates the atmosphere? Should we try to trigger these? Gregory Benford suggests two strategies: Hide the carbon by burying it in the Gulf of Mexico; and reflect away sunlight. These would require stable technology and tight control, neither of which we could provide. Anthropogenic changes to the atmosphere are usually limited to trace compounds such as carbon dioxide or aerosols from biomass burning or fossil fuel combustion.

4.4.2.2. Water Cycle

The water cycle is driven by climate and geology. We are influencing the water cycle by increasing the rates of evaporation. This is through the drawdown of ten-thousand-year-old aquifers. Too much water in a system or cycling through a system leaches nutrients, resulting

in a nutrient-poor environment, such as tropical rainforests. Although the rainforests have a tremendous biomass, they need rapid nutrient-cycling to survive. Cutting trees and burning shrub areas can result in erosion, which depletes nutrients faster, so that the environment is not capable of supporting regrowth of rain forest nor even Swidden farming. Cutting trees on a large-scale or over a large area in a rainforest has to be avoided. We need to keep the reservoirs for water, like the ocean, healthy and clean. The exchange pools for water, such as clouds, need to be in active turnovers.

4.4.2.3. Solid Cycles/Nutrient Cycles

Some material cycles between other ecosystems or in larger patterns in regions. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are century or millennia long. Human beings do not pay much attention to very long cycles or to those we perceive as not affecting us. Alan Drengson is fond of saying we do not see important operations of nature because we are looking through the wrong paradigm (acting like a pair of glasses, focusing on what we want).

4.4.2.3.1. The Phosphorus Cycle

Phosphorus also plays a key role in the cycles of such biologically essential elements as nitrogen, oxygen and sulfur. One can characterize phosphorus compounds in water and soil, estimate how fast phosphate cycles through natural reservoirs, estimate long-term phosphorus burial in the oceans through geologic time, pinpoint phosphorus sources in different ecosystems, determine fluctuations in phosphate concentrations at certain times and places, and study the effects of phosphorus pollution in estuaries and lakes.

Part of the phosphorus cycle is a nutrient cycle through ecosystems. Nutrient cycles change with the succession of an ecosystem. Design for optimum phosphorus has to do with keeping it in cycles, but out of the ocean. And it is equally important not to concentrate it in agricultural systems or water bodies.

4.4.2.3.2. Nitrogen Cycle

In the nitrogen cycle, the compartments are the atmosphere, vegetation, forest floor, and mineral soil, while the transfers are precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification. Each compartment keeps the nitrogen for a certain time, termed the residence time; for a hardwood forest floor, for example, residence time is about 17 years. Human interference in forest cycles can collapse the residence time; for example, clearcutting alder in Washington State causes very high nitrogen losses.

We have to make sure that nitrogen is abundant, but not overwhelming. The nitrogen flux is not particularly high. For the nitrogen cycle, we need to keep the transfers, such as precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification, moving. We need to make sure the compartments of the nitrogen, that is, the atmosphere, vegetation, forest floor, and mineral soil, are optimally full.

4.4.2.4. Ecosystem Cycles: Elephants

The scale of the system defined, for example, wooded patch, ecosystem or temperate broadleaf forest, depends on the scale of the phenomenon being addressed. Mangrove forests are in phase with the frequency of hurricanes, although hurricanes may not influence the life

histories of short-lived organisms as much as daily or seasonal cycles. Microbes, for instance, are affected more directly by short-term cycles of precipitation and temperature. To keep many cycles operating, we could restore key species, such as elephants, that shape whole landscapes and push the cycles in a healthy direction.

At this time, however, we are threatening elephants with extinction. Tens of thousands of years after humans saw and coveted the ivory of elephants, people are still hunting elephants, until the species is threatened with extinction. Ivory is still use for medicine and art, for paperweights and billiard balls. Poachers take pictures of the dead elephants, perhaps as memories or trophies in themselves, since they sell the tusks. Conservationist take pictures and films of the dramatic living elephants to show how impressive they are, not just physically, but emotionally and socially. We recognize the emotions in them, as well as their struggle to survive our nonstop invasions of their habitats to plant fields and build houses for our communities.

It has proven to be impossible to stop the demand for elephant tusks. There is a thriving trade in these tusks. It is supported by the fact that poachers can make much more money killing and harvesting elephants than they can by farming or making artifacts or tools. Partly, this is a flaw of the economic system. When everything can be traded for money, that is, symbols of real wealth, there is no connection to the sources of wealth. Partly it is a flaw of culture, that values 'real' ivory, although the plastic and chemical forms are quite the same. And, partly, it is because people believe that they need the 'real' thing to be fertile or artistic.

We have tried ways of saving elephants: United Nations Animal program; International law; International opinion; values related to cultures; penalties for ivory trade; restrictions on hunting. Rationing might be tried. But, none of those seem to have been effective. Regardless of our design sophistication, elephants cannot be saved if humans do not stop spreading out into their territory. Elephants cannot be saved if there are too many people making demands on them. Elephants cannot be saved if humans approach them with inappropriate images as pets, slaves or machines). The image of a machine with interchangeable parts is ridiculous and incomplete. Elephants cannot be saved if we cling to our detachment and remoteness, watching violence and misery behind a glass wall of television. Elephants cannot be saved if humans cannot acknowledge and enforce limits and rules.

Elephant saving campaigns are not really constructive in the sense of architectural or educational campaigns because they are defensive. Furthermore, what is defended is, first, in the process of change, so it can not be saved as it is; second, it will always be vulnerable; third, it is an ambiguous concept misperceived by opponents; and fourth, it is ultrahuman. What is to be saved is the potential for evolution of uninhibited development of the in its ecosystem. Animals do not need to be saved from natural death, a great regulator of life, but from unnecessary suffering, experimentation, and premature extinction. We do not seem to have the will to protect elephants. Until there is a dramatic shift in perspectives and awareness, until elephants have legal or ethical standing, until dangerous historical traditions can be discarded without destroying a culture, elephants are doomed.

At end of the recent Ice Age, elephant-like mammals roamed on every continent, except Australia and Antarctica. But, they disappeared from 90 percent of their range later, with climate change and human hunting. In Africa there may have been ten million elephants, 20 times recent numbers. In India, there may have been 2 million, again many more times the remaining numbers.

African elephants eat anything, preferring tree leaves. They can destroy trees quickly, trampling seedlings and small Acacia trees. And they maintain the savanna with their dislike and exploitation of trees. By late 1800s, elephants were almost totally wiped out from the Serengeti by ivory hunters. Much of the Serengeti was dense forest. The Masai had abandoned it because of the tsetse fly. Colonial administrators set it aside as a park. When elephants returned in 1955, the forests started to retreat and grasslands advanced. The Masai returned with their cattle. It was thought there were too many elephants. But, elephants are ecosystem engineers, reshaping their landscapes. This results in changes of species. Lizards lose out, but antelope and zebra prefer elephant savannas; and lions and other predators prefer antelope and zebra. Elephant droppings are rich in undigested plant seeds and elephant-made waterholes help other animals.

Despite adequate rainfall and good soil, elephants kept trees from encroaching into the savanna. Likely megaherbivores shaped the grassland character of much of the planet towards the end of the Ice Age. Elephants tamp hard paths that other animals used. Elephants can make caves to mine salt; the caves are later used by leopards and bats. There are ripple effects (cascades) with animals in a food web. Leopards that get porcupine quills are more likely to hunt humans. Most involve predators. Without Elders to keep them in line and show them water holes and routes to food, young elephants can get violent and lost. Elders are necessary for animal social structure, and memory of the best paths for food or migration. Young elephants relocated without elders started killing Rhinoceros (their musth period had also extended). Until recently, there were Indian elephants (and tigers) in the Western Ghats in India. Many of these elephants are captured in the wild and used for heavy moving and carrying. There has not been enough time for the systems to react to their absence and shift away from mature vegetation.

Because of their size, food intake, and social structure, elephants define the savanna, bush or forest ecosystem where they feed. They need extensive land areas to browse for food. The population of African elephants has been halved in the past 30 years as farmers take over their territory and hunters kill them for parts of their anatomy. Habitat loss and poaching are severe threats. Territory needs to be set aside for or shared with elephants, with as much coverage of African habitats as possible, and with corridors connecting individual reserves. The population should be encourage to be at least 1.3 million, about the population in 1970, and possibly 2 million to rewild significant areas. Likely, tourist income would more than make up for farm destruction in shared lands.

Indian elephants could be doubled from about 28 thousand to 56,000; they could continue traditional movement patterns and shift vegetation, especially in southern India, where groups could be combined. Smaller numbers in southeast Asia might be increased to 20,000, but smaller populations are vulnerable to habitat conversion and might need formal parks, especially in Myanmar, to avoid further fragmentation. We need more elephants working for a healthy planet!

4.4.3. Conclusion: Designing to Adjust to Change

We could design our impacts on cycles so that they continue. We could design civilizations to avoid collapse. Such designs would have to determine optimum areas for wilderness and food-producing areas, then relate the human population and intensity to that. That would involve setting goals. Then we would have to survey and monitor resources and ecosystems. We would

have to figure out how to make budgets for all foods (maybe in terms of kilocalories), then make their budgets and follow them.

For instance, to address atmospheric warming, we could create a series of regional carbon budgets, within a planetary one. First we would set up an emergency budget, using carbon totals from 8000 YBP. This would sharply decrease carbon emissions. Then, figure a second budget with carbon emissions from 1400 or 1800 CE for 10-50 years later. Finally, we could install a permanent budget, by calculating a world cultural carrying capacity (CCC), based on ecosystem productivity and population goals. We would sum all capacities and assign that to be 100%. For example, if China has 13% of the CCC, then it would get 13% of the carbon use at 8000 BP levels or at whatever level was decided on.

The benefits of Contraction & Convergence, a suggestion by UK politician Aubrey Meyer, is this: Everybody has an equal right to pollute a limited amount of greenhouse gases. This right could be traded, similar to those outlined in Kyoto. Under a global C&C agreement, citizens of the US would have to buy or trade carbon credits from poorer countries where people use a hundred times less. Meyer suggests 3 steps. Reach an international agreement on a cap on atmospheric CO₂ concentrations. Then, estimate how to cut back to that goal. Then, divide the budget among the world's population on per capita basis. That would not work; that is why it should be based on a carrying capacity number, as above—otherwise the system would reward fast breeding. Furthermore, the target number should be set much lower than the goal, in order to reduce increased use.

We understand that many factors can potentially cool the earth: Growing trees take up CO₂; the sedimentation of plants in water or soil; dust and jet contrails, and DMS (dimethylsulfide) evaporation into the atmosphere from ocean algae. DMS is the most abundant single biological sulfur compound emitted to the atmosphere. Emission occurs over the oceans by phytoplankton. These atmospheric DMS aerosol particles or droplets are oxidized to sulfuric acid and act as cloud condensation nuclei. Through this interaction with cloud formation, the massive production of atmospheric DMS over the oceans may have a significant impact on the Earth's climate.

We need a push for immediate action. Right now, we have problems agreeing on anything. Will a grave emergency alienate those who do not recognize it or care? Or will it galvanize them into acting? There are many things we can do, from small things, to effective things, to heroic things. We can regulate our lives, especially the three Cs: Cattle, cars, and chain-saws. What kind of things can we do? There are five small things, of course, and these are heavily recommended and advertised: Save energy with better light bulbs; Drive less, travel less; Consume less, consume smarter, and stop using CFCs; Conserve more land; Suggest changes, and participate in making changes.

In addition, there are five effective changes that are more difficult on a personal level: Stop eating meat; Share tools and machines; Stop deforestation and plant a lot of trees; Reduce conversions of wild systems to croplands or pastures; Change the tax structure.

Then, there are five heroic changes: Reforest regions; Turn off the air-conditioning; change energy generation to alternate sources like solar or wind; Do not have children; Stop building new houses; and Participate in a Jeffersonian revolution.

Reducing human population would make everything else easier. We could start by having a year of consideration, where no children are planned. We could base population on ideas of ecosystem and cultural carrying capacities.

We could cut our wastes dramatically, simply by using less and sharing more. We could place waste in the context of industrial ecologies. To reduce the chances of anthropogenic atmospheric heating from carbon dioxide, we could start a carbon budget for the planet, by decarbonizing the power grid with solar, wind, and other sources; we could ban new coal-fired plants and regulate existing ones; we could extract CO₂ from the atmosphere by planting trees under permanent agriculture.

We could retract many of our transportation networks, especially parallel roads and logging roads. We could cut transportation by half, by not travelling as much or as ignorantly. We could optimize transportation; cars could get 50 mpg or better, by increasing the number of hybrid or solar cars. Trains could be solar or electric. Ships could return to sailing, perhaps the clipper ships, especially for cross-ocean trips. Airplanes could be grounded for three days a week.

We could stop expansion of urban and agricultural areas. We could severely reduce the conversion of wild ecosystems and preserve larger wild areas; and, we should preserve wisely, with north-south ranges, as well as regular, wide corridors to connect wild areas and allow animal populations to exchange individuals, even through cities and fields.

Is that it? Things are really complex, but we should try to make it better. We do not need to protect regions or the planet as much as fit within its limits and healthy cycles. The cycles are connected in many ways, such that we need to refrain from interrupting them. Making natural cycles and processes visible brings the designed environment back to life. Effective design helps inform us of our place within nature.



Figure 53-1. Agricultural Field Pattern in Southeast Asia

4.5. Regional Design Factors: Forests

By Twila Jacobsen, Mike Barnes, and Alan Wittbecker

Forests hold a disproportionate amount of biomass on the planet. Forests are able to survive a wide range of climate changes. The importance of forests, not just to the balance a region, but for human use, is often severely neglected.

4.5.1. Forest Planet

The earth seems to be an ocean planet, in terms of surface area. On the land surface, there are deserts, grasslands, ocean, rivers, swamps, and snowfields, but forests are the most significant feature. In fact earth is very much a forest planet. About ninety percent of the biomass of the planet is in trees. Trees allow water to achieve greater heights, that is, to stand against the force of gravity of the planet. Trees are animated, standing water. A forest, however, is much more than trees. Trees are embedded in the vast interconnected process of living, participating in an implicate order (David Bohm's term to describe internal relationships).

Most forest ecosystems, like many marshes and oceans, are detritus ecosystems, where only five to ten percent of the production is grazed and the remainder sinks to the forest floor. This allows biomass to build up, which concentrates carbon and increases soil depth. The forests are connected to the land, air and water; everything is constantly changing in a gigantic intricate web. The patterns are persistent configurations of processes. Order and chaos seem contradictory because of our linear thinking.

4.5.2. History of Forests

Forests have been changing for millions of years. If we could compress space-time in a macrochronoscope in low orbit over the planet for the last several billion years, it would show forests moving like shadows over the landscape, as a result of climate changes, glaciers, and shifts in moisture. Then, at one of its greatest extents, forests would start shrinking, as humans learned to use fire to select certain plants or landscapes, and as they converted large areas to agriculture. Later we would see pyramids, irrigation grids, small changes in green, the Great Wall, then gray-white cities, then smog, plumes of smoke, fleets of ships, and lights everywhere. The immense patterns are easy to detect with this imaginary device. On the ground, changes seem chaotic—forests remember, are chaotic systems—and slow.

4.5.3. Forest Participation in Cycles

In a mature forest very little material actually leaves the forest. It is held in cycles. Materials cycle above and below ground, between the atmosphere and trees, between trees and insects, and squirrels and fungus. Chris Maser is fond of saying that most of the cycling is invisible because it is underground or in the air. Many cycles can be investigated through ecosystem analysis, where energy and materials are traced through transfers through compartments in an ecosystem. For example in the nitrogen cycle, the compartments are nitrogen, atmosphere, vegetation, forest floor, and mineral soil, while the transfers are precipitation, throughfall, leaching, litter fall, mineralization, fixation, and denitrification. Each compartment keeps the nitrogen for a certain time, termed the residence time; for a hardwood forest floor, for example, residence time is about 17 years. Human interference in forest cycles can collapse the

residence time; for example, clearcutting alder in Washington State causes very high nitrogen losses.

Virtually every material cycles through the forest: nitrogen, carbon, phosphorus, potassium, calcium, sulfur, magnesium, water. Some material cycles between other ecosystems or in larger patterns around the planet. Some of the cycles are daily; some are seasonal or annual; others are years or decades; a few, like the carbon cycle, are century or millennia long. Human beings do not pay much attention to very long cycles or to those we perceive as not affecting us.

Table 452-1. Changes to Regional Forests

Human use of fire	60000-35000 BCE ongoing	Selection of fire adapted species. Reduced forests in Europe
Glacial maximum and warming	18000-8400 BCE ongoing	Squeezed or eliminated species
Human colonization of Americas	14,000 BCE	Shifted ecosystems to grasslands
Climate change Hunting stress	12,000 BCE	Megafauna extinctions in N. America
Farming & domestication of animals and plants	9300 BCE	Shifts in wild species. Conversion of forests to fields
Forest clearance	6000 BCE ongoing	Europe, Middle east, Mediterranean
Climate change	5500 BCE	Desiccation of Africa and Middle east
Polynesian colonization of pacific islands	2100 BCE	Extinctions of endemic species, including palms
Tropical forest clearance	1750 AD	Desiccation of tropical areas
Fossil fuel use	1800 AD	Additions to atmosphere/energy systems
Industrial Forest clearance Extinction spasms	1940 AD	Interference with habitats

4.5.4. *Designing Regional Forests within Cycles*

Because forests provide so many useful beings and things, such as mushrooms and wood, forests are intensely used by humanity, without regard to the limits of forest ecosystems and or to the minimum cover that they provide. Crises sciences, such as Conservation Biology and Ecoforestry, and crises philosophies, such as Deep Ecology or Radical Philosophy, are dedicated to protecting forests as well as restoring large areas of forest cover.

Deep ecology, for instance, can ask important questions about forests, forestry and planning. For example:

- When does clearcutting increase the health of a forest, if at all?
- What is a minimum, optimum or maximum forest cover for various watersheds? Science might identify minima or maxima but philosophy can aim at optima.
- How much wood can be taken from a forest? How much biomass can be taken before the system collapses?
- What kinds of stability should we encourage or maintain: persistence, resilience?

- What is the character of nature undisturbed by human beings (asked by Dan Botkin)? Or what is the quality of nature with limited disturbances? (These are bad questions—there is no single state anyway. There is no nature undisturbed, but the kinds and rates of disturbances have changed)
- What is the difference between exploitation in a forest and disturbance or interference?
- How much disturbance can a forest take? Is clearcutting a natural-enough kind of disturbance?
- How can we manage with unpredictability (after Chris Maser)? Science can deal with unpredictability to some extent, but philosophy can provide other analytical and synthetic tools.
- At what level should management take place? Individual? County? National? Global?
- How can we design forests for the long-term and high diversity? What are the limits of biodiversity? How much of the forest can we design?
- How can we design forests for neutral elements in interrelated processes in a landscape?
- What are we restoring when we restore an ecosystem without all the parts or good knowledge about the ones we have?
- Can we limit our take so the forest is still self-sustaining and self-repairing? Philosophy can provide images of rich frugality.
- Why do we need old growth? We can support it ecologically in terms of nutrient flow and diversity, but we should also recognize what part it plays in human psychology and myth.
- How can we apply ethics to the forest in our current sociocultural situation that emphasizes short-term profits?
- What kind of certification should we promote? Third-party only? What are the implications of certification?

These questions highlight the uncertainty we face in dealing with large, wild, complex, long-lived entities like forests. Forest managers have to live with uncertainty; this means that management decisions are essentially gambles. Gambling is a profession that acknowledges the operation of chance and makes conclusions in the absence of facts—few people are successful at it. This is an important admission, that we do not have facts to base our actions on, that nature is a stochastic process, and that ecosystems always changing. Furthermore, we do not know for sure what effects our actions will have on the forest, which used to live so long, in such diversity, in so many places. Successful gambling suggests that the proper attitudes for gambling with nature are awareness, humility and courage, and not arrogance, fear and maximum use.



Figure 453-1. Old growth at Wildwood 1994

4.5.4.1. *Design Goals for Forests*

Over 50 percent of the planet was forested at one time—down to about 28 percent now. We could restore at least 20 percent in the next decade, leaving all old growth untouched and the last 2 percent for tree plantations.

4.5.4.1.1. Functional Cover

On the other hand, how much forest cover do we need to keep the regional airshed or atmosphere functioning the way we like it? Carbon dioxide (CO_2) accumulates in the atmosphere at the rate of 4×10^6 tons annually. Deforestation possibly releases about 2×10^6 tons of carbon per year (only a third as much as from fossil fuel combustion). Reforestation could remove carbon from the atmosphere. We need about 7×10^6 square kilometers of new forest to store 4×10^6 tons of carbon annually (after George Woodwell's estimates).

4.5.4.1.2. Regional Goals

Regional goals are appropriate for bioregions and isotopes (similar places). Notice that the number of goals decreases as the scale gets larger.

- Zone forests at the landscape level for preservation, conservation, or selection use
- Maintain ecological and evolutionary processes in healthy forest landscapes
- Preserve all old-growth—none of the new forestries can be a substitute for keeping the remaining old-growth, and no secondary forest can match old-growth for biological richness or ecological importance
- End logging in national forests; Clinton's 1993 FEMAT reported that the only way to ensure a chance of maintaining viable populations of all species in PNW coastal forests was to halt all logging—Option 9 (from outer space? An Ed Wood movie?) allows for extirpation or extinction of 800 species.
- Diversify the institutions that deal with forests; relate people diversity to forest diversity
- Eliminate government subsidies for timber harvesting
- Reduce fragmentation of landscape patterns with responsible selection harvesting
- Accept and plan for natural change, disturbance, uncertainty, ambiguity—part of the process
- Restore forest cover in North America to pre-European levels
- For the US, replant 142 million hectares of forest lands—up to 438 million hectares (the approximate level of cover in 1600)
- For Canada, replant over 80 million hectares of forest, up to 530 million hectares
- For the Northwest (Pacific NW coast forest, US and CND), replant up to 47 million hectares
- For the Northeast (northern hardwoods), replant up to 11 million ha
- For the Southeast (Oak-pine forest), replant up to 129 million ha
- For other ecoregions, replant to a high percentage of 2000 BC levels, especially around the Mediterranean
- Relate (or limit) population and consumption to the productivity of ecosystems—without such limits, forests will eventually be destroyed

4.5.4.2. *Design Considerations for Forests*

Shapes are as important as coverages. Location is critical, as soils are important. To restore the extent of forests before a nonarbitrary time, e.g., at 40,000 years before the present (before extensive fire use) or 10,000 years before the present (before extensive agriculture) or even 500 years before the present (before industrialization), decisions about replanting, or even relocation of cities and roads, have to be made.

4.5.4.2.1. Location

Forests thrive on good soils; some forests can do well on fragile, unproductive soils that are too thin, cold, wet, or rocky, if they have time to develop. Unfortunately, many cities and other human habitations have replaced forests on good soils. By building cities on poor, rocky soils, and by expanding agriculture into cities, especially rooftops, a greater area of good soils could be left for forests

4.5.4.2.2. Shapes

The shape of a forest can influence the numbers of tree fall from storms, the amount of active interior space, and many other parameters. The shape can determine the total area. Currently most shapes are the result of cutting and conversion; even plantations seem to be rectangular to simplify future harvests. Designing the shapes according to the topography and with regard to the goals of the forest could improve the health of forests. The space between trees influences the kind of wood growth and branch patterns. The space between forests influences the amount of genetic exchange.

4.5.4.2.3. Restoration

Many of the local and global goals require restoration. But, is that a good idea? What is weak about restoration? What are we restoring? An ideal? Richness? Context? Function? Patterns? The past configurations? Are there too few parts? How large an area is needed? Do we need places for DNA, zoos, parks, and cryogenic labs, if we cannot save the entire forest?

We need to start to plan for future biotas that may be less beneficial for humanity and more necessary for forest and planet health. Many of these will be restored or assembled from exotics, reintroduced natives, or engineered species. What are we restoring when we restore an ecosystem without all the parts or even good knowledge about the ones we have? Ecosystems are not built by selection in the same way that organisms are. Their irregularities are caused by external forces and constraints. Although the components of ecosystems may be erratic, they seem to be organized in predictable overall patterns. So, we can guide restoration.

Restoration projects have the potential to save entire ecosystems. The intensive management of (usually) small areas could restore sets of species critical for forest functions. Landscape ecology and island biogeography can identify candidate ecosystems for restoration, and candidate ecosystems for preservation, conservation, or reservation. Conservation biology and ecoforestry recommend how to restore clearcut areas: Replant with native species; restore damaged streams and wetlands; restore natural connections and corridors.

Forests start from bare land or reestablish their range at various scales (after an ice-age for instance) or continue through the death of individual trees or shift into different kinds of forests. Natural forests often contain small relatively even-aged stands of trees. This can be observed regularly with old-field restoration, where planting continues over several decades

and, where a forest surrounds the fields, natural regeneration continues.

Part of any management scheme must be to improve local and global supplies of wood by replanting and caring for forests. Ecoforestry management could help re-establish forests on heroic scales. R.A. Houghton (1990), for example, has suggested that there might be as much as 3 million square kilometers of once-forested, now-degraded land in Africa, 1 million in South America, and 1 million in Southeast Asia. Even North America could probably benefit from a million square kilometers or two of restored forests.

Even industrial forestry has become concerned with restoration. Management is now considered necessary to restore trees to previously forested areas, to preserve the genetic information in forests, and to iron out the boom and bust cycles of wild nature by controlling environmental factors, such as mineral deficiencies, as much as possible. Furthermore, federal management assumes that it must set standards for knowledge and development that local communities might not have.

4.5.4.2.4. Design Cost Considerations

Design may be costly. Restoration may be more costly. For example, grassland restoration costs about \$1500 per acre per year, based on the first two years. Forest restoration costs more. The cost of the design itself could be significant, at \$300-400 per acre. Design may take a long time—longer than human lifetimes. How does this cost compare to expenditures on ice cream, make-up or medication for erectile dysfunction?

The forest may be too complex to design. Consider a thought experiment about how to design a forest using artificial pieces, such as giant sponges or shade cards. The experiment could make people uneasy, possibly because it is absurd or too complex. How do we design a forest, a complex, self-making, self-sustaining wild forest? Management has to recognize the limits of design. Limits of ecological design include:

- Forests are wild, we have no real control
- The scale of forests is too large to manage everything
- The longevity of forests is too long, we will never complete the design in human lifetimes
- The costs may be prohibitive—indeed, we have depended on the free goods of forests for economic advantages
- Other human limitations apply to our ability to see and understand the forest.

Most forest designs will not be restorations, because of the uncertainty about the kinds and associations of native vegetation. Furthermore, humans are now an large part, although not yet an integral part, of the system; therefore it could not be restored to a premodern or prehuman state (and even if it could, which state?). This design is not the biotechnological design of a new ecosystem, either; we cannot accurately control and predict ecological events in most ecosystems. However, we can steer some of the events in a known direction—known because we have historical records of the system, although not complete. We can also reduce those human activities that we know alter the conditions of the forest, such as overcutting and pesticide use.

Although ecological design attempts to restore some kind of balance, the balance does not exclude human activity. Rather, it integrates it into the larger community. A moderate number of human impacts can be absorbed by the system—too many interferences destroy the systems capacity for self-maintenance. The design should be open to evolution and to human

technological and social development. The design should be based on a model of ecosystem functions, considering diversity, complexity, and the maintenance of natural process—natural here meaning a self-sustaining system composed of elements now lost through human disturbance.

The goal of ecological design is not to restore, but to revitalize and reinhabit forests. We do not want to live in the dead bones of a mechanistic failure. We want to live in a healthy environment with aesthetic appeal, which is a requirement for human health. Every forest has physical, biological, economic, and political characteristics. The design, planning, and management for a forest describes the system in a comprehensive interdisciplinary approach, using dynamic concepts such as feedback and stability, recognizing limits to change and sustainability with different levels and scales of structure and function in an anticipatory, flexible planning approach, recognizing human and nonhuman goals, and incorporating personal and institutional interests.



Figure 454-1. River Forest on the Shenandoah River 2004

4.5.5. *A Partial Green Sahara*

The Sahara desert is the largest hot desert on the planet (the cold Antarctica desert is 50% larger) with an area of 3.3 million square miles (8.8 million square kilometers or roughly 10% of the continent) typified by erratic dunes (ergs), plains of rugged rocks (hamada), and relatively high mountains (11,000 feet). The desert is bounded by the Atlantic Ocean, Mediterranean Sea, Red Sea, and the Sahel, which is a semi-arid tropical savanna.

The desert may be as old as 2.5 million years. During the last 40,000 years the borders of the desert moved southward or northward. At times, it disappeared completely, as wooded savannas, like those found in eastern Africa, replaced sand dunes. Recent research with radar technology discovered a web of channels in the depths of wide valleys. Some were as broad as the Nile; the Niger River once originated in Sahara.

During the Jurassic, the Sahara was covered by an ancient sea, which was 15,000 feet deep in some places. There is still, at a depth of 2500 feet, a subterranean sea of fossil freshwater estimated at 150,000 cubic miles. By 135 millions years ago, dinosaurs roamed the Sahara landscape.

When the Ice Age had reached its peak 18,000 years ago, the Sahara was located 250 miles further south, and it was larger due to lower precipitation. As the ice melted between 13,000 to 8,000 years ago, rainfall increased due to low pressures over the ice sheets in the north. By 6,000-8,000 years ago, a flourishing Neolithic culture made rock paintings in the Tassili n'Ajjer Mountains and other areas of Sahara, depicting oryx, antelope, gazelles, and other animals found far south now, such as crocodiles, ostriches, rhinos, giraffes, buffaloes, hippopotamus and elephants. The Sahara was filled with lakes in the region of modern Niger. The mountains were covered by forests. Then, about 4,500 years ago, the region turned more arid and the desert expanded, although some savanna patches and shrub species still exist. The donkey was domesticated from the African wild ass. It was replaced generally as a beast of burden about 2000 years ago by the dromedary camel. Since 1900, the desert has expanded south into the Sahel in a band over 155 miles wide.

Geographically, the Sahara covers parts of several African nations including Algeria, Chad, Egypt, Libya, Mali, Mauritania, Morocco, Niger, Sudan and Tunisia. Most of the Sahara Desert is undeveloped and features a varied topography. Most of its landscape has been shaped over time by wind into sand dunes, sand seas, barren stone plateaus, gravel plains, dry valleys, and salt flats. About a fourth of the desert is sand dunes, some of which reach over 500 ft (152 m) in height. There are also several mountain ranges within the Sahara. The highest peak found in these mountains is Emi Koussi, a shield volcano that rises to 11,204 ft (3,415 m), in the Tibesti Range in northern Chad. The lowest point in the Sahara Desert is in Egypt's Qattera Depression at 436 ft (133 m) below sea level.

Most water flow in the Sahara is in the form of seasonal or intermittent streams. Other water can be found in underground aquifers and in areas where aquifers reach the surface in oases. The amount of water varies with location. The central desert is hyper-arid, with little to no vegetation, while the northern and southern portions have sparse grasslands, desert shrub and sometimes trees.

The climate of the Sahara is hot and extremely dry. The annual rainfall in the Sahara is below 1.1 inches (25 mm) per year. It is one of the hottest regions in the world. The average annual temperature for the desert is 86°F (30°C) but can exceed 122°F (50°C), with the highest temperature ever recorded at 136°F (58°C) in Aziziyah, Libya.



Figure 455-1. The Sahara and Sahel in Africa

Plants and Animals of the Sahara are limited by high temperatures and arid conditions. The plant life is sparse and includes only about 500 species, which are for the most part drought and heat resistant varieties and those adapted to salty conditions (halophytes), where sufficient moisture exists. Acacia and Tamarix species occur along wadis and dayas. Endemic species in the dry woodlands include the Saharan cypress, wild olive and Saharan myrtle, out of perhaps 162 endemic species of plants.

These harsh conditions play a role in the presence of animal life, also. There are a few endemic species, such as the Western giant Spiny-tailed Lizard and a fish (*Gymnocanthus vandesandeii*). In the central and driest part of the desert there are around 70 different animal species, 20 of which are large mammals like the spotted hyena and dama gazelle. Other mammals include the gerbil, sand fox and Cape hare. Reptiles like the sand viper and the monitor lizard are present, also. Ants and arthropod are numerous.

Neolithic humans most likely moved into the Sahara after 8000 BCE, followed by Egyptians, Phoenicians, Greeks, Romans, Arabs, and Europeans. The current population is around 4 million with the majority of the people living in Algeria, Egypt, Libya, and Mauritania. Because about half of the people are nomads who move from region to region, there are many different nationalities and languages, although Arabic is most widely spoken. Urban populations are increasing. Minerals that are mined and traded include iron ore (Algeria and Mauritania) and copper (Mauritania).

4.5.5.1. Planning to Restore the Edges of the Sahara

Since the Romans plundered North Africa for its resources, some people have wondered if the region could be made productive again. Richard St. Barbe Baker started an international environmental organization—The Men of The Trees—in the 1920s to conserve forests and plant trees. After studying forestry at Cambridge, he became a conservator of forests in Nigeria and Kenya. In the 1930s, he was instrumental in the campaign to save California Redwoods and in the Civilian Conservation Corps through his friendship with President Franklin D. Roosevelt. Later, Baker crossed the Sahara on a ‘groundbreaking’ ecological survey. He became obsessed with the idea of reforesting the Sahara in a military-style campaign with an army of 25 million tree planters. He traveled around the desert, visiting every Saharan leader to promote the project.

More recently, Charlie Paton, Michael Pawlyn, and Bill Watts created a Sahara Forest Project to turn the Sahara into a source for food, water, and energy, as a partial solution to resource problems. The project would combine concentrated solar power and seawater greenhouses in a massive holistic, synergetic 'biomachine' that would turn the region into a flourishing oasis that could export energy to the rest of Africa and Europe. The two proven technologies, seawater greenhouses and concentrated solar power technologies would seem perfectly suited to work in hot, dry climates. Seawater greenhouses could turn saltwater into freshwater for growing crops in arid regions, even producing a surplus. Concentrated solar produces energy, and would use water (to turn to steam) to do it. The water the greenhouses produce would feed the solar turbines, and use the power the solar produces to run them.

They would also expect to grow biofuel crops (such as jathropha) and food in the greenhouses. The extra water to reforest the immediate area and sequester carbon. This is touted as biomimicry on an industrial scale. And it would be an innovative design to accelerate the pace of positive change. The development team expects that the Sahara Forest Project would span 20 hectares and cost about 80 million Euros.

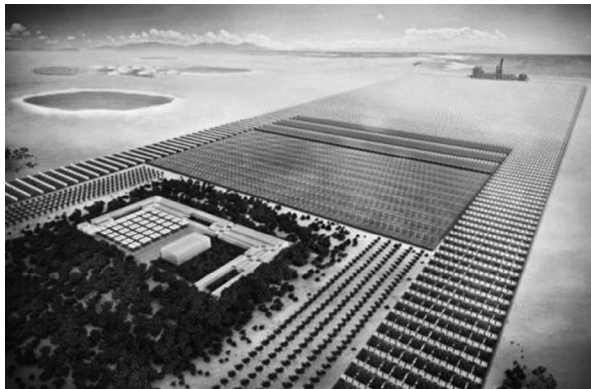


Figure 4551-1. Norwegian-Jordanian Saharan Tree Plantations test in Jordan

In another attempt, the southern side of the Atlas Mountains in Algeria's desert is being turned green, as a vision of the civil engineer Madjid Abdellaziz. An area has been turned into a wide green oasis, where now fruit trees, vegetables, wheat, and even truffles grow in the desert sands. The garden area is producing local rainfall, which is helping the persistent water shortage from the latest drought of 2003. Mr. Abdellaziz's methods to grow plants and bring rain back to the region are based on the bioenergetic principles of Wilhelm Reich and others.

The 'acupuncture' of the sky is the 'treatment' of an energetic imbalance in the atmosphere with a simple installation that was devised and first applied by Wilhelm Reich, and now applied by James DeMeo as 'Cloudbusting.' The cloudbuster, according to Reich's descriptions, consists of a special movable antenna resembling a large 'pipe organ,' which can be aimed at different parts of the sky. The device taps into and influences natural energy currents in the atmosphere and ground, and when used in certain specific ways, 'wind and weather patterns respond accordingly.'

Another tool being used is the Groasis Waterboxx, which is said to have great potential to help reforest arid and semi-arid land. In tests in the Sahara, 88% of Waterboxx-sheltered trees survived versus 10% of trees with traditional cultivation.

There are eleven nations participating in 'The Great Green Wall' tree-planting project to attempt to halt the spread of the Sahara desert. These countries are Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Eritrea, Ethiopia and Djibouti. This project aims to plant a wall of trees 4350 miles (7000 km) long and 10 miles (15 km) wide across the southern edge of the Sahara desert. A larger plan to irrigate the Sahara is being considered.

Geoengineering, even terraforming an entire region, has been suggested as a corrective for global warming. In the journal *Climatic Change*, Leonard Ornstein, David Rind and Igor Aleinov propose a plan to pump desalinated seawater from the coast to the desert. The pipes, buried underground to avoid loss to evaporation, would irrigate fields of *Eucalyptus grandis*. As the trees take root, they would replenish the soil and cause more rainfall, allowing for even more growth. The researchers estimate that as the forest grows, it would fix 8 million tons of atmospheric carbon, equivalent to the total emissions of the planet today.

In a similar plan, Craig Embleton addressed the potential for reducing atmospheric carbon dioxide levels through solar-desalinated irrigated vegetation of the Sahara and Arabian deserts. He also decided to research *Eucalyptus grandis x urophylla* because of the strength of the literature available on it as a forestry plantation tree, although he acknowledged the shortcomings of the tree for the establishment of a monoculture forest. His calculations suggested that existing technologies such as concentrating solar power and reverse osmosis were feasible for the irrigation of the sites and establishing vegetation.

He proposed a larger-scale plan, where 73.5% of the 11,430,000 km² of land that currently makes up the MENA deserts would be transformed into forests by irrigation using water produced by desalinating seawater, using electricity produced by concentrating solar power. He calculated that the eucalyptus forest would be capable of sequestering 6.4–11.9 gigatons of carbon per year, while the soil across this area may sequester additional carbon at the rate of 1.6–2.4 gigatons. Non-land-use-change anthropogenic emissions of carbon are currently 8.7 gigatons per year, less than the higher estimate of carbon sequestration.

The forest would have a water requirement of 7,560 – 8,400 km³ yr, which would be provided by desalinating seawater using reverse osmosis in plants covering up to 6,300 square kilometers of land. The reverse osmosis plants would require electricity, as would water pumping stations. The total electrical requirement would be 56,144 – 62,553 TWh per year. Embleton proposes that this electricity could be produced using concentrating solar power units, which would cover up to 579,194 square kilometers if arranged in parallel troughs.

4.5.5.2. Discussion of Consequences

Many reasons are listed for greening the Sahara, including carbon sequestration, restoring its forests and grasslands with their complements of wonderful species, and feeding a growing human population. Part of the reason is the human idea that land should not be wasted but be properly exploited.

Certainly a green desert the size of the Sahara would be an impressive carbon sink, but the effects of this change would result in many other unintended changes, many of which could be negative, such as a shift in westerlies. The scale of these proposals would result in many unforeseen or unintended problems.

There would be a high initial cost, possibly 2-9 trillion dollars. While that may be less than the cost of temperature changes and rising waters, it would be incurred all at once. Irrigating the desert with water from desalinization plants operated by solar power would be

expensive, for 8.4 million square kilometers. Doubtless surplus electricity could be generated.

The need for human control of a project that large might be beyond organizational capabilities. People would have to control large processes over large areas. They would have to control desalinization as well as the catchment and use of fresh water. They would have to control the placement and interactions of species.

There are already massive problems with irrigation, including salinization. Every irrigation system in history has collapsed at some point from the effects of evaporation and salinization. Although, with the practice of having the system lie fallow and be flushed out, the problems would be reduced. But, every irrigation practice in history has been exploited to a maximum, without any reduction in pressure. This project would have to be different.

There have been similar problems with large-scale energy projects. Most of those have been used to a maximum. Most of them have experienced catastrophic failure at some point. Like any large system, its complexity insures that some critical element will fail at some point. The fact that it is monitored by human beings and under human control insures that human mistakes will cause the system to fail at some point.

Several proposals have recommended fast-growing exotic plants like eucalyptus. Single-species or simple ecosystems established at once are more fragile than diverse ecosystems that formed over long periods of time. Furthermore, exotic species that have been borrowed from other native contexts bring their developmental habits with them. In the case of eucalyptus, the species is fire-dependent and burns rapidly under hot droughty conditions. This would be sure to happen regularly in the Sahara environment, as it happens in its native Australian environment. This would offset any advantages from its other characteristics, such as being quick-growing. Algae or biofuel species may require constant intervention to survive.

Creating a complex, multilayered system, whether a grassland or forest, would be even more difficult, especially if it was assembled from various exotic species pieced together from desirable characteristics. Many of the species would die out immediately, as the system settled into a new state. Deaths from competition or fire would release a significant amount of carbon back into the atmosphere or severely reduce the productivity of the system for human needs.

Another difficult decision would be allowing the native Sahara species to be lost or go extinct. These species have developed over very long times as they adapted to severe conditions and other species. They are probably the optimal response to those conditions. Introducing new species for the purpose of increasing productivity and changing environmental conditions, such as rainfall, would destroy most of the old system. One of the hopeful present trends is preserving uniquely diverse systems. If the old system proved to be a better or more permanent adaptation, reestablishing it might be difficult, expensive or impossible. How would we decide which system is more appropriate or valuable? Even if we were restoring the Sahara to an earlier state, how would we decide which state? The pre- Ice age state, the Ice-age state, the first post-ice-age state, the current state, or a totally anthropogenic once?

Any large-scale change in the Sahara will bring changes to local weather patterns. Increased local precipitation will certainly promote more growth in plants, both desired and weedy species. Furthermore, insect pests, such as locusts, or other plants, such as molds, would also increase, threatening the target species or the balance of the system.

Regardless of how desirable these might be, it is likely that they will influence or change regional and global patterns. A newly forested Sahara might create a low-pressure atmosphere that would draw more moisture from central Africa, perhaps drying out the tropical forests

there, or it may bring more polar air to Europe. The wind-born dust that is carried from the Sahara to the tropical forests of South America would decrease significantly, perhaps reducing soil fertility in those forests, as well as reducing the quantity of Atlantic Ocean life. Similarly, the moisture that would have been picked up by the dust would be lost to the Amazon forests.

With a system of this scale, we might reach the limits to knowledge quite quickly. We have not created an encyclopedia (or Wikipedia) of information about species interactions or about large-scale ecological changes.

4.5.5.3. Summary: Benefit Shifts

The deep history of the Sahara and the planet suggests that deserts occur under certain conditions that balance other areas of the planet. Many scholars suggest that the planet cannot maximize the number of efficient, productive systems at any time. Others suggest that maximization might not be desirable as a characteristic on dynamic systems existing in a nested complex of changing conditions. It might be possible that a maximal system is vulnerable to a more complete collapse and that the current ranges of systems is more stable in the long run.

The Jurassic was an ice-free geological period dominated by a warm climate and large terrestrial species. However, the interior of the single large continent (Pangaea) was dry and desert-like (mostly due to the weather dynamics of a supercontinent); in fact dinosaurs moved through desert landscapes as often as tropical ones.

While it might be possible to reforest or regrass the Sahara for our benefit, the project could force other changes, such as drying or collapse, in other ecosystems, which might have greater impacts or damages to agricultural systems. Reducing the amount of anthropogenic carbon dioxide in the atmosphere is a good goal to keep the planet cooler. New vegetation would sequester more carbon, especially in longer-lived organisms, such as trees. New vegetation would change wind and moisture patterns, as well as albedo, which could increase the local temperature.

Data on desert soils are low. Data on carbon sequestration rates and transpiration efficiency is low or missing. Given the real limits of ecological knowledge, and given the certain problems with large-scale projects, we should limit the restoration of grasslands or forests to many small local experiments, beginning with those already begun and expanding to sheltered areas across many environments. Land-use changes, as a form of global geoengineering, might be preferred to the technological production of orbiting mirrors or ships full of iron-filings, but the scale is still a problem.

The expense of the project might be prohibitive, at 2-9 trillion dollars. The use of seawater could reduce some costs. Hiring and depending on local people would keep the money in the local economy.

Although there are several new media for rooting, only covered drip systems should be used for irrigation to minimize evaporation. Irrigation itself might be minimized in the desert. Irrigating with seawater might give an initial boost to ecosystems, but they would be saltwater wetland systems.

The green wall should be tried to help the Sahel, but with the understanding that the wall is permeable. Sand, as well as air, pollen, and animals, will slip through. The wall would limit the Sahara and protect the Sahel from desertification. Forest restoration should be attempted only with native African species, such as acacia and cedar, which have adaptive interactions with other endemic plants and animals.

4.6. *The Nilgiri Reserve in India: A Regional Case Study*

By Michael W. Fox

International efforts to improve human health and wellbeing are now recognizing that such efforts will not succeed if the quality of the human environment is ignored. Improving environmental quality is an integral component of ‘planetary CPR’ —environmental conservation, preservation, and restoration.

The importance of improving the health and welfare of domestic animals as an integral component of both ‘planetary CPR’ and improving human health and wellbeing, is now also gaining recognition. For too long, animal welfare and protection have taken a low priority on the philanthropic, international aid, development, and humanitarian agenda. This overview of the essential connections between people, animals and nature presents the case for a more integrative approach to wildlife conservation, human wellbeing, and domestic animal protection and health.

4.6.1. *Revisioning Health*

The old definition of health as the absence of disease has been broadened by the World Health Organization to include social, economic and environmental considerations. This broader definition may be adequate for urban people, especially those of the industrial West. But for the majority of the world’s rural communities and indigenous (tribal) peoples, it is insufficient. It is inadequate for the formulation of appropriate policies and implementation of effective aid and development programs, because the health and welfare of the domestic animals living with these people and the protection of wildlife, conservation and restoration of natural habitat (‘biodiversity’ and ‘ecosystems’) are integral to human wellbeing, on many levels. These include public health, family nutrition, economic security, community sustainability, cultural identity, and traditional and spiritual values. Biodiversity and cultural diversity are interlinked, codependent and coevolved in all ecosystems that include the human species.



Figure 462-1. The Nilgiri Reserve (Southern India)

4.6.2. *Global Biosphere Reserves Program*

The brilliance of the United Nations Man and the Biosphere initiative, which has now identified over 400 Global Biosphere Reserves around the world, is in the recognition of this vital linkage between culture and Nature, and between the integrity of cultural and biological

diversity. Integrity does not imply a preservationist paradigm that seeks to freeze the human and wild and domestic animal and plant co-communities in some kind of static limbo in time and space. Such limbos would be virtual realities, akin to theme parks, requiring constant and costly external correctives.

The Biosphere II project, the experimental, hi-tech but closed human, plant and animal biotic community in the Arizona desert, failed to be a self-regenerative biosystem because of unforeseen consequences that led to a decreasing supply of oxygen. A sustainable, low-input, regenerative biosphere system is one that is open, fluid, and biodynamic, rather than closed, controlled, and 'biostatic.'

4.6.3. *Sustainable Biosystems*

Sustainable human biosystems are the antithesis of the agricultural, agroforestry and aquatic monocultures of the industrial age. Self-sustaining systems incorporate and enhance biodiversity through locally and bioregionally appropriate polycultures of various domestic plants and animals (i.e. mixed farming, forestry and aquaculture systems); and through the sustainable management and exploitation of natural resources, including wild animals from bees to buffalo, who are treated humanely because they are respected as integral to the wellbeing of both the human community and the entire biotic community.

The factors that are endangering both indigenous peoples and wildlife—biocultural diversity—in many of these UN-designated Global Biosphere Reserves often have a synergistic effect, as I discovered and documented in one of these Reserves in Southern India. The Honey Kurumba tribals in this Nilgiri Biosphere Reserve in Tamil Nadu traditionally adopt sustainable use and management practices of forest resources, including the wax and honey of wild bees, which are now endangered, along with the Kurumbas and other tribal peoples. The Toda tribal pastoralists in this same Reserve, for example, face illegal land encroachment of the traditional grazing lands and the near extinction of their unique Toda white buffalo that are integral to their cultural identity and religion, from a lack of adequate veterinary services. (See details below.)

I worked with my wife Deanna Krantz in India for several years where her project advocated and activated several integrated programs based on an expanded World Health Organization (WHO-UN) vision of health and human wellbeing. This expanded vision linked the health and wellbeing of domestic animals, upon whom the indigenous peoples depend economically, culturally, and spiritually, with the health and conservation of wildlife.

The protection of wildlife, conservation and restoration of natural habitat, are linked with the traditional and innovative sustainable farming methods and other community-based, environmentally friendly activities, including social forestry and soil and water conservation practices of indigenous peoples.

4.6.3.1. The Animal Component

This holistic, integrated paradigm means: Healthcare = Peoplecare + Animalcare + Earthcare. A healthy domestic animal population—achieved through free community veterinary services, humane education, training in animal husbandry, and enforcement of animal anti-cruelty laws—means improved income for livestock keepers, and control of zoonotic diseases (like rabies and foot and mouth disease) that unhealthy domestic animal populations harbor and variously spread to people and wildlife.

We put into practice a working model project whose replication in other Global Biosphere Reserves would do much to ensure the continued protection and restoration of biocultural diversity because of its grass-roots, rather than top-down, approach of working with the people for the people. Animal welfare is to human welfare, as nature conservation and biodiversity are to human culture and diversity. Hence, the value of an interdisciplinary approach where improvement in the human condition is linked with improving environmental quality, wildlife and habitat conservation, preservation, and restoration, and with domestic animal health, productivity, and welfare through improved veterinary care and humane husbandry education.

More recent, post-colonial efforts to protect wildlife and habitat have involved indigenous peoples in such roles as working as wildlife eco-safari trackers, conservation monitors, and anti-poaching teams; in reducing the adverse impacts of their domestic animals through improved grazing, land management practices, and animal health and productivity; and by adopting economically viable, sustainable agricultural practices and cooperative, socially just marketing networks.

Similar kinds of illegal and legal activities, from poaching and diverting streams to grazing too many animals and poisoning and snaring predators, as we documented in the Nilgiri Biosphere Reserve (see Addendum), are likely to be encountered in other Global Biosphere Reserves. Hence, the need for close collaboration with reliable local NGOs, government officials, village leaders, and tribal elders who understand the need for reform, collaborative oversight and effective management, coupled with appropriate animal protection and conservation law enactment and consistent enforcement, and the implementation of economically viable, environmentally friendly, and socially just ways to meet the needs of the people.



Figure 463-1. A satellite view of the Nilgiri

International organizations like Wildlife Conservation International, and Heifer Project International are adopting the bottom-up rather than top-down approach, working with local NGOs and government authorities at the grass roots, putting compassion into action, and facilitating mutually enhancing symbioses between people, animals, and Nature.

The critical state of the world's ecosystems and precarious future of most indigenous communities present a global triage situation for those governmental and nongovernmental organizations dedicated to human aid and development, and to saving the last of the wild.

The UN Global Biosphere Reserve initiative identifies those places and peoples that, given the finite nature of financial and other external inputs and resources, have the best chance of being conserved, protected, and restored.

4.6.3.2. Wildlife Research Needs Ethical Boundaries & Veterinary Supervision

There are several documented, and many word-of mouth accounts of chemically immobilized and otherwise restrained endangered species like the Asian elephant and African wild dog being severely injured, killed or dying soon after capture and/or release. In some instances there was an association with the animals being injected with untested and unapproved modified live virus vaccines. In other instances the injured or killed animal was a pregnant or nursing mother.

Experienced veterinary supervision is called for especially when research biologists are loose in the field using drugs and vaccines on their animal subjects and applying various methods of capture and restraint which may cause serious injury, capture myopathy and even death.

Wildlife continue to be harassed, stressed, and subjected to these in-field risks so that tissue and blood samples can be taken (though DNA evidence can be obtained from feces and rubbing/marketing areas), radio collars and cameras fitted, and microchips implanted. The generation of more scientific data from such field research may help advance careers and engender more funding, and give some substance to wildlife management schemes. But when the animals in question are put at risk, and there are no in-place regulations and effective law enforcement to protect and restore their existing habitats, and to extend the same in order to help minimize accelerating loss of genetic biodiversity, then these wildlife researchers should cease and desist.

Such activities alone have nothing to do with wildlife conservation and at best give the false impression that something is being done, or that the foreign presence alone is a deterrent to poaching and destruction. Yet in reality, from a bioethical perspective, the risks to the animals far exceed the immediate and foreseeable benefits. So I appeal to all appropriate institutions, governmental and nongovernmental, for-profit and not-for profit, to encourage alternative, noninvasive wildlife research, and to cease funding and permitting any form of wildlife capture except for urgent veterinary and conservation-translocation reasons.



Figure 4632-1. Tiger poisoned by villagers (from M. W. Fox)

4.6.4. *A Case Study: Problems in the Nilgiri Global Biosphere Reserve*

Thanks to an information network of villagers and tribal peoples who had intimate knowledge of the jungle, and who came to trust our in-field CPR (conservation, preservation and restoration) work in the Nilgiris that began in 1995, we were able to document and report to the appropriate authorities various illegal activities in the Global Biosphere Reserve, which the local people could not do for fear of reprisal, even death. These illegal activities invaded every sector and included:

- Construction of guest lodges, tea shops and temples;
- The operation of a brick factory in restricted areas;
- Land encroachment for agriculture;
- Grazing livestock in restricted areas;
- Illegal diversion of rivers and streams into private lands and pumping water from the same to irrigate cash-crops, and pollution of same by agrochemicals and small industries;
- Expansion of eucalyptus, tea and coffee plantations that seriously depleted and variously polluted the water table;
- Opening up of new roads and illegal improvement of forest roads in the Reserve restricted for use by Forest and Wildlife Departments only;
- Illegal cutting of trees for firewood and lumber;
- Nonsustainable, destructive harvesting of forest products (mosses, lichens, gooseberries, soap nut, tamarind, etc.);
- Movement of unquarantined, uninspected and infected livestock into the Reserve;
- Sport hunting, poaching, and sale of wild meat, skins, elephant ivory and other wildlife products;
- Killing elephants and other wildlife with homemade bombs and by shooting, electrocuting, poisoning, and snaring ('snoosing');
- Illegal removal of cattle manure and the quarrying and removal of rocks and sand;
- Burning of the remains of killed elephants and endangered wildlife guar, tiger, leopard by forest staff to avoid punishment for not catching the killers;
- Procurement of tribal girls for prostitution at local guest lodges, and the killing and suicides of same;
- Misappropriation of foreign funds, which were provided to empower tribal women and to facilitate family planning and economic security, but were used to bribe officials, purchase land and vehicles and to build a guest lodge for eco-tourism;
- Illegal receipt and misappropriation of foreign donations and government funds to operate a bogus animal shelter and refuge that provided no free services to the local community as mandated by its Charter of Incorporation;
- Bribing of various government employees, including high-ranking government officials, roadside check-post officers, police and SPCA animal welfare inspectors, veterinarians falsifying livestock numbers, vaccination records and autopsy reports on wild and domestic animals;
- And, providers and purchasers of contaminated and inferior grade food for captive elephants falsifying receipts, and elephant caretakers falsifying body weight, injury and treatment records.

The Indian Institute of Science (IIS) enabled a German student to bring several hives of

domesticated bees into the Nilgiri Reserve to study their behavior and adaptability, an extremely irresponsible project that could endanger the wild bees through contagious infections and competition, and thus endanger the traditional sustainable economy of the Honey Kurumbas. IIS scientists have been doing research studies on elephants and other wildlife for decades in the Nilgiris, accidentally killing some, for instance, by tranquilizing elephants for radio-collaring. They have shown no evidence of any active and effective involvement in species and habitat protection and restoration at the local level, where it is clearly needed and involves cooperative efforts with local peoples and government officials. Doing research for its own sake, and not getting involved in the politics of CPR, as elephants and other endangered species are on the brink of extinction, is irresponsible, like Nero fiddling while Rome burns.

Other government and nongovernment projects like tree planting, introduction of 'improved' water buffalo, and growing feed and fodder for local livestock have failed over the years due to poor management, lack of oversight, misappropriation of funds, and limited if any consultation with village leaders and tribal elders, whose wisdom is rarely appreciated.

Other major problems included increasing human incursion and settlement with increased pressure on water and fuel wood resources; the accidental introduction of a highly invasive weed like *Stephasegria* in imported crop seeds; the abandonment of growing traditional, rain-fed and highly nutritious varieties of staple crops like ragi for local consumption; and, a high population of 'scrub' cattle raised primarily as manure producers (for out-of-state sale as organic fertilizer) and which are extensively grazed, become extremely malnourished. These cattle suffer terribly during the dry season, compete with wildlife, and spread disease.

4.6.5. Conclusion: Knowledgeable People are Critical

A local information network of knowledgeable people is critical to any conservation effort. Improving environmental quality cannot be achieved without such a network, and human health cannot be achieved without environmental health. In the Nilgiris, politics and special interests are still damaging the system. The local people, who have the knowledge, interest and investment, have to claim the power to control this system.

4.7. *Regional Animal Patterns*

Animals are mobile organisms, including zooplankton and insects, which survive by preying on plants or other animals. Each organism is inseparably related to a place; breaking the bond with place may mean death for the organism. Organisms and places shape each other. Even if individuals can be described in terms of vortices, as the poet Pound did before the physicist Prigogine, they do exist materially, and they participate in the field in which they exist. The organism must adapt to the environment, which implies having a memory and being capable of learning; the organisms must also reproduce, that is, duplicate its pattern in a separate being. Organisms are goal seeking, and often stability is sought above change or complexity. The individual is a subject centered in a milieu. Because of this implied point of reference, J. Rodman concludes that ecology is teleological. Often, organisms strive for well being beyond just survival. Their goal is to come into the fullness of being; A. N. Whitehead considered that all organisms have three urges: To live, to live well, and to live better. Living better is being more attuned, stimulated, receptive, flexible, spontaneous, and integrated into a milieu.

4.7.1. *Wild Animals: Individuals, Species & Ecosystems*

Animal populations vary according to cycles or unknown causes; they move and concentrate or disperse. Because animals fluctuate in such a cyclic manner on the tundra, for instance, management by the maximum sustained yield concept is even more difficult and questionable. Furthermore, the ranges of caribou and birds cover more than one ecosystem; wilderness designation for areas outside any one focus must be coordinated. Animals move between ecosystems, carrying their biomass and experience. Wolves, elk and other species use different systems for feeding, mating and sleeping. Other species, such as birds, can connect ecosystems separated by thousands of kilometers.

Microbes are vital to the environment because they participate in the Earth's element cycles like the carbon and nitrogen cycles. Microorganisms are involved in the production of oxygen, biomass control and 'cleaning' the Earth of remnants of dead organisms.

4.7.1.3. *Disappearance & Images*

The disappearance of wildlife and wild places to live is a problem. Many people do not miss wolves, but they are very important to keeping the deer populations adjusted and healthy. Pets and domestic animals also need to be considered as competitors for wildlife. But, they also need care, even when it means sterilizing them to keep them from breeding freely. The solutions to this are to save some habitat, that is, do not convert it to tree farms, farms, or roads. Zone the valley, using an ecological plan. Then, limit the takes of all wild species, not just wolves but also deer.

Wolves in Bulgaria, for instance, are excellent hunters and prey on large hoofed animals, such as roe deer and red deer. Since wolves weigh far less than their prey, they must hunt in packs. Although a single wolf could kill a large deer, hunting in a pack is safer and more reliable. Except under rare conditions (such as heavy snow), wolves do not determine deer populations, whose numbers are limited by food supply. Instead wolves cull weak and diseased individuals that lag behind their herds. Wolves help strengthen herds by killing such animals. Wolves are also efficient scavengers of domestic animals that are sick or have died. Old or

unhealthy animals can be a burden on a herd, for example, by eating browse that a healthy animal might need or by infecting young deer. By eliminating such animals, wolves perform an important natural function in wild ecosystems.

Their persecution could reduce the complete functioning of ecosystems in immeasurable ways. Wolves are keystone species and an indicator of the quality of wildlife habitat. Their actions are crucial for maintaining the long-term viability of ecosystems. Other predatory species are also supported by wolf kills. These species include ravens, foxes, wolverines, vultures, bear, and eagles. Wolves contribute to an ecological 'balance' and prevent overpopulation in deer and other grazers. Wolves are evidence of the diversity that we value so much, from genetic diversity to the full spectrum of an ecosystem.

All of nature is not human nature, however. There are many other sentient species. All animals, 'two-legged and four-legged,' are equals in the view of Black Elk. Science is only beginning to support this idea in terms of ecosystem functioning. Adolf Portmann shows that every form of life appears as a gestalt, developing in a specific place. All living forms create an image of their environment. Genetics provides the proper image choices for some—frogs, for instance, focus most closely on objects that have the same size and trajectory as flies. Others must learn what is valuable.

Humanity is exploiting nature recklessly, without attention to the minimal health of ecosystems. Yet various societies are working to preserve animals, species, and habitats. Their efforts are described, according to three levels: individuals, species, and habitats. An ecological philosophy is outlined as a basis for the united effort of these societies. Ecology supports the uniqueness of individuals in their life-worlds and the interrelatedness of species in communities. Psychological and geographical studies support the importance of healthy places for human beings. The concept of earth as home is proposed as a metaphor for the development of appropriate attitudes and participation in appropriate ways of living.



Figure 4822-1. Tracking wolves in the Central Balkan National Park, Bulgaria 2000

4.8. Tracing Northern Hemisphere Wolf Paths

The gray wolf once inhabited a wide variety of habitats throughout most of the northern hemisphere north of the 20°N latitude. Because the animal preyed on livestock and competed with humans for wild prey, it was extirpated from much of its range outside of wilderness areas. Environmental awareness in the late 1960s brought for the wolf legal protection, increased research, and favorable media coverage. The species has increased in both Europe and North America, is beginning to reoccupy semi-wild areas and agricultural land, and is causing increased damage to livestock. Because of the wolf's high reproductive rate and long dispersal tendencies, the animal can recolonize many more areas. In most such areas control will be necessary, but the same public sentiments that promoted wolf recovery reject control. If wolf advocates could accept control by the public rather than by the government, wolves could live in far more places. Insistence on government control discourages some officials and government agencies from promoting recovery. The use of large or small-scale zoning for wolf management may help resolve the issue. Public education is probably the most effective way to minimize the problem and maximize wolf recovery, but the effort must begin immediately.

4.8.1. Natural History of Wolves

Grey wolves are pursuit predators. The grey wolf first evolved, it appears, in the arctic biome, Alaska, Canada and maybe Eurasia. For 35 million years wolves evolved in isolation in North America, but 5 million years ago, were able to invade to Eurasia; 3 million years ago true wolves went, but came back repeatedly to N.A. Half a million years ago, wolves moved south throughout Eurasia, becoming almost the same as the modern wolf. Wolves also moved south through N.A. and northern S.A. It may have evolved into the dire wolf south of the ice in SA. The dire wolf, much larger and heavier than the grey, was likely a pack hunter and scavenger. Then over the past 130,000 years grey wolves recolonized North America south of the ice, becoming middle carnivores between dire wolves and coyotes. The current grey wolves seem to have arrived less than 13,000 years ago, after extinction of the dire wolves and after human arrivals, possibly from Alaska and Eurasia. The red deer (elk) may have been resident for a million years; but, they may have arrived 13,000 years ago, also. The same time period held giant, long-horned bison.

With the European expansion, fur-traders blasted their way through every species with fur—50,000 wolves a year, and an equally disgraceful overexploitation of bison, fox, and cats. At least 400,000 wolves were killed (and probably 400,000 plains people). Over 60,000,000 bison made the grass a piss-driven prairie. The buffalo declined from kills, then wolves and native peoples declined.

4.8.1.1. Population Characteristics

Wolves fit a cursorial carnivore niche, and other diverse niches. The species may have formed in marginal habitat, such as the high arctic. The system of reproduction of alpha animals, with nonbreeding helpers, is unique and suitable to poor northern and arctic environments. This unusual social system allowed them to fit into human communities as well. Canid evolution is considered to be 'vacuum-driven.'

Wolves anticipate the behavior of their companions, demonstrating intelligence. They

also solve a wide variety of environmental and social problems. They communicate with a variety of sounds: Squeaks, yelps, growls, woofs, yawns, and howls. Woofs are associated with uncertainty. Howling can mean territory occupied (6 mi range in forests, 10 in tundra), identity, mood, and probably many other things.

Scent-marking behavior is important. Wolves are wide-ranging and it is difficult to defend the entire home range. 3 kinds of defensive behavior: scent-marking, howling, direct attack. Scat may carry anal gland secretions. Scratching may distribute secretions from interdigital glands. An olfactory howl? Scent marking allows archival data to remain for weeks. Scratching adds info, as well as visual clues to scat.

Wolves are travelers. They may go 16-35 miles overnight, 45-100 in a day. Wolves usually travel single-file on hard-packed surfaces. Sometimes in thick cover and climbing a hill, they fan out. This may scare prey or make it easier to catch. Abandoned roads make life easier for tracking and moving. Russian proverb—the wolf is kept fed by his feet. They tend to travel where prey lives. Ignoring mountains if prey are in valleys. Wolf routes may pass 5-15 deer and 2 boars an hour, where a random tour might pass 5 animals or less. They prefer easy routes, roads, trails, lakes, shorelines, and ridges. In long linear routes rather than zigzagging or circling.

Hunting involves locating, stalking, encountering, rushing, chasing, attacking, and killing. Wolves focus on and kill prey that are vulnerable. Bad weather, such as snow, makes prey more vulnerable. Snow hinders walking, especially in heavier deer such as red deer (elk). Snow also reduces foraging for deer.

Weather influences vegetation, prey and predators. Predators influence prey, which influence vegetation. So, there are cascading effects in both directions, up and down. Vegetation and nematodes influence each other, as do squirrels and fungus, hawks and squirrels.

Wolves do not require wilderness or 'pure' nature. Wolves do require food and shelter, as well as territory for hunting, den sites and cover to hide. Wolves respond to some kinds of stress by reducing family size.

Wolves are members of an ecological guild, which is a group of species using common resources in a similar way. The wolf guild includes large carnivores, such as bears and lions, and scavengers, such as ravens, eagles, coyotes and others.

4.8.1.2. Research on Wolves

Not much research has been done on wolf and nonprey species. Interactions are mostly anecdotal observations and stories. A few projects have been designed to investigate sympatric wildlife populations and to address role of wolves in ecosystems.

There seem to be no histories of competition between wolves and other species that result in spatial partitioning of resources in an area. Bears for instance seem to use the same territories. Some predators, such as coyotes, can be eliminated, however. In northeastern Asia, tigers do not defend against wolves; there may be some commensalisms. European lynx are almost as large as wolves (2-3 times larger than NA populations). Wolves specialize in roe deer in Bulgaria, for instance, lynx specialize in hares, but also kill roe deer (15% of diet). Interactions with jackals may be same as with coyotes. In central and eastern Bulgaria, there seems to be no evidence that wolves kill jackals (Wittbecker 2002).

The results of exploitation competition are expressed slowly, through differential survival

and reproduction. This could lead to extinction or divergence. Interference competition is a little easier, since there are usually direct attacks.

4.8.2. *Wolf Habitat Regions: Alaska to Siberia*

Wolves occupy many ecosystems in the northern hemisphere. Studying wolves and tigers will do much to preserve sufficient habitat for wolves and indeed all large predators. A large size preserve sufficient for wolves should be sufficient for all other predators and plant species as well. Ecological studies would enable us to determine the criteria for natural habitats of a variety of predators.



Figure 4822-1. Norwegian Wolf Survey 1987 (3 tracks near border)

4.8.2.1. Russian Asia

The niche of the wolf is as the northern predator of large mammals. The only other animals in the northern hemisphere of Asia, besides humans, that prey on large mammals are tigers. Tigers, however, do not have the density or distribution that wolves have.

The northern boundary of the wolf in Siberia coincides with that of the reindeer, about 75 degrees N latitude. The species also occurs in Kamchatka (*Canis lupus albus*). Wolves occur in the forest zone of Russia (*Canis lupus lupus Linnaeus*). However, the wolf is not evenly distributed. There are large forest areas where no wolves have been observed. Wolves were abundant on the Sikhote-Alin in the 1950s, possibly due to the high reproduction of protected wapiti. The wolf occurs on the Sudzukhe Reserve. Wolves are rare in the southern part of Sakhalin, according to Stroganov.

Since wolves weigh far less than their large-mammal prey, they must hunt in packs. Although a single wolf could kill a large ungulate, hunting in a pack is safer and more reliable. Tigers, however, weigh almost as much as the prey (227-272 kg or 500-600 lbs) and hunt alone. A tiger devours about 30 large animals per year; by comparison, each wolf in Alaska may eat the amount of five average caribou in Alaska. Tigers (*Panthera tigris L.*) sometimes attack livestock or dogs. Tigers have been known to stalk bears, attacking from above. Presumably they would attack wolves under certain circumstances.

There are numerous concerns about studying wolves. Sophisticated wolves, those cohabiting territories with humans, are difficult to observe directly. Possibly, the number of tigers is less than the minimum viable population. The predation patterns of wolves, bears, tigers, and other carnivores, such as wolverines, in the Russian area of the eastern Asian continent, have not been studied. A study of the area is required, including location, elevation, topography, geology, climate, and vegetation. And a study of the prey species, including red

deer, rodents, and other species, is necessary. Of special concern population characteristics, and food habits. Understanding the effects of predators on each other, as well as on the habitat, and prey species is important. Of special interest are wolf paths through the region.

4.8.2.2. Northern Europe: Scandinavia/Finland/Norway/Sweden

The niche of the wolf is as the northern predator of large mammals. Since wolves weigh far less than their large-mammal prey, they must hunt in packs. Although a single wolf could kill a large ungulate, hunting in a pack is safer and more reliable. Except under rare conditions (such as very heavy snow packs), wolves are not a limiting factor for ungulates, whose numbers are limited by food supply; instead they cull the population of weak and diseased individuals. Wolves have an important part to play in wild areas; wolves are keystone species and an indicator of the quality of wildlife habitat. Their persecution could reduce the complete functioning of ecosystems in immeasurable ways.

In Norway, wolves have been persecuted until only 3 were censused in the 1987 Norwegian Wolf Survey. Since these animals were tracked near the Finnish border, it was likely that they were adventurous Finnish wolves. In later surveys, slightly larger numbers of wolves were counted (over 40), but some of these were shot as part of later wolf control measures.

The wolf population in Finland declined to about 100 wolves by 2000. Since then the numbers have climbed to 200 (2006). A national management plan (2005) intends to increase the population further and considers all wolf-related questions. However, there is resistance from the public, especially in Lapland, where wolves are perceived to disrupt reindeer husbandry, which covers one-third of the area of Finland. Wolves have killed dogs, especially during elk-hunting season, and do kill a few domestic animals, such as sheep, every year.

Most of the wolves in Finland live near the border with Russia. Some of the wolves counted may be Russian wolves on vacation. This means that the wolf population in that area is dense, but very sparse in the rest of the country. There is an European Union Habitats Directive that fully protects wolves, and the EU Commission has brought legal action against Finland for hunting and killing a number of wolves.



Figure 4823-1. Bulgarian Wolf Survey, Central Balkans 2001

4.8.2.3. Central & Eastern Europe: Bulgaria/Serbia/Greece/Italy/Turkey/Israel

Wolves started returning to Bulgaria about the same time that other transitions occurred in the human cultures. With the creation of new larger national parks, a good percentage of territory has been set aside for wild nature-much of this is good habitat for wolves. However, many of

the old attitudes towards wolves remain, so that there is hunting, poaching and random killing of wolves throughout Bulgaria.

Although some studies have begun, and the needs to wildlife management has been certified in numerous official documents, there are few studies of wolves in Bulgaria. Hence, there is little certainty about the numbers and growth rate of the wolf populations. Nor is there a clear direction for policy.

Wolf research is used to determine habitat preferences, prey selection, movement corridors, mortality causes, and the location of critical areas such as den sites and trails. Animal abundance is one appropriate measure for gauging the success of wildlife management, monitoring the status of threatened and endangered species, and determining the outcome of many experiments. Thus, estimates of abundance are among the most important information needs of wildlife managers. Unfortunately, wolves, like many carnivores, are cryptic, secretive, and occur at low density. Accurate estimates of abundance are seldom obtainable for such species, so indices of relative abundance often substitute. This information can have an important bearing on the management of protected areas, and may influence selection of locations and levels of human use of trails, facility location, and seasonal closures in critical areas, such as den and rendezvous sites. This project intends to use the most sophisticated techniques to acquire and disseminate information on wolf populations.



Figure 4823-2. Observing Wolf Trails in Kraishde Region of Bulgaria

4.8.2.4. Canada/Alaska/United States

Wolves are ecological generalists, one of the most adaptable species on the planet, with a wide coverage of habitat types (although not able to adapt to human agriculturization and urbanization). Van Valen attributes its adaptability to a low rate of speciation (supported by a narrow range in chromosome number). The rate is attributed to its mode of speciation (allopatry), characteristic of species with extensive home ranges, general feeding habits, K-strategists, and high vagility (distance between birth and death places).

This means problems for the management of wolves. Large areas of land are needed. Regional prey depletion has to be avoided. Gene flow should be maintained between local demes (for long-term adaptation). Perhaps the stream hierarchy model of management, suggested by Meffe and Vrijenhoek for fish in dendritic water system, might be an appropriate management strategy.

4.8.2.4.1. Conservation Genetics

Conservation biology is a practical political program designed to use current scientific knowledge to preserve the natural diversity of species under natural conditions—natural meaning not dominated by humans. It is multi-disciplinary and crisis-oriented. Its efforts are based on a set of ethical statements (diversity is good, extinction is bad, complexity is good, evolution is good, diversity has value, and so on).

Goals of conservation biology, according to the Society for Conservation Biology, are to investigate human impacts of biological diversity, and to develop practical approaches to prevent extinction. A third item, not always mentioned, are the human resources, economic and otherwise, available for conservation efforts. Conservation Biology is more comprehensive than traditional disciplines and differs from them also by having the long-term preservation of the entire biological community as its consideration—economics is secondary. The crucial test to its validity as a field will not be a coherent theory, but whether or not biological communities actually survive.

Diversity is problematic though. Diversity is intraspecies, as well as interspecies and ecosystemic. Instead of attempting maximum diversity in conservation, we might aim for an optimum diversity based on the characteristics of a native (uncompromised) ecosystem.

Diversity is a genetic problem, also. Avise suggests that management for genic heterozygosity by maintaining a large number and avoiding unnecessary inbreeding is important in conservation programs for rare or threatened species. Frankel and Soule (1981) state that “there is no safe amount of inbreeding” for normally outbred organisms. They suggest a threshold rule above which fitness relentlessly declines. This 1% rule is a basic rule of conservation genetics. This rule serves as the basis for calculating an irreducible population size (50 individuals usually). Franklin and Soule (1980) suggested that a minimum population size of 50 is required to stem inbreeding depression. Over 500 is necessary to prevent long-term erosion of variability by genetic drift. A 70-year study of bighorn sheep (*Ovis canadensis*) bear this out—any groups with less than 50 have died out within 50 years. Those populations with more than 50 have persisted so far.

There are problems with the 50/500 formula, with wolves, many of whom do not mate and with plants that are concentrated in a small area that can be wiped out by catastrophe. Not all adult wolves in a pack breed, according to M.W. Fox; many aunts and uncles function as helpers while others may exhibit ‘nonideal’ behaviors. This means that the minimum number has to be 3-6 times as many, perhaps 150-300. Assuming that each wolf needs 260 km², the minimum area for a wolf preserve becomes 39,000 to 78,000 square kilometers according to Frankel and Soule—Yellowstone is only 9,000 km², but the State of Alaska could hold a minimum at 1,717,854 km². The 50/500 rule has many assumptions—random mating, equal numbers of males and females, nonoverlapping generations, absence of fluctuations—that are unlikely to be met; therefore, the minimum should be increased by factors of 2-3 or more.

There are a few problems with ecological time scales. Outbreeding species take at least 200 generations to diversify to point of speciation (Stebbins 1950)—some western pines, for instance, don’t mature for 50-70 years—that’s 10,000 years! These time scales can only really be addressed on reserves for living species (*in situ*), rather than in artificial seed banks that require human social and technological stability (*ex situ*). The keystone mutualists and mobile links are needed for natural selection. Ignorance of genetics, disease, biogeography, and community ecology, and maybe economics and culture, can lead to the destruction of any reserve.

4.8.2.4.2. Speciation & Conservation Biology

The Endangered Species Act in the United States provides a means for saving ecosystems. The situation of conservation biology is difficult. Triage may be necessary. Because of limited economic resources (and maybe limited interest), species will have to be ranked to be saved. Triage as a conservation strategy was borrowed by Normal Myers from William and Paul Paddock, who used the concept for food aid, after borrowing it from military medicine. Triage has three classes: Those who will die regardless of treatment, those who will live regardless of treatment, and those who can be saved only with prompt treatment—when resources are severely limited (as in battle) only the third class gets treated. Applied to conservation, this would put California condors in the first class, coyotes in the second, and Siberian tiger in the third. As a solution triage may seem unethical and may be divisive, but it may also be rational. On the other hand, these kinds of judgments can be mistaken.

Hybridization may be a solution to the survival of some species, but it is a problem with ESA classifications. Biological and legal issues are raised by documentation of instances using molecular markers. O'Brien and Mayr's conclusion, regarding the ESA Hybrid Policy, is that red wolves should have endangered status; they are descendants of a historical subspecies, regardless of the classification as *Canis rufus* (not *lupus*). Red wolves contain genetic material from coyotes. Historically, land clearing favored the expansion of coyotes at the same time red wolves were declining precipitously. Paradiso concluded that the current Texas red wolf is a fertile *lupus* x *latrans* cross, although there was a pure red wolf strain that could not adapt to changing environmental conditions. Red wolves have been reintroduced at a refuge in North Carolina (42 captive-born animals); packs have been established and animals seem to survive by hunting and eating carrion.

Hybridization, like speciation, is a dynamic natural process influencing how diversity is organized. Avise states that conservation legislation is naive already. If molecular markers are used to put eastern wolves off the endangered lists because of past hybridization with coyotes, then science may encourage this kind of cost-saving rationalization.

Any large-scale change, such as the greenhouse effect, could induce changes in natural selection in all species. Large-scale changes in habitats, such as from land clearing, may result in hybrid zones between closely related species; perhaps Ontario is such a hybrid zone. According to Barton and Hewitt (1985), hybrid zones can lead to speciation over enough time; hybrid zones are also a source of new genetic variants with new ecological properties. Hybridization can preserve characteristics for a generation or two—although it can lead to domestication in plants. Allendorf and Leary suggest two conservation-related concerns of hybridization: Reduced fitness due to developmental abnormalities, and the danger of genetic swamping with loss of locally adapted populations. But, these concerns are probably not as important in dynamic ecosystems, as in zoos and preserves dominated by human control.

What is the value of wolves? Enrichment of nature? Their role in keeping prey healthy, and the system more diverse? Redundancy in an ecosystem? Economic value from tourism? Consumptive value in wolf skins? The sale of pelts in the United States totaled \$21,000 in 1927. Dollars from tourism to see the wolves reintroduced into Yellowstone Park have exceeded many millions.

4.8.3. *Calculating & Linking Reserves & Paths*

There is reason for caution for the design of any reserves for wolves. Data on species like the wolf are almost never complete. Not enough ecosystem details are known. Human modification and destruction of habitats has a decided effect on the rates of gene flow between populations. The reintroduction of species from conservation centers will be meaningless without great and successful efforts to restore the patterns and depths of habitats.

Although genetic information is essential, knowledge of large-scale patterns is crucial. The structure of a community, from behavior to culture, in the context of a changing environment, is what determines the size of a population. Dobson, Mace, Poole, and Brett suggest that genetic considerations tend to guide the management of captive populations, while demographic and taxonomic considerations tend to guide “studies of free-living populations and communities.” They conclude that cooperation between ecologists and geneticists is necessary to improve the effectiveness of conserving endangered species.

It is possible to set aside large areas for the wolf in the northern hemisphere and some natural corridors between the areas, especially mountainous areas. Wolves had no significant problems dispersing through rural areas in Eastern Europe or western NA. It would also be possible to link almost every area with new corridors. New links would not require much coverage and could be relatively narrow. This should have little effect on the species and populations, since 13,000 years ago most of the hemisphere was available to wolves.

In Canada and the United States, there are wild horse populations that are not influenced by predators. More wolves would keep the populations healthier. In Siberia there seem to be many predators. Prey animals, such as red deer, could be reintroduced to some areas to balance the predators. Designing the wolf paths would allow mixing of some populations.

Finally, restoration is phenomenally expensive, conservation is very expensive, but setting aside preserves is only moderately expensive, and much of that resides in perceived losses from the denial of exploitation. According to Conway (1986), to maintain an effective population size of Siberian tigers will cost almost \$600,000 a year. Maintaining the integrity of the natural habitat may cost far more. To set aside a series of wolf paths in the northern hemisphere may cost \$50 billion USD in modifications and twice that much in lost revenues from resources. Because wolves seem perfectly comfortable using human roads to travel and for hunting that number may be reduced. Significant parts of the money would be required for education and signage. Within the limits of human altruism—restoring what we have been destroying—we simply should set aside 50% of the planet as reserves and let evolution proceed, with the self-organizing configurations that we term species, as genomes embedded in ecological communities.



Figure 483-1. Preliminary sketch of Northern Hemisphere Wolf Paths

4.9. *Defining & Describing Regional Wildness*

What should we call the regions that we do not use or want? Those that are not domesticated? Wildness? Wilderness? Wilderness has been the name used by many cultures for uniformly empty, chaotic, useless, valueless, or untamed areas. Although what remains currently is still largely untamed, wilderness is not uniform, empty, chaotic, useless, or valueless. Recently, wilderness has been recognized as holding resources and as being important for recreation. Wilderness has also been realized to be the source of agricultural and cultural richness.

Indeed, these reasons are presented as justification for saving wilderness from exploitation or interference. But there are more basic reasons to save wilderness: It is the source of diversity, it exists apart from human concern and industry, and it is the only sanctuary for wildlife apart from humanity. Wilderness is filled; it has its own values and uses, even if they are nonhuman.

No one of the ancient or modern descriptions and definitions is adequate to define wilderness. It is not a negative thing or the opposite of humanness; it is wilderness itself. An understanding of ecological knowledge shows the importance of wilderness itself and what it entails—other beings for themselves, dynamic system stability, and finally the health of systems upon which humanity is dependent. A set of definitions and distinctions are recommended to justify and plan the preservation of many kinds of wilderness.

4.9.1. *Wilderness as Empty Disordered Useless Waste*

The Romans did not really have a word for nonhuman nature. Words or phrases they applied to wilderness meant emptiness, loneliness, and deserted place (the etymologies of words are useful for tracing traditional thought). The definition of nonhuman nature changed slightly over centuries. The modern word wilderness comes from the Old English word meaning “of wild beasts.” Wilderness was understood as a region uninhabited and uncultivated; an empty region; or a confusing multitude.

In the 17th century, untilled heaths and fens were regarded as a reproach to civilization. John Houghton in 1681 called Hampstead Heath a ‘barren wilderness.’ Cultivation was a symbol of civilization, whereas “wild and vacant” lands were thought of as a deformed chaos. Similarly, mountains were thought worthless. Wilderness meant uncontrollable, and was also applied to the beasts of inhospitable regions. Something wild was untamed or untilled. Samuel Johnson (1755) defined wilderness as “a desert, a tract of solitude,” or as a wild place inhabited by deer.

4.9.1.7. *Wilderness Definition*

Wilderness remains essentially undefined; it has been defined as emptiness; and it has been defined recently as a place “where man is a visitor who does not remain” (Fromm 1974). But, these definitions are vague. The popular wilderness definition, where man is only a visitor, is utilitarian; humans visit for recreation and relaxation. There are flaws in this utilitarian approach to wilderness; wilderness is considered a resource, and it is related to human experience exclusively. Wilderness does not have to be destroyed or used or even visited to be beneficial. It is valuable as wilderness, because it is there. Humans are already using a very large percentage of it indirectly.

The most important definition of wilderness treats it as a “vital organ” for the life of

the earth, the generator of hydrological, geochemical, and atmospheric cycles. It is where nonhuman species live for their own purposes. None of these 'definitions' is sufficient to identify wilderness exactly, just frame it with words. Definitions have become more complex as more about the functions and values of wilderness becomes known. There are differences between ecological definitions of wilderness (as a 'mature ecosystem that changes with time') and cultural definitions, which vary with cultures, from wasteland to sacred spaces. Wilderness is more than a geographical concept; its boundaries can never be just geographical. It is an abstraction. It is hard to define wilderness exactly or objectively. Any region that can be described verbally is also a state of mind. And because it is a state of mind, it is ambiguous. Consider the biblical attitude toward wilderness, first as a howling wasteland, then (in Revelations) a sublimity greater than the world of "man," that enabled contemplative prophets to see the Divine more clearly. What originally held the disorder of humans now holds the order of nature. Wilderness is a changing process. And, the English language becomes imprecise and mystical dealing with process thought. Benjamin Whorf pointed out the problem with verbs. A forest is not just there ("is"); it is being and becoming, treeing and animaling. Many attempts to define wilderness limit it to human experience. Obviously, that cannot be done. Wilderness is still greater than, or empty of, most human experience.

Definitions have to consider the nonhuman nature of wilderness, as well as the pervasive human influence on all ecological systems. Definitions also have to consider traditional human reference to wild areas, as well as areas that are restored or created to become wild. Despite the inadequacy of strict definitions, it is possible to describe different kinds of wilderness.

4.9.1.7.1. *Kinds of Regional Wilderness*

Wilderness can be delineated by human use and nonhuman use, as well as by global function. Eight distinct kinds of wilderness are identified: Sacred landscapes, Foundation Areas, Reservation Areas, Preservation Sites, Restoration Areas, Neopoetic Communities, Conservation Parks, and Wild Forests (or Fields).

4.9.1.7.1.1. *Sacred landscapes* are those areas set aside out of respect, for habitats for others, where humans do not belong, and for species that cannot coexist with humanity. Examples of sacred landscapes are mountains, fisher/marten habitat, and large areas of tundra. In many archaic cultures, significant parts of the landscape are regarded as sacred (and, although not used, the wilderness is considered a part or center of their territory). This may be a mountain at the center of the world, a burial ground, or the portion of a river that belongs to the fish gods. Sacred spaces are highly valued locations, with limited access and usage. Such spaces have great symbolic value to societies where they are associated with significant events (or divine manifestations). The assignation of sacredness may result from functional necessity, to prevent flooding, limit population, or to balance the economy. In sacred landscapes no direct human impact should be permitted; mapping would be possible from satellite or airplane observation.

4.9.1.7.1.2. *Foundation areas* are zones that contain active wild communities where the integrity of nonhuman life is not challenged by human interference. Foundation Areas house the depth of wilderness. The depth of wilderness is what allows recolonization after disruption or human influence. Foundation areas could include common lands, that is, one of each kind of ecosystem, regardless of aesthetic value. Some visitation could be allowed, but without permanent residence or machinery. Human impact would be limited to noninterventive

science (perhaps based on Goethe's method of contemplative nonintervention). Examples of foundation areas would include large areas of the Amazon.

4.9.1.7.1.3. *Reservation Areas* are zones for the support of nonindustrial native cultures expressing traditional ways, that is, natural systems in which humans play a limited role—limited by a percentage of net ecosystem productivity, for example, the Miskito in Central America. Many traditional or archaic human cultures play a large part in the design and maintenance of these areas, not only by using fire, but by their traditional hunting practices. Limited human use often increases the diversity of a system, although the diversity tends to flow from human preferences for some plants and animals. Removing humans from this kind of wilderness would alter it and perhaps diminish it, so human use is retained.

4.9.1.7.1.4. *Preservation Sites* are places where the system is maintained by human activities, such as burning or planting. Specific kinds of preservation areas could include: Boundary areas, ecotones or lands bordering agricultures, small patches influenced by human activities, or corridors. Human impact could be limited to traditional, experimental science. An example could be the central long-grass prairie in the United States. In these areas, human activity is consciously limited to maintaining the desired state of the system, where the system has lost keystone species or where the area is too small or oddly shaped for the large-scale processes of an ecosystem to work independently.

4.9.1.7.1.5. *Restoration Areas* are zones which are set in a former native pattern by human activities, but which may not need further intervention. This may include the experimental restoration of ecosystems disturbed by human activities or natural events, for example, Lake Shagawa or larger restored areas of Tall-grass Prairie. Once the system has been reestablished, it would be allowed to develop on its own. This zone requires large enough areas for the natural processes to continue.

4.9.1.7.1.6. *Neopoetic Communities* are areas that have been created through the introduction of exotic species over time, but have become naturalized. Most of these recent areas have been started by human activities, but saved as self-regenerating systems and not built up or interfered with, for example the California grasslands, which have been changed with Mediterranean plants, e.g., wild oats, wild mustard, wild radishes, and wild fennel, or the *Stara Planina* of Bulgaria, which have been modified by grazing over thousands of years, so that grasses replaced the shrubs and trees.

In a sense, every ecosystem and community is neopoetic. North America once boasted a wide suite of large mammalian species, including camels, horses, jaguars, and mammoths—a combination of circumstances, that may have included climate change and human hunting, resulted in their extinction. It seems these niches were never quite filled completely by the immigrant species from Eurasian continent. Species compete or partner for space in ecological systems. They are always making and remaking the assemblages, causing new combinations or new extinctions. Creating a wilderness in North America by reintroducing similar megafauna from South America and Africa would be an experiment in creating this kind of community.

4.9.1.7.1.7. *Conservation Parks* are areas set aside for multiple use of resources without interfering with the operation of the ecosystems. Research may be conducted to answer questions as to whether the park is big enough and shaped correctly to constitute a proper habitat for its inhabitants. Human recreation would be permitted in temporary camps and with some light machinery, for example, the Boundary Waters Canoe area in the United States. These areas would have been adapted to human presence and exploitation of many species.

4.9.1.7.1.8. *Wild Lands* (Forests and Fields), as well as other wild systems managed for the harvest of wild species, such as antelope or fish, are a final category. Although forests can be lightly harvested for wood and other products, they are predominately wild, and would be left wild, rather than being clearcut and replanted with a single species. This is an unusual category of wilderness, since we do not always consider forests and some kinds of agriculture as wild. In fact, wild species in wild systems have been shown to be more efficient in their use of resources and more resistant to other wild species that we humans consider pests. In fact, as regards forests, wild areas are preferred to agricultural areas such as tree farms, for many reasons, from automatic regeneration to the quality of wood. In this category, we recognize that areas of wilderness can be used without being destroyed or domesticated.

By just wilderness, the first three areas are included indiscriminately. They all have similar values, as mirrors of existence, examples of natural, complex processes, expressions of love for nature, and wild, nonhuman places.

All wild systems have had human influences for thousands of years. Even now, human influence extends into every system through pesticide drift and artificial gases. Yet, over 30 percent of the earth now has no permanent human settlements. In general, none of these wilderness areas will be inhabited (at least by industrial cultures), none of them will have permanent built roads, and management would be limited to temporary intervention.

Each of these categories would occupy different percentages of the planetary surface, depending on calculations of minima and maxima, and depending on cultural values and decisions. I recommend placing 50 percent of the land area in the first five divisions (eighty percent of ocean and water surfaces); then 16 percent in each of the last three (five for water); leaving 2 percent for completely artificial landscapes—industrial or city (three for water). These figures are consistent with several earlier proposals. Eugene Odum, suggests 30 percent forest cover world-wide, with 60 percent in tropical areas. C. A. Doxiadis offers 67 percent of the surface area of the planet left in wilderness. Paul Shepard argues that 75 percent of the land area should be left wild in a techno-cynegetic society. Regardless of exact percentages, reserves of every kind of region need be saved, and be large enough to preserve natural cycles.

4.9.1.8. *Separating Wilderness*

Many popular arguments against wilderness share the following six statements of “fact:” (1) Wilderness locks out people, so they are separated; (2) wilderness is a human construct; (3) wilderness is a false dichotomy between man and nature; (4) native people improve on nature with deep knowledge; (5) humans have always modified all of nature; and (6) people need to be put first, since nature is our garden and millions will starve if we lock wilderness away. One does not need to argue against them, but the framework can be expanded, so that they disappear into a common ground.

Paul Shepard concludes that the consequences of ecological conflict in technological, humanistic civilization are either exile or sanctuary; and sanctuary is the only solution available to the humanitarian ideology. The idea of sanctuary recognizes the multiplicity of factors necessary for viable populations. But, although there are sanctuaries for frogs and ferrets, it would be impossible to establish one for every creature. Shepard discounts the humanitarian objective as considering only ‘worthy’ species. Yet, if all species were considered, the whole planet would end up as a sanctuary. Therefore, he considers sanctuary an unfeasible 19th

century political solution, based on a time when space was unlimited. Shepard states that exile (extirpation or extinction) and sanctuary are allopatric choices (meaning 'life not occurring together'). Allopatry (from the base word for fatherland) is seen as being consistent with the tradition of personal property, domination of nature, and model of the nation state.

What Shepard has overlooked is that humanity was never really sympatric with most other species. It never lived together (the meaning of sympatry) with major carnivores and noxious insects, if it was avoidable. Therefore, allopatry is consistent with the nonexploitation and nondomination of nature as well. Sanctuary as personal property or as nonhuman property is a moot point if habitats are saved from destruction. Personal property, of the wealthy elite or of religious orders, has often allowed species, especially plant species, to be saved (the dawn redwood or yellow pine for instance). Domestication and enslavement are sympatric forms. A conservation program, despite Shepard's argument, cannot be based solely on sympatry. Not all species occur together in the same place. Sympatry describes only those that do. At the habitat level, allopatry is the most intelligent use of available resources by animal communities. Large herbivores, such as elephants and rhinoceros, may choose poorer quality food to avoid competition with smaller animals and to exploit an untapped food source. Many interactions between different species contribute to the mutual benefit of the members of the community, as well as to the community itself. Humanity must be allopatric with most wild species and allow them to develop independently in their own places.

Separate areas are necessary, although thinkers such as Gary Snyder question whether complete compartmentalization is healthy. Snyder suggests that some land is saved like a virgin priestess, while other land is overworked like a wife, and some is brutally reshaped like a girl declared promiscuous. This argument is certainly good for human lands, but wilderness lands should be compartmentalized for the use of other species, which do not share our treatment patterns of females.

Saving wilderness means saving large areas of land. It means placing wilderness, which is support for cultivated and industrial areas as well as natural communities, off limits to development and perhaps to any use. Every ecological community should be allotted a place for self-development, a foundation area. Wilderness is not land that is locked up, as several U.S. Senators have claimed; it is quite interactive. We are already living with it. Foundation areas are not museum pieces, as Birch seems to think—only humanity is directly absent.

Wilderness costs are sometimes considered too tremendous to bear, in terms of lost opportunities, resource use, and administrative overhead, according to Lehmann and others, but that cost is reckoned without considering the free services of wilderness. Their conclusion is based on the assumption that everything that can be used should be used. Wilderness areas, left by themselves, would require a minimum of management costs. Often, when it is suggested that wilderness areas be left without human management, critics conclude that humanity is not being considered as part of the environment. This is an unfortunate conclusion and untrue. Humanity does not have to convert every system to be a part of it.

4.9.2. *Wooing the Wild*

Currently, our stewardship of wilderness seems to be a form of exploitation. We simplify ecosystems of which we are still greatly ignorant, killing billions of creatures. The rate of extinction of species exceeds our rate of learning about them. Shepard rejects the model of exploitation: "The historical model we have for being lieutenant of the planet is the shepherd

and husbandman, who always destroy the wildness of the animals they seek to protect.” The professional form of this exploitation is ‘wildlife management,’ where the manipulations are more extensive and include fencing, marking, trapping, breeding, and game farming. Humans can never be stewards as long as they dread every intrusion of wild nature into their gardens, neighborhoods and fields, as long as they try to control everything. Stewardship is based on knowledge that we only think we have. Nature is already self-governing; we do not need to be stewards. Nature will heal herself, either through self-healing of the human species or its self-destruction, which would allow alternate forms of life to flower. There are several possible human relationships to the earth or to wild beings: among them, pandominant species, lord-and-master, good steward, or fully conscious and self-limiting beings. Historically, we have preferred lord-and-master.

There is an arrogant belief, from Plato to J.S. Mill to Rene Dubos, that all human action improves the spontaneous course of nature. Dubos, for example, is disturbed when farms revert to natural vegetation. He dreads forest regrowth in New York as barren and uninteresting. He claims that the statement “nature knows best” is wrong. But ecosystems that seem inefficient and wasteful are many times redundant, and therefore stable and flexible. Natural processes that seem destructive are cyclic and preservative. The humanized landscapes that Rene Dubos praises are the result of a long-term adaptation with limited means. The interplay was slow, so that many species, although not all, could adapt.

The natural state is adaptive, generating a coherent system. But that system is not the only possible one—and it may not be the best one. Many things in nature seem ineffective: population crashes among lemmings; or the partial recycling of carbon (as coal and gas). Dubos claims that guano accumulation on Pacific islands is a recycling failure, but what if it is a way to remove nitrogen from the cycle—a cycle that otherwise may be disturbed? Foresters regard forest fires started by lightning as a waste. But, lightning is essential to life by breaking down amino acids into ammonia, methane, hydrogen, and water; burned forests (from lightning-strike-caused fires) are necessary to maintain diversity and keep single species from taking over.

We have been persuaded that humans are able to transform any habitat on earth and benefit from the transformation. Africans practiced this reclamation, as did Assyrians, Greeks, and American Indians. Occasionally it worked, and long lasting systems were established. But often, the reclamation only contributed to deserts. The United States, Nepal, Brazil, and other countries lose enough soil annually to form a new country in the ocean. Civilization is both adventurous and stupid—it destroys habitats that are the tissue of its existence.

Civilization is also inefficient. It wastes land and moves on. Wild species have been destroyed and replaced with various cultural domesticated favorites. Then, those domesticates wasted soil and disrupted animal, plant, mineral, and soil cycles. The increase of favored species displaced others that may be more adapted.

Human motives to transform appear rational and prudent, but really are often prompted by ignorance, greed, and destruction. The means and scale of the destruction has increased dramatically. Managing other species usually means manipulating wild or domestic species to exploit them for profit.

A high human civilization has to limit its consumption of natural resources, its place in wilderness, to consider wilderness and future generations. Wilderness is a limiting factor in the health of human civilization. It is probably not a precise function, but we may be close to the

minimum for the earth. As Bateson pointed out, it is not safe to be limited by lethal variables.

Understanding ecological relationships permits the toleration of fluctuation, irregularity, uncertainty, diversity, spontaneity, flexibility, looseness, and limits. The correction for ignorance of ecology is knowledge. Knowledge by itself, however, merely permits a more efficient utility. Knowledge cannot be the sole basis of decision making. It is always incomplete and therefore cannot describe all aspects of the earth that bear on human life or environmental quality. Something more is required.

Rene Dubos takes the heroic love-adventure of humankind to be the wooing of the Earth. The wooing of the earth is both sweet and sour—sweet because humans can create enchantment within nature, and sour because they can spoil desirable places—possibly to the point of ruining nature's recovery mechanisms. The wooing of earth implies more than converting wilderness into humanized environments. It also means preserving natural environments in which to experience mysteries transcending daily life and from which to recapture an awareness of the natural forces that have shaped humanity.

Dubos celebrates the human ability to woo the earth by creating new environments that are "ecologically sound, aesthetically satisfying, economically rewarding, and favorable to the continued growth of civilization." While that is noble and just, and realistic, there are two erroneous assumptions contained therein. First, civilization does not have to grow to develop; it is development that is important, not growth, which is plainly unfeasible. Second, 'to woo' means to solicit love or to make love. Dubos assumes we will remake nature in our image. And love, as everyone should know, entails respect or reverence. It does not remake the loved one in one's image; it respects and allows freedom and difference. That is the larger meaning. We should 'improve' on nature where we live, but we do not need to try to improve on all of nature. We do not need to domesticate all beings for human use. Joseph Wood Krutch recognized that ecology without reverence or love is only shrewder exploitation.

That does not mean that we cannot change places by living there. We can create places only by living there; by slowly adjusting. Human modifications of the earth can be lastingly successful only if their effects are adapted to the invariants of human and physical nature. Ecological management can be effective only if it takes into consideration the visceral and spiritual values that link us to the earth. Although some of nature can be regarded as a garden to be cultivated, large areas should be preserved as untouched reserves or necessary systems for global balance. Other areas could be studied or urbanized as population centers. Our tendency to redesign nature into a human form, rather than tolerate and cherish, is dangerous; it leads to 'curing' abnormal people and 'solving' weed problems. We do not respect the wild, complex side of human nature or wildness in nature. Perhaps in this sense, design needs to be a form of limiting human impacts as well as restoring natural balances that have been disrupted by human impacts, and not a blueprint for controlling every natural process for human benefit.

It is not possible to address the dimensions of wilderness without considering the beings that make it up, without considering it as a unique pattern of lives, without considering animal behavior and human ethics, without considering human evolution and the history of the earth. A true definition of wilderness is not found in human needs and desires. Wilderness is not for people. It is for itself. It makes and defines itself. For humans, it is a land classification. But a unique one, for it is one which is nonhuman and unmanaged, unknown and unused. Wilderness is not incoherent until human beings give it form. It already has form. Wilderness

is made by the life-images of the species and beings that inhabit and inform it. Wilderness is not empty. It is full with living beings whose goal is fulfillment.

The primary justification for wilderness is as a sanctuary for other beings that constitute the richness of the earth. Many of these cannot live with humanity; they are allopatric and anthropofugic (meaning that they actively flee human presence). If, as many believe, wilderness is necessary for human development, its protection can be justified on that basis also. But, its value to humans consists of its separateness, as well as its diversity, aesthetic nature, its economic benefits in recycling wastes and trapping energy, for recreation and inspiration.

Many voices defend wilderness itself. But more urge its use. We humans are ambivalent, we want to save areas created by the destruction of wilderness. We want areas that bear no record of us, yet we want to leave our mark everywhere. We want nonhuman places, but we want to live everywhere. We want to use everything, but save it. There are many alternatives, from indifference or conservation, to a more radical alternative: Creating new social organizations, then using technology to solve problems and incentives to save natural places.

Humans need a human way of being, and human worlds. But, these worlds are derived from the wild universe. We need a wild universe to live fully. When we understand our roles and relationships in nature, then we will not be managers or stewards, but participants and sharers in experience. An ecological basis gives human activity dignity. But that in no way negates the life-images of nonhuman beings. All beings are centers of experience.

We must emphasize the value of all nonhuman beings and try to use as few individuals as possible from as many species as possible—moderate yields, within the limits of the food chain. Many species should probably not be used at all, whales and wolves, for instance; they do not respond well to hunting stress. Plants and animals are as much of our heritage as art, history and tools. Ignorance of one is just as sad as ignorance of another. Our survival depends on an expanded ecological awareness of the global system in its complexity and connectedness. The spirit of humanity depends on an ecological consciousness that places humanity in a proper relation to the wild places of the earth, taking what it needs, but letting the rest be.

Perhaps new technologies and new philosophies may permit larger human populations or the expansion to other planets or solar systems, but we must be cautious with what wilderness exists here. Conservation and creation must be tempered with preservation. We are too ignorant to tamper with everything. If we cannot live sensibly on earth, the emptiness of space and wilderness of stars will not be home.

4.9.3. Determining Regional Wilderness Designs

The scope of this section is to determine how much wilderness needs to be saved, on a global level, to prevent, or reverse, increasingly significant annual losses of biodiversity, species and ecosystem services (and wilderness is pragmatically defined as areas necessary for global maintenance that have minimal human industrial or technological impacts). In his previous studies (1970, 1972), Eugene Odum suggested that forty percent of ecosystems needed to be set aside to provide ecosystem services for human populations. In his lecture just before this one [at the IV International Congress of Ecology, 1986], Odum emphasized the importance of wilderness for the planet, as well as a general knowledge of ecology by the everyone.

There are significant problems in dealing with wilderness, however. To begin, we are not sure how to define wilderness. Nor do we know exactly how much of it remains anywhere. Next, we are saving wilderness from the bottom up, as separate species or habitats, rather

than from the top down, which would identify entire wild areas to represent each kind of ecosystem, especially those that do not have grand viewscapes or charismatic animals. Furthermore, we are losing wilderness faster than we can understand it, and the more endangered the wilderness ecosystem is, the faster it seems to be declining or disappearing. Finally, we are not even identifying wilderness fast enough, and we do not have plans to survey and monitor all wilderness ecosystems. We know that most wilderness is not protected, but we have not studied the missing pieces of wilderness, such that we can save the processes that create and maintain the great diversity of wilderness.

This discussion of wilderness will expand two points: Wilderness definition and the idea of a minimum—or an optimum if we prefer to be safe and thoughtful—area of wilderness. First, wilderness definitions have tended to be restricted to banning human activity in mountainous areas. This kind of definition needs to be expanded to include every kind of ecological system, including those shaped by traditional cultures, as well as ecosystem dynamics of all systems.

Second, the idea of a minimum needs to be refined. A static minimum is easier to calculate, but a dynamic minimum is necessary to consider. The idea gets fuzzy because of the variables. Therefore, it is better to try for an optimum, rather than risk missing variables and adhering to a figure that is relatively meaningless.

4.9.3.1. *What is Wilderness Again?*

Wildernesses are ecosystems that are self-creating and self-maintaining. An ecosystem itself can be defined several ways. First, an ecosystem can be a thing, a vegetation type, a plant association, a natural community, or a habitat defined by structure, age, geography, condition, or other ecologically relevant factors. Thus, old-growth forests, bogs, sagebrush steppe, wetlands, oak-pine savanna, free-flowing rivers, a downed tree, or a pitcher plant are considered ecosystems. This concept of ecosystem is hierarchical because broad vegetation types include many plant associations, and habitats are part of broad vegetation types. The concept of ecosystem has been criticized for being too general and scalar. However, the generality of this definition allows assessment of structural, functional, or compositional aspects of ecosystems at any spatial scale or level of the classification.

As a special kind of ecosystem, wilderness is a human classification of an area (including air, water, land, and species) that recognizes that the content is determined by natural physical and evolutionary processes. Of course there are many classifications of wilderness and other definitions. This article does not address the definitions of wilderness that refer to human inspiration, recreation, purity, separateness, fiction, or myth. We have placed so much baggage on the word that it may not be useful. Wilderness is not a pure ecosystem. There never has been, for the past ten thousand years or more, a pure, humanless nature. Nor should wilderness be considered a simple playground for human needs for entertainment or therapy. Here, wilderness is simply a designation of natural systems that are not dominated or significantly modified by human processes.

Wilderness is a metaphor, after all, an invention of city people to describe the kind of nature existing outside their walls. This definition anticipates that nature was being converted to human nature rapidly. The metaphor has a psychological dimension. For instance, the forests of Greece were wild. But, the contemporary degraded landscape is also considered wild. No definition can be completely objective, due to this psychological dimension. Wilderness is

a state of mind combined within a state of nature.

Wilderness is designated by boundaries, usually formal ones where governments have set aside wild lands. But, the boundary does not have to be formal, as long as there are rules. It could be recognition of places left alone because they are cold or remote. The boundary can be a limitation on interference or conversion, and perhaps a limit on the number of people or on their use of technology. In this discussion, all of these refinements are included under the umbrella term wilderness.

4.9.3.2. *Do We Humans Need Wilderness?*

Human needs have been placed by the psychologist Abraham Maslow into five groups: Physical (food, shelter, clothing), Safety (law, order, security, freedom), Psychological (belongingness, love), Esteem (strength, self-sufficiency, competence, attention, prestige), and Self-actualization (achievement, creativity). I reason that wilderness provides the basis for each group.

We humans need wilderness physically. It is the matrix that is producing and supporting us. Even if we understood all of the intricacies of the process, and thought we could duplicate it in artificial environments, on spaceships for instance, we would still need wilderness—as a source of basic ecosystem services (that keep every system functioning) and as a source for ecosystem and human health.

Wilderness, as an ambihuman ecosystem, provides safety through its intrinsic order. In fact, wilderness has provided security for people because of its resources and because by definition it has not been under cultural control. More so, because traditionally it has been a source of freedom from the many kinds of human political tyranny.

We depend completely on the natural environment psychologically. Psychologists, such as D.O. Hebb, have conducted experiments that show the effects of a limited environment. Cut off from external stimuli, the mind becomes strange. The external world is needed to keep us alive and sane. This world is composed of remote occurrences, on polar icecaps and distant stars, as well as immediate personal events. Wilderness provides a constantly self-recreating environment. The human body links this exterior to mental interior. The person is inextricably woven with the world; the body is a mode of presence to others.

Living within many kinds of wilderness, as do many foraging and horticultural cultures, allows the development of strength and self-sufficiency. And, this results in feelings of competence; although, this may be true also where wilderness is used for recreation by industrial cultures. In Archaic cultures, wilderness, as sacred space, is reserved as sacred; it confers more prestige on the sacred chiefs, e.g., Tonga or Samoa (where prestige is the power to influence others, due to success or status). Wilderness can provide sources of prestige that are outside of inheritance or social rank.

We need wilderness mentally and spiritually. Wilderness, basically as sets of places where nonhuman beings could continue, is necessary to the human psyche, where “otherness” continues to exist. It is a source for inspiration from the nonhuman. It permits creative expression and spiritual development, outside of the human cultural limits. Wilderness is the source for all human creativity. It is the experimental ground where forms are recombined.

4.9.3.2.1. *How much Wilderness do we need?*

Wilderness is an ambiguous and indefinite thing. It is a need like the sun is a need. But, we do not need to live in it or even visit it. It supports and cycles our human ecosystems. We need

it because it is not us, not human and not human-made or maintained; it is the source of all nonhuman being. It is one of those things that we need as much as possible of. We can not know exactly what the minimum is, either for the region or planet, or for human physical or psychological requirements. Even if we could determine a minimum, we should consider a more conservative number, or an optimum.

For ecosystem services, that is, for clean air, water, food, shelter, we could calculate a minimum (or optimum) regional wilderness area, based on a number of criteria. To ensure the continuity of many habitats and species, we need to restore many systems that have been degraded; and save every one that is left. The hot continental region has been transformed for agriculture and little natural vegetation remains. Nevertheless, many of these areas could be restored as common areas, and support a suite of species that is adapted to the system.

Perhaps, there is enough wilderness for inspiration, but to inspire a billion people may take more than is left in a region. Humans are inspired by different things, so a token wilderness will not likely serve as inspiration for every one who is part of the current or projected population. There may be enough wilderness at this time, especially if we employ better technologies and more discipline in their use. For growing populations, we will require more wilderness. Without knowing how much wilderness we need, it may be possible to calculate an amount that might serve our needs, after considering a few more questions.

4.9.3.2.2. Does the region need wilderness? Do species?

The region, as a self-creating and self-maintaining system, needs a minimum volume of wilderness to continue the cycles necessary for renewal. Because the region is a sum of local areas, a mosaic of different systems, those areas need to be considered individually.

Diverse habitats form a mosaic on the landscape, e.g., patches. A patch is also a landscape element. Each patch contains internal habitat diversity. Disturbance in a patch is a major determinant of species number and size. For sustaining a species there has to be a Minimum Dynamic Area. Patches have different patterns. Squirrels for instance, may be found in small patches but be absent from or scarce in large ones, which may contain predators such as owls. The same situation may be true with land snails, which may be preyed on by wild pigs. There may be a patch size restriction.

The Minimum Dynamic Area is the smallest area for a reserve to have a complete natural disturbance regime in which discrete habitat patches may be colonized from other patches in the reserve. Larger patches are required to sustain a species indefinitely. Formann defines the Minimum Dynamic Area as the patch size required so that the natural disturbance will not eliminate a species.

Although area is one criterion of a landscape, ecosystems are not completely defined by spatial criteria. One reason that it is difficult to have area define an ecosystem is because of the watersheds and airsheds that are larger than one system. In many ecosystems, plants through transpiration cause precipitation in the larger airshed. The spatial boundaries of an ecosystem are more dynamic due to air and water. Of course, parts of the ecosystem are based in soil processes and the plants themselves.

The scale of other pathways contribute to the size of an ecosystem. So, when calculating a minimum or optimum size for ecosystems that need to be labeled wilderness, we have to be sure to increase the area to make sure that the largest extent of water and airflows are also self-sustaining on that scale. The pathways have to be complete within an area, a natural

surface with a large number of limits (water catchments, nutrient deposition, nutrient limits, temperature limits); this includes biochemical pathways. The minimum critical size of ecosystems remains one of the central topics in conservation and is dealt with in greater depth by Lovejoy and Oren.

Because the regions are the sum of plant, animal, and material interactions, it may be necessary to calculate some wilderness in terms of keystone species. All animals use environmental signals to time their life events. Day length or availability of food can trigger reproduction. These signals provide predictable information about conditions that are forming in their environment. Sometimes, however, unpredictable events, such as storms, can disrupt behavior. Animals therefore learn to cope with many kinds of unpredictable events. Human actions, such as pollution, introduction of exotics, or large-scale disturbance are also unpredictable events to animals. Population declines of animals can be accelerated by: Genetic change, such as a loss of variation; demographic fluctuations, due to changing birth or death rates; and environmental fluctuations and disturbances, such as fire or poisons. Wilderness is a way to reduce the number of unpredictable events so that animals can flourish.

D. Terborgh (1974-1975) demonstrated that very large areas on the order of 1,000 square kilometers are necessary for long-term survival of species (without those large areas, bird species loss has been reduced to 1 percent of the original avifaunal complement per century). Although this particular approach has been questioned, other considerations such as problems of population densities and the likelihood of extinction from random population fluctuations support the general conclusion that large reserves are necessary to keep ecosystems healthy and intact.

Thomas Lovejoy and Richard Bierregaard, ornithologists, started a Minimum Critical Size of Ecosystems Project in Brazil. Using a Brazilian law requiring rainforest tract owners to leave 50 percent of the land in tree-cover. Working with landowners to leave patches in size from 1 to 1000 hectares, they started to survey diversity. The purpose of this project is to answer the question: How much land is required to sustain 99 percent of all original species for 100 years?

The diversity of small islands decreased more rapidly. The extinction of species was also accelerated by day winds that were able to penetrate into interior forest, killing trees 100 meters or more deep. Edge species increased. Interior species, including ants and shade-loving butterflies declined. Large mammals, such as pumas and jaguars and peccaries, migrated away from smaller plots. Without peccaries to create wallows in forest pools, some species of frogs failed to breed and disappeared. Beetles needing dung or carrion became scarcer. Second and third order changes would continue down to mites and parasites.

Wildly fluctuating populations are also more vulnerable to other events. Below a certain threshold, a small population is in danger of extinction. Edward Wilson notes that a tenfold rise in population size may increase chances of longevity thousands of times. A modest increase in habitat size may put a species beyond the threshold. Animals may be vulnerable if they are specialists, or if they are large. Large-size predators means smaller populations, which means vulnerability to extinction.

While the general conclusion that large reserves are necessary is undoubtedly valid, the topic has not been dealt with in anything like the depth it needs, from the viewpoint of either conservation or theoretical biology. The main purpose of their study is to determine the role of ecosystem size for primary productivity, autotrophic biomass and system respiration and their

temporal stability in experimental mesocosms and natural ponds and lakes. In any landscape, productivity can vary over short distances, due to differences in topography, air temperature, water availability, and history. Therefore, regional averages are used.

We should create a Minimum Critical Volume for regional wilderness, below which cycles would wobble or collapse. We are not sure about size or stability of planetary cycles or ecosystems. Worse, the delay time between instability and collapse is likely more than one human lifetime, so unless we start monitoring all ecosystems, we will have a hard time understanding which systems are dying and which are changing to new points of stability.

4.9.3.2.3. *How do we know how Much Wilderness a Region or an Ecosystem Needs?*

Or how much species or guilds of species need?

It is thought that if we save a large percentage of a region in wilderness that will be enough to automatically save both ecosystems and species. However, it will not save part of each kind of ecosystem. It is thought that we can save minimum viable areas of each kind of ecosystem, and that would save most of even the larger species. But, that will not save at least one population of each species. For that, we need to inventory all the species on the planet. Then we could calculate areas with adequate populations, or Minimum Viable Populations (MVPs).

4.9.3.2.3.1. *How Much Wilderness Does a Region Need?* That's hard to say, because there are so many human variables, not to mention evolutionary variables. A region may continue with fewer, simpler ecosystems. What we are really concerned about, I think, is richness. How rich a system do we want? Do we want cathedral-like tropical forest canopies that host millions of different species, each making a home there? Or will we settle for desert ecosystems, blasted by centuries of war and destruction? Of course, these ecosystems have their own stark beauty, even after the adapted species have been destroyed. The vast number of species existing now have existed for over a million years. These species have proved resilient to all kinds of natural changes and disturbances, except for human ones, which can interfere with renewal.

4.9.3.2.3.2. *How Much Wilderness Should there be in an Ecosystem?* I am not sure how much area an ecosystem needs to be self-renewing. Of course, that depends on the ecosystem. And, the larger and more complex the ecosystem, the greater the likelihood it has dependencies and exchanges with other ecosystems. We know about exchanges, especially bird watchers, who follow the objects of their fascination for thousands of miles. Birds carry information, genes, viruses, and seeds to distant ecosystems.

4.9.3.2.3.3. *How Much Wilderness Does a Species Need?* For species, we can calculate minimal areas to maintain minimal viable populations. But, even then, there are many variables to consider, depending on the species. For example, some species, such as wolves, use nonbreeding individuals to help with education of the young.

Each species needs to keep a minimum number to be genetically healthy. Biologists have been attempting to determine minimum viable population size (MVP), which is the smallest number of individuals to maintain a population indefinitely. How big should a population be to avoid extinction? Population viability analysis is a comprehensive analysis of environmental and demographic factors that affect the survival of a population.

Michael Soule has suggested 500 breeding individuals as the minimum. The 500 breeding individuals is the effective size; the real size may be quite larger, especially where the generations are shifted to elderly or where not all members mate. Long-lived species are also vulnerable, for example, the Pacific Ridley sea turtle or African elephant. So, we could safely

use 2500 as the optimum number.

How big is the minimum size of area that will sustain a MVP? What is the minimum viable area? For a forest patch size in forest marsh grassland, a minimum area can be calculated for typical species:

- One to four hectares (ha)—amphibians, frogs, a very few common edge birds, such as Downy Woodpecker or Great Crested Flycatcher
- 10 ha—still dominated by edge species, but may have very small areas of interior which supports numbers of forest interior/edge species, such as Hairy Woodpecker or White-breasted Nuthatch
- 50-75 ha—still predominantly edge, but will support small populations of most birds except those with very large home ranges. Least Bittern may be present in marshes of this size - more bird species (Northern Harrier, Short-eared Owl)
- 100-400 ha—all forest-dependent bird species diving ducks (Canvasback, Ruddy Duck)
- 1 000 ha—suitable for almost all forest birds. Some forest-dependent mammals present, but the size may still be inadequate for Sharp-tailed Grouse and Greater Prairie-Chicken
- 10 000 ha—an almost fully functional ecosystem, but may be inadequate for a few mammals such as Gray Wolf and Bobcat (100,000 ha has been suggested as a minimum)
- 100000 ha—a fully functional ecosystem. It may be a minimum size for a functional ecosystem but some species may still be below or near their minimum viable level.

It might be best to use a strategy that combines all three approaches: a percentage of the planet, in addition to special ecosystems and then special species. Without knowing how much wilderness the planet, ecosystems or species need, it may be possible to calculate an amount that might serve those needs.

4.9.3.3. *If we don't know how much is Needed, how much should we Save?*

Obviously, we should be cautious and save as much as we can of every habitat. If the area is large enough, then probably the top predators will survive and keep the system diverse and healthy. The current reserves are inadequate; wild species decline on limited reserves. Designing reserves requires a biogeometry, knowledge of the shapes of ranges. Left to themselves, in an adequate preserve, species may be dropped or generated. Human progress deprives many species of existence, simplifying ecosystems of which we are still greatly ignorant. Industry destroys billions of creatures more than unscrupulous hunters or multiplying homesteaders. The rate of extinction of species exceeds our rate of learning about them. Humanity as a species must develop an awareness that it is infinitely enriched by the organic world, and is poorer each time a species is eliminated or natural community degraded.

There are many ways to approach minimum (or optimum) wilderness areas. Some ways are simple, and others are complex, perhaps too complex. Some simple ways are probably unacceptable to the human populations. Several approaches can be described as follows:

1. The Remainder method (*What's left?*)
2. The 50 percent rule (*Best guess?*)
3. The Acreage method (*After Eugene Odum*)
4. Minimum System Method (*Processes, after Lynn Margulis*)
5. Key Species: Top predator home range (*With genetics/ecoregions*)
6. The Mixed Method (*Appropriate for various areas*)

These approaches are expanded in the following paragraphs.

4.9.3.3.1. The Remainder Method

This method works by calculating how much wilderness is left and not critical for human needs. This would result in about 30-36 percent of the planet, according to satellite information. Early satellite information revealed that 32 percent of the land area was not being used in a way that compromised the systems self-renewal. A 1987 survey by the Sierra Club revealed that about 34% of the land area is undeveloped wilderness in blocks of 400,000 hectares. The Wilderness Society estimates that a wilderness area should be at least 400,000 hectares (1 million acres or 1600 square miles). Presumably, this would permit minimum cycling. Only about 20 percent of that is protected. Including Alaska, wilderness in the US occupies only 4 percent of the land area (and two-thirds of this is in Alaska). The US has 233 distinct ecosystems; very few of them are protected. But, 40 million hectares of public lands could be designated wilderness in US.

Wilderness remaining by continent has been calculated by J. M. McCloskey (Sierra Club, see Table 49331-1). This could form the basis of saving the remainder. In “Wilderness: Earth’s Last Wild Places,” a publication by Conservation International and Agrupación Sierra Madre, the authors found that “wilderness areas” still cover close to half the Earth’s land, but contain only a tiny percentage of the world’s population. Over 200 international scientists identified 37 wilderness areas that represent 46 percent of the Earth’s land surface, but are populated by just 2.4 percent of the world’s population (excluding urban centers). To qualify as “wilderness,” an area must have 70 percent or more of its original vegetation intact, cover at least 10,000 square kilometers (3,861 square miles) and must have fewer than five people per square kilometer. Five of the wildernesses are also biodiversity hotspots, home to thousands of species found nowhere else. These are Amazonia, Papua New Guinea, the Congo, the North American desert and the deciduous woodlands of southeastern Africa.

Table 49331-1. Remaining Wilderness by Continent (Region)

Antarctica	100%
North America	36%
Africa	30%
Oceania	30%
Asia	27%
South America	20%
Europe	7%

However, this does not tell us if it is enough to guarantee the functioning of representatives all ecosystems, for minimum function. Nor is there any way to tell if it is enough to support human populations at any level of luxury.

4.9.3.3.2. The 50 percent rule

The application of this rule is quite simple. Simply set aside half of every region or system to be maintained by wild processes. As a minimum (or maximum depending on perspective) guide, this rule could be derived from the operation of exponential change (doubling). For instance, if in a lake the algae is doubling every day, then 50 percent of lake will be covered the day before it is entirely covered. The problem with this method is that a growing population (algae or

people) has to be kept within the remaining limits, and those limits may have to be exceeded to provide sustenance. Although this might be possible with an increase in urban agriculture and with more appropriate technology, but it would wreak havoc on traditional diets and traditional agriculture.

4.9.3.3.3. The Acreage Method

Eugene Odum (1970) suggested using land area as a measure of human carrying capacity. Odum was one of the first to consider the implications of such limits. The minimum per capita acreage requirements, with a temperate area like Georgia as a model for a quality environment, is 2.02 ha (5 acres). The percentages are broken down in Table 49333-1.

Table 49333-1. Necessary Acreage Per Capita (after Odum)

Food-producing land	30%	.606 ha
Fiber-producing land	20%	.404 ha
Natural support areas	40%	.808 ha
Artificial areas	10%	.202 ha

The state of Georgia has a mean Net Primary Productivity (NPP) of 1200 grams per square meter per year ($\text{g}/\text{m}^2/\text{yr}$). Most of the state is a temperate deciduous forest. By comparison, the mean NPP of the entire planet is $782 \text{ g}/\text{m}^2/\text{yr}$ —this includes desert and prairie areas—and this is only two-thirds as productive as temperate forest areas.

Using this figure for wilderness of 40 percent per person, and considering the difference between mean productivity, we can calculate an optimum wilderness area for any region, using the human population of the region.

Table 49333-2. Calculation of Wilderness Percentage

[Sahel area] x .808 ha x 1.53 =	ha
Convert to square kilometers	km^2
[Sahel] land area	149,450,000 km^2
Percentage of Sahel area	56.77%

This calculation results in a figure of just over half of the area for Sahel wilderness. Of course, as the population increases daily, then the amount of wilderness required also increases. This is not happening; wilderness is not being created or restored at the same high rate as population growth. Wilderness needs to be increased to provide the ecosystem services that more people need. At the same time, we might find it prudent to decrease our populations.

4.9.3.3.4. The Minimum System Method (Process)

When the ecosystem is the smallest unit capable of recycling the elements of its membership, then for each type of ecosystem, a minimum area can be calculated that would permit the processes to continue to function. For example, organic carbon can be expired, fixed, reacted, or transformed. This method requires intimate knowledge of an ecosystem. For most ecosystems, we do not have that knowledge. Until we do, we should use a more conservative approach to determine a minimum or optimum.

4.9.3.3.5. Key Species Method (Top Predator and Genetics)

By calculating the minimum viable area for each kind of ecosystem, using the largest habitat of the top predator, and summing for all ecosystems, a figure can be calculated for a wilderness area for the planet (if wilderness is equated with ecosystems MVAs). Predation is a key to initiating and sustaining the diversity of ecosystems. Humans, by wiping out the predators have made the systems less healthy. The predator serves as a top-down limit for prey species, keeping them healthy by altering their behavior, and by removing young sick and old individuals. Of course, in the system, there are bottom-up limits also, as plants change their chemistries to attract or avoid predators of their own.

The idea of saving wilderness now is the idea of saving ecosystems complete with predators, most of which cannot compete with humans. Yet, the systems are crucial to human survival. The conclusion then is to save large systems, as wilderness, complete with predators, not only to keep the biodiversity strong, but to allow those systems to provide those things that humans cannot do without, such as clean air and ecosystem services. The ecosystems have to have viable populations to be stable.

The size and geometry of reserves can be approached from considerations of large predators such as Grizzly Bears and Mountain Lions. It is possible to determine the minimum home range of such species by means of radio telemetry and to calculate a minimum critical area by making some assumptions about the minimum population size needed for genetic considerations. But such a procedure does not take into consideration the problem of dispersal of the young, who may not be tolerated within established areas. To remedy this situation, some have suggested reserves linked by corridors of similar habitat for dispersal so that there would be essentially islands of habitat for people rather than islands of habitat for wildlife .

Maximum population density scales as mass, therefore the requirements of individuals for space increases more rapidly with size than the space available. There is an overlap in the ranges of large mammals and birds. Large mammals that are grazing herbivores are not territorial. As species decrease in size they tend to be more patchy in their use of the environment (but many carnivores having a healthy population size also exhibit this tendency), which leaves a lot of space unused. However, those populations may shift territory, so it would be difficult to fence off only the territories they use currently.

We can calculate the areas for a few keystone species for instance, using their home ranges. Home range is the area around the home of an animal, used for feeding or searching for mates, commonly shared by mated animals with offspring. Defended territory is usually a smaller area that an animal will defend actively. Animals also disperse and migrate, both vertically and horizontally. Keystone species can be top predators, such as the Sea otter, who preys on sea urchins, which graze on algae and kelp, the dominant food source, e.g., fig trees, a connector, such as mycorrhizal fungi, a habitat modifier, such as the beaver or African elephant, a mutualist, such as cellulose-digesting microorganisms. Co-evolving species appear to alter the structures of landscapes over which they evolve. They then tend to have the highest fitness and survive the longest in their physical landscapes.

Predators have different sizes of home ranges, and the shape of their ranges reflects various habitat needs. Some predators have relatively small ranges that have a linear shape. For instance, the skunk, an omnivore that digs subterranean dens along hedgerows, has a home range of 1 km² per animal; the range is linear around edges. The red fox, a nocturnal carnivore that also creates subterranean dens, has a home range of 10 km² per animal; that range is also

enlongated rather than round in shape. River otters, piscovores living along rivers and valley streams, have a home range of 160 km² apiece, whose shape is guided by water courses, but also changes by seasons.

Other predators have larger ranges with other geometric shapes and may use several ecosystems. The Canada Goose requires numerous landscape features for summering and overwintering, roosting on open water, feeding in fields by day, resting on shorelines during day, and staying in protected coves in bad weather. Migratory birds are declining as a whole because not all of their territories are protected. In many cases, wintering grounds are being destroyed by logging. These species need several kinds of habitats to avoid extinction.

Owls are also vulnerable to habitat destruction, although they reside in one ecosystem. The Spotted owl requires 1000 hectares (10 km²) of old-growth forest for each mated couple. Other owls have less stringent needs. The pygmy owl requires half the territory and survives in second-growth forests. As a key species the minimum area for a viable population is 250,000 hectares (2000 km²).

Coyotes each require a minimum area of 700 ha (7-10 km²) for a home range; although the range follows natural features, it tends to be much less linear in shape. An effective population of at least 500 individuals may be needed to maintain genetic viability of each animal species (Frankel and Soule, 1981). Since not all coyotes in a group breed—some become aunts or uncles and help care for pups—it is necessary to assume 3 coyotes per breeding unit. Using coyotes as the key species, the minimum area for a viable population becomes at least 525,000 hectares (or 5250 km²).

With wolves, it is necessary to assume at least 3 wolves per breeding unit. Assuming a minimum viable population of 750, and a requirement of about 80 km² per wolf, the minimum area for a viable self-sustaining wolf population would be 60,000 km². Many species, such as wolf, use clusters of ecosystems, including corridors, such as roads or frozen streams, as well as fields and forests; they avoid wetlands and human cities. Larger carnivores, such as Siberian tigers, require even larger areas (two tigers require 10,360 km² or 4000 square miles. Five hundred would need over 5 million square kilometers).

This system is quite a lot of work. But, the calculations can be simplified using three levels of tertiary predators across all identified ecosystems. For example, the US has 233 distinct ecosystems. Wilderness for the US, using three levels of tertiary predators for the 233 ecosystems, can be calculated in Table 49335-1.

The total area of the US is 9,373,000 km². By this calculation 55.9 percent of the country should be set aside as wilderness. By extension, that percentage could be extrapolated to the rest of the area of the planet (.559 x land area plus a calculated sea area). The current wilderness in the US, which is the result of conservation efforts, is inadequate. Again, including Alaska, wilderness in the US is only four percent (374,920 km²). But an additional area, 40 million ha (400,000 km²), of public lands could be designated wilderness in US. Eight times as much would have to be created or restored.

Table 49335-1. Wilderness Area to Hold Top Predators

77 x 2000 =	154,000 km ²
78 x 5250 =	409,500 km ²
78 x 60,000 =	4,680,000 km ²
Total =	5,243,500 km ²

There is another way to calculate Minimum Viable Areas. That is to sum the requirements necessary for each species, since each species is genetically unique, not simply address the top predators. This is considerably more difficult, since we do not know how many species exist, where they are, or how much home range they need; nor do we always understand how the areas overlap. This calculation will have to wait on a complete inventory and monitoring program for the planet.

4.9.3.3.6. The Mixed Method

A mixed method might be more appropriate given the differentials in wilderness saved, unused but unprotected areas, and humanized landscapes. First, set aside those areas that are essentially wilderness already. Antarctica is especially important because we do not really know if it is possible to save only half of it, while drilling and utilizing the other half. Because of its influence on the water level of the rest of the planet, as well as political uniqueness as a research continent, it should be preserved intact. Other parts of the Arctic, Sahara desert, and Micronesia, should also be set aside, that is, be limited in terms of not increasing human impact. Therefore, we have these areas:

- Antarctica (14,100,000 km²)
- Arctic parts of NA, Europe, Asia
- Amazonia, Central Africa, Asia
- Micronesia Australia

Then we add hotspots of diversity:

- Madagascar
- Klamath
- Ecuador

Then we calculate areas of wilderness from the remaining areas, in terms of countries:

- United States
- Russia
- China
- Europe

Then, we calculate the areas to be restored to minimum wilderness areas (in the categories, neopoetic and restoration, from the previous system):

- Europe
- Asia
- Africa

This could be done in terms of ecoregions or ecosystems. See Table 49336-1 for a sample calculation of one ecodomain.

Table 49336-1. Wilderness Calculation by Sample Regions

System	Size (km ²)	Planet %	Save %	Save size (km ²)
400 Humid tropical ecodomain	38,973,000	26.64		10,382,434
410 Savanna division	20,641,000	14.11	35	7,224,000
M410 Savanna Mtns	4,488,000	3.07	75	3,366,000
420 Rainforest division	10,403,000	7.11	70	7,308,000
M420 Rainforest Mtns	3,440,000	2.35	75	2,580,000

4.9.3.4. After we decide on wilderness numbers, how do we set it aside and protect it?

Does wilderness have to be separate from humans?

There are species that cannot coexist with humans. There are habitats that are critical to the functioning of the planet. There are habitats too fragile to bear human interference. There are habitats that are of virtually no use to us. All of these could be set aside and monitored from satellite (even airplanes can have some impact on some systems).

The wilderness that could tolerate small incursions, such as scientific research, would

probably tolerate some human presence. Those wilderness areas that have coevolved with human cultures could simply be controlled by limiting human presence to traditional cultures or to sophisticated ecological cultures. Not every person in every culture wants a car and television. The allure of simple traditional cultures is such that many people would like to go back to them and live that way.

Some wilderness areas could probably tolerate a higher impact from people. Traditionally, borders (between human and nonhuman habitation) have tolerated human impacts. Most borders are between cities and unused areas. These are permeable and undefended, except for the few reserves. The boundaries are fuzzy anyway, due to the ability of pollution and trash to reach any area.

Even the idea of wilderness has been turned inside out, from the nature outside to the nature preserved from us and our activities. Confucius declared that *fang-wai* (outside the square) was the edge of his interest; now that we understand the interconnections, we need to reverse that attitude as well.

The patterns we impose on all of nature now determine what species thrive and what do not, their numbers and ability to move and evolve. We tend to homogenize nature—homogenize is such an appropriate word—it means made the same, but also perhaps the process of sameness promoted by *homo sapiens*, the homogenizer.

The numbers look great, but how important is shape? These areas have to enclose a large percentage of interior space to protect interior species. The areas also have to be lined up with watershed and airshed patterns. The context landscape is also an important consideration. Historical developments, such as drought patterns, should be considered; for example, to accommodate anticipated changes from global warming, reserve designs could have longer north-south axes (For a longer discussion of shape, see the regional design for the Palouse, Section 6.8).

4.9.3.5. *Summary: Service & Wisdom*

Wilderness provides necessary ecosystem services to the planet and its inhabitants, including regulation of weather, developing and maintaining biodiversity, sequestering carbon, and maintaining watersheds. Wilderness is the source of evolutionary change. For humans, and possibly other beings, it has political and spiritual significance. Wilderness provides and maintains conditions conducive to human life, globally, regionally and locally. Maintaining wilderness areas permits continued global ecological sustainability. According to Reed Noss, “wilderness” protection and restoration must be the first major ecological conservation strategy.

Ecosystem conservation offers several advantages over a species-by-species approach for the protection of biodiversity. It directly addresses the primary cause of many species declines (habitat destruction), it offers a meaningful surrogate to surveying every species, and it provides a cost-effective means for simultaneous conservation and recovery of groups of species. The idea of representing examples of all ecosystems in protected areas extends back to the nineteenth century in Europe and in Australia and to the early twentieth century in North America. Ecosystem conservation does not remove the need to understand the autecology and the protection requirements of individual species. It is not a replacement for existing conservation measures such as the Endangered Species Act of 1973 in the United States. Not all species that have gone extinct in the United States since European settlement would have been saved by this kind of coarse filter, which does not protect all presently endangered species.

We must save rare and endangered species along with this plan.

Conservation plans for all ecosystems should be developed, starting with those that are at greatest risk of degradation or conversion. Regional conservation, in general, has to include key elements: Salvaging the hotspots, including Madagascar, Hawaii, Klamath, and Ecuador; keeping the five largest remaining frontier forests in tact: Amazon, Congo, New Guinea, Canada, and Russia; ceasing logging in all old-growth forests; saving wetland systems, rivers, shores, and marine hotspots; restoring some of the oldest landscapes, e.g., Mediterranean coasts, African wetlands, and Iraqi grasslands; and, restoring areas that are overused or under-represented, such as grasslands and deserts.

Conservation plans have to include monitoring. This requires understanding the rates and locations of land-cover change, as the result of natural processes, natural disturbance and human interference, and understanding the processes associated with biological productivity. Both involve monitoring and assessment of landscapes that are changing rapidly due to extensive and intensified land use and natural disturbance regimes.

These plans must be kept in the context of human populations, cultures, and technologies. Human populations must be balanced with wilderness. If human populations cannot be reduced, then large areas of wilderness have to be restored.

Many wilderness areas and ecosystems are endangered, especially those that have a long history of human settlement, such as the eastern coast of North America, or those that hold desired resources, such as the beech forests at the tip of South America. Most ecosystems, much less ecoregions, have little or no legal protection. They have been ignored only because they are inhospitable or resource-poor. Plans to protect them have to have a strong legal component.

Wilderness is not something that can be preserved in one desired state; it is always changing. But, the processes that are continuously creating wilderness can be preserved by preserving the boundaries that limit wilderness from human landscapes. The wilderness cannot be managed; it is that which is not managed by definition. But, people, technologies and interactions can be managed.

Partly, things change, partly we reinvent things. Now we need to reinvent wilderness, cities, homes, and intercultural interactions. We need to keep everything in a complete context. That means political changes and population planning, as well as just designating and protecting wilderness. We need to act as if we were wise, according to Jonas Salk. Wisdom is a kind of action, based on theory, and with an understanding of ignorance.



Figure 4935-1. Oregon Landscape, Mountain Grove 1993

5.0. Facing Culture Through Design

Human beings are mammals—omnivorous, social, bipedal, featherless, symbol-using, tool-making, game-playing, neotonous, bilateral-hemispheric, generalist mammals. Human beings are mammals who live in groups and are good at imitation. These talents have allowed humans to create cultures to adapt to stressful environments. Cultures became useful in many ways, from externalizing memory to training the young. Many adaptive patterns were developed over the past 12,000 years, from agriculture and cities to technology and industrialization. While these adaptive patterns allowed great and dramatic improvements, their application in every circumstance is resulting in tragedies. Perhaps one solution is a global culture or a conscious framework for traditional cultures, but this solution would depend on understanding cultures and human motives.

5.1. What is Humanity? Is Humanity Regional or Global? What are Human Limits?

Human beings are mammals. As George Woodwell put it, they live as “one species in a biosphere whose essential qualities are determined by other species.” Mammals are bound by biological requirements that must be met if a population is to survive. These functional requirements are rather minimal for humans, however, being only food, clothing, shelter, and reproduction. Other requirements, such as respect and self-fulfillment, depend on adaptive sociocultural systems. Like other mammals, humans change their habitats to suit themselves. Other mammals alter their habitats through chewing, digging, and burrowing. Rodents can dislodge earth at a tremendous rate (18-120 m³/ha/yr). In many cases these activities improve the conditions for the growth of vegetation. Mammalian grazing promotes regrowth and the movement of seeds. Bison and prairie dogs were responsible for much of the character of the American plains. Rodent caches may account for 15 percent of Ponderosa seedlings. Beavers and other rodents create their own microsystems. Wide-ranging caribou transfer energy between systems.

Humans have modified animal and plant associations in a different way, simplifying patterns of energy and chemical exchange, solidifying themselves at the end of many food chains as a dominant species. Unfortunately, they often dominate their habitats. A dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the character of the habitat.

Probably no consequence of human development has had a greater impact on the natural landscape and ecological processes than the production of food. Patterns of eating have influenced the constitution of species and the very contours of the earth. Throughout their history, humans have used animals and plants for food and clothing. Animals were followed, herded, corralled, tamed, and finally bred. Plants were domesticated later. As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances. Early domestic animals were revered, but nondomestic animals were considered competitors or nuisances. Now, animals are treated as commodities processed in factories and wildlife is regarded as useless. Hunting persists, but mainly as recreation. A few plants provide the bulk of human diet; the rest are considered

ornamentals or weeds.

Humans are omnivores, although they have been represented as carnivores, vegetarians, or fructivores by different factions. In view of our control over animal and plant populations, a reexamination of our eating habits, and our use of animals and plants, is critical. The functional biological requirements are rather minimal for humans, however, being only food, clothing, shelter, and reproduction. Other requirements, such as respect, comfort, and self-fulfillment, depend on sociocultural systems.

5.2. What is Culture? Are There Regional Cultures?

The word culture has been used to identify human groups, as well as describe their unique beliefs and artifacts. The word is also applied to emergent properties of other living groups from wolves and termites to bacteria and fungi.

5.2.1. Are There Regional Cultures?

Human societies have tended to grow larger over time. Settlements grew from band houses to cities. Decision-making increased from a leader to a central bureaucracy. With the change in scale of populations, other changes have occurred in the structure of settlements, fields, governments and religion. These changes may foreshadow some kind of regional or global culture or government.

A healthy culture has many of the same properties as a healthy ecosystem. Unlike an ecosystem, however, cultures tend to grow beyond maturity to a point of collapse. At that point or sooner, another major difference manifests itself: Violence in the form of war. Big problems of human culture include: reproductive success, ecosystem conversion, then overshoot and stagnation, followed by stupidity and violence to try to rebalance the culture. Violence does sometimes work for a culture, usually by reducing the population and redistributing some of the wealth. In fact, every culture goes through a cyclic that may have from two to six phases. For example, George Modelski describes long-term cycles in cultures in terms (1) preference for order and (2) availability of order, each of which may be high or low.

The time structure of the operation of a complex system is a set of phases. Moving through a sequence of phases can create a whole cycle. Phase one could be global war; afterwards, phase two initiates a new world power; then, plenitude and security erode, and the system becomes delegitimized; finally, a low pressure for order and a preference for wealth, combined with low available order, deconcentrates the system. Modelski suggests that nation states are in the second part of the long cycle, a phase of decline. The model predicts rising nationalisms associated with increased conflicts. It could be leading towards a new global war.

In normal stochastic processes, from molecules to nations, things bunch together or move apart. We can identify cycles of this. For instance, great wars and dominant political powers can be also correlated to major innovations in discovery or technology. Cycles in politics are not just repetitions—they spiral outward, taking up the old ideas and processes—who says we do not learn unconsciously from history.

Based on this system, cultural historians William Strauss and Neil Howe suggest that modern history moves to the rhythm of life rather than just to institutional or economic cycles. They suggest an 80-year cycle, perhaps related to a human lifetime (or 4 generations

perhaps, which would correlate with the 4 phases), composed of four phases: (1) The High, or first turning, is confident expansion as a new order replaces the old. Perhaps the most recent one began in 1945. (2) The Awakening is an inward turning away from the outer order, which is rebelled against. This phase may have started in 1964. (3) The Unraveling is characterized by waning public trust, fragmenting culture, changing values, and alienation. This phase may have started between 1983 and 2003. (4) The Crisis represents a major discontinuity, leading to a new order that replaces the old order. They suggest that this phase began around 2004; it might continue for twenty more years.

Interestingly, C.S. Holling and his group used a more ecological approach to identify four phases of a cultural cycle, based on high or low values of capital and connection. These kinds of cycles may explain many kinds of phenomena in cultures. Order is certainly a major factor in a culture, as are connections and capital, ecological or financial. One wonders if a cycle of the life of a culture or one cycle within its life, could be explained by combinations of population growth, security, stagnation, overshoot and environmental challenges, such as drought. Stability seems a characteristic of archaic cultures. We can even state it in Newtonian terms: A culture at rest tends to remain at rest. According to Harding (1960), when forced to act on changes, a culture will only accommodate those changes that preserve its fundamental character. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. Since cultures have been traditionally self-reliant, resistance to imbalance is a positive act. Resistance to change or other cultures, is an adaptive mechanism that may encourage isolation. Yet, isolation is what allows a culture to develop in a unique way. Yet, without stimulation and invention, isolation may lead to stagnation.

5.2.2. The Growth of Regional Cultures

Some cultures grow, and in growing, decide that growth is a good thing to have without limits. Many lucky accidents, such as the rediscovery of the Americas, gave some cultures an impetus to keep growing. Other developments, such as science and industry, followed the conditions created by plagues and environmental restraints. The Spanish became a megaculture after benefiting from their exploration and exploitation of the Americas and western Pacific. The English became a megaculture after establishing an empire from North America and the Caribbean to Africa and Asia. North America became a megaculture in the Twentieth-Century. Each megaculture was able to dominate part of the planet with its influence and to see some of its products or rules become ubiquitous.

Global capitalism undermined many traditional cultures by offering consumerism in the place of traditional cultural guides for behavior. Social roles seemed irrelevant by comparison, if the good life could be bought without effort. Yet, it did not seem to work in Europe and the U.S. Instead of being free from economic want to develop their potential as creative human beings, people became trapped in a consumer cycle. Self-actualization was postponed for self-gratification. Democracy seemed to be good for balancing a middle class in some cultures, but it ignored other cultures and economies.

By virtue of its demomass and political system, China is becoming a megaculture. Chinese products are dominating the economies of other nations.

5.2.3. *Emergence of Connected Regional Cultures*

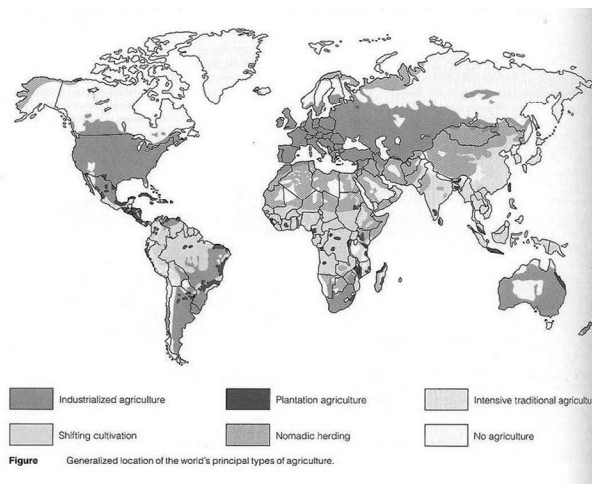
Trade and exchanges by various cultures extend to distant lands. Over time, regional systems start to develop, with newer connections and technologies, which draw the cultures and civilizations, of all ages, into a tighter pattern. Technology draws the cultures and civilizations, of all ages, into a tighter pattern. Some global civilization may result, but what effect will it have on the earlier patterns? So much is lost, of ways of being and acting in a more natural less technological environment. The world is acquiring a global economic structure.

A global political system is emerging, as there is increased vertical differentiation, evolving from nations and regions, that leads to differentiation into political groups and economic interests. The world does not function very well politically at a global level. It could be made better. It functions in the absence of a common culture or language. There is no world law, but there is a set of rules regulating international behavior; these are generally observed and understood. There is a small homogenous subculture, which belongs to the rich elites of every nation. This serves to integrate to some extent.

The modern world has become a very interactive system, especially with computer and communication technologies, which can lead to totally integrated mass communication and the extreme compression space and acceleration of time.

It is said that the global system has no center. That is a good thing. But, it is expanding without limits and that is a bad thing. It could cause the disintegration of natural systems that are interlinked with our economic exploitation.

Perhaps this emergence can be linked with a major cultural revolution, as identified by W.I. Thompson, Planetization, as there is absorption of a new consciousness surrounding the old. Other earlier revolutions resulted had a similar attendant process of miniaturization. The forest was miniaturized in clumps of trees; animals were miniaturized in artistic image; time on a lunar tally stick; plants in a garden; women in a household; and, nature by culture in 1800 (under the glass roof of the Crystal Palace as Thompson notes). The question is whether consciousness can create a coherent global culture.



5.3. Regional Design Factors: Adaptive Patterns—Agriculture

Agriculture is a system of plant use that people developed towards the end of the ice age, when the weather and other conditions became much more variable. Changing climate after the last ice age forced many animals and plants to migrate or adjust. It is possible to look at agriculture as an adaptation to those conditions, which included drought, species shifts and extinctions. Changes in wind patterns brought more moisture to some areas and new populations of plants. Growing plants allowed people to survive longer droughts and the disappearance of large game animals. Of course, it is also possible that after 40,000 years of gradual but constant population growth, people had filled all the available open niches for hunting. In that case agriculture was an adaptation to the shrinking availability of land for hunting and gathering.

5.3.1. Advantages of Agriculture

Agriculture offered many advantages. The source of food was more stable and more reliable. The plants could be isolated in fields or behind walls. Travel was reduced, since the plants would be brought to people, instead of people traveling to select plants when they were ripe. The select plants could be bred for increased food value and decreased toxicity. There would be a surplus that would allow people to live in one place, where more people could be supported on a smaller area of land. The surplus would also allow intoxication to be domesticated and expanded. Humans learned to cultivate soil, plant seeds and wait until crops grew. A hunter needed 10 square kilometers per person for nourishment; intensive agriculture lowered this to 1 hectare (1/100 km²). Agriculture could be 1000 times as efficient in terms of area.

5.3.2. Ecological Changes from Agriculture

Agriculture is an integral part of the environment in which it is practiced. Agricultural systems are distinctive types of human-modified ecosystems. An agroecosystem is a natural ecosystem that has been modified, or arrested at an early stage of succession, an immature stage. This is a form of disturbance by humans.

In an ecosystem, humans are just one more group exploiting the system. But, in agroecosystems, humans are manipulating the entire system, that is, they are modifying the system and isolating it from neighboring systems. They do this in many ways, by: Simplifying the system by removals; managing the system with domestics; and harvesting the bulk of productivity. Each of these has effects on the system. Simplifying the system, or lowering diversity, allows fewer species in the system. Not just the crop species, but pest species. Crops are analogous to early colonizing plants, that is weeds, which exploit ephemeral resources following disturbance and maximize their seed output. Plowing favors crops that grow rapidly.

5.3.2.1. Changes in Diversity from Agriculture

The diversity of use narrows with agriculture. There are roughly 250,000 described higher plants. Perhaps 30,000 are known to be edible. Of those, about 7000 have been used as food by foragers and horticulturists, and only 150 have been used as important crops—but only 15 are used as crops to supply over 90 percent of agricultural foods. Three cereal crops—wheat, rice and corn—provide over 50 percent of protein. The early agroecosystems were more diverse. In 1949, Chinese farmers had 10,000 varieties of wheat. In 2002, 300 were used. In

Java, tropical gardens had between 100 and 350 species per hectare. Tree densities in Javanese gardens may be 2000 stems per hectare, with a biomass of over 120 tons per hectare. The Javanese used interspecific and intraspecific polyculture, that is, not only different species, but different cultivars of the same species, such as corn. Mathematical game theory shows that this strategy increases the chances of a good harvest.

Diversity is low because people try to plant monocrops. But, uniformity is also a problem. All individuals are the same kind, size, age, and use the same resources at the same time. It is a perfectly uniform predictable food source for insects and pathogens. So, there is no protection from diversity in genetics, age, and size. The selection of the cultivars for what we want to harvest has eliminated some defensive traits in wild plants. From a weed's perspective, it is a boringly predictable competitor for light and water. Weeds can compete because of the bare ground disturbance.

5.3.2.2. Changes in Disturbance from Agriculture

Disturbance can be created by ground disturbance, such as plowing. Energy is used to maintain the early stage. Soil carbon is also oxidized and lost with plowing, as are phosphorus and potassium, also. Plowing eliminates members of the soil community such as earthworms. Plowing also breaks down the soil types, so that erosion increases as the surface is exposed. Carbon, nitrogen, and phosphorus decrease from the upper horizons. Disruption inhibits mutualistic links such as fungi. With disturbance, energy and material subsidies are needed to be productive.

This limits efficient nutrient cycling, diversity, and resistance to disease. It ensures that the system will have low amounts of organic matter, small organisms with short life cycles and broad niches, open mineral cycles, undeveloped detritus communities and linear food webs. Nutrient flows are simple, one-way flows, from the industrial source of chemical fertilizers to outputs in harvested materials or mostly water runoff. Nitrogen for example, is applied in pulses and ends up being leached out. Applied fertilizer, usually anhydrous ammonia, which is oxidized to nitrates, can acidify the soil. Synthetic fertilizers inhibit the action of nitrogen-fixing organisms and detritivores, which work best when soil nitrogen is low. Erosion of the soil itself is a problem. Techniques expose the soil to wind and water at critical times.

5.3.2.3. Changes in Scale and Recycling from Agriculture

From an ecological perspective, there are regional consequences of monoculture specialization. Most large-scale agricultural systems exhibit a poorly structured assemblage of farm components, with almost no linkages or complementary relationships between crops and soils, or between crops and animals. Cycles of nutrients, energy, water and wastes have become more open, rather than closed as in a natural ecosystem. Despite the substantial amount of crop residues and manure produced in farms, it is becoming increasingly difficult to recycle nutrients, even within agricultural systems. Animal wastes cannot economically be returned to the land in a nutrient-recycling process because production systems are geographically remote from other systems, which would complete the cycle. In many areas, agricultural waste has become a liability rather than a resource.

Recycling of nutrients from urban areas back to fields is difficult. Part of the instability and susceptibility to pests of agroecosystems can be linked to the adoption of vast crop monocultures, which have concentrated resources for specialist crop herbivores and have

increased the areas available for immigration of pests. This simplification has also reduced environmental opportunities for natural enemies. Consequently, pest outbreaks often occur when large numbers of immigrant pests, inhibited populations of beneficial insects, favorable weather, and vulnerable crop stages happen simultaneously. As specific crops are expanded beyond their “natural” ranges or favorable regions to areas of high pest potential, or with limited water, or low-fertility soils, intensive chemical controls have to overcome limiting factors.

5.3.3. *Cultural Consequences from Agriculture*

How did agriculture affect culture in early Mesopotamia, for instance? Just as a result of irrigation? From changes in religion, from otherworldly gods to specialist gods? There are many general associated changes from shift to agriculture; they can be considered cascading effects from positive feedback loops. For instance, clearing larger areas of land and irrigating to transfer water to land lead to technological improvements in the channeling and manipulation of water. New tools extended efficiency. More crops required new ideas of storing foods. There were more innovations in general. Domestic animals were used to haul loads and then work in the fields for preparation or harvests. This required new kinds of digging sticks and new kinds of harnesses. The kilns for ceramics required more wood, which often came from newly cleared fields or transport from remote forests.

5.3.3.1. Agriculture & Population

Agriculture did produce one unexpected change. Initially, farming peoples suffered from increased sickness and mortality. But, they also saw greatly increased fertility. Populations in Europe increased one-hundred-fold. Of course, agriculture allowed people, by virtue of remaining in one place, to have more children than they could previously, in hunting bands, carry or travel with. So, the sedentism of agriculture allowed larger populations to exist in place. Furthermore, the nature of work meant that more children were useful for labor.

Population increased. Perhaps the fertility of women increased when they stayed in place. Being in place may have removed those controls from prolonged breast-feeding or sexual abstinence. Agricultural populations increased and spread, bringing their crops with them, pushing hunters into the periphery where crops could not grow. Once the initial agricultural startup costs were paid, such as truncated diversity and nutrition, as well as decrease in human size and health, other advantages accrued, such as specialization, creating a different form of political control, which allowed armies. Agricultural society now had a massive social advantage over foraging societies.

Perhaps related to population growth and size, have come changes in cultural status, especially related to equity, distribution, and dominance. Status has to do with standing in society, and with appearance and ownership. Status may come from longevity, of the self or ancestors, as well as from the results of good decisions, from hunting for example, or from owning more than others, or just more things or more people. Status is a powerful human need, and may drive the growth of goods or populations. As distribution becomes more unequal and as conflict occur more between groups, dominance and slavery appear, and are both related to status.

5.3.3.2. Population Size

The maximum number of individuals that an environment can support is its carrying capacity, which fluctuates with various factors. Physical limits may be absolute or flexible. Population control can either be accomplished through crowding, by the food supply, or by natural resources. There tend to be as many people as there are utilized natural resources for, and unpolluted room and food for. The greatest number of people over time implies that the living population be limited to biological carrying capacity. Any permanent destruction of carrying capacity to allow a larger living population implies a future reduction in population indefinitely, or until ecosystem restoration (if possible).

5.3.3.3. Property

Agriculture, by creating permanent places, allowed people to accumulate far more property than they could carry or put on a horse or buffalo—or move. This new property allowed people to have things that were luxuries rather than needs. It let them collect things that might normally be given away or reworked. Agriculture set in motion many kinds of physical and technical changes, that resulted in further social, economic and political changes (the consequences of agriculture are summarized in Table 5333-3).

Table 5333-3. Summary of Agricultural Changes

<i>Change</i>	<i>Economic change</i>	<i>Social/political change</i>
Seeds/resources	Trade	Standard value, writing
Manipulation	Increase size	Domestication dependence
Personal fields	Ownership, limits	Conflict / Protection / taxes
Working	Increase in hours	Scheduled work
Water needs	Canals	Cooperation
Sedentary lifestyle	Field exhaustion	Field expansion
Permanent fields	Settlement	Mobility decrease, Growth
Permanent settlement	Cities	Concentration, critical mass
Timing	Calendars	Schedules
Tools	Technology	Specialists
Specialization	Specialists	Pay, records
Distribution of crop	Pottery	Standard sizes, records
Surplus accumulation	Storage places	Protection, buildings
Property accumulation	Larger homes	Protection

Many of these are intricately related and developed out of previous changes. Trade, for instance, expanded from a few necessities, such as seeds or ochre, to many forms of tools, clothing, and luxuries.

5.3.4. *Minnesota Agriculture: The Fall of 2010*

By Dr. Michael W. Fox

My reading this fall of our excellent local newspaper, the *Star Tribune*, and the magazine, to which my wife Deanna Krantz, an alumnus of the University of Minnesota and I subscribe, gave me a picture of issues in agriculture which go far beyond this one state and the future viability of its economy.

5.3.4.1. *Food Animals First*

The cover article “Minding the Herd: Does Minnesota face a food-animal vet shortage”? (*Minnesota: University of Minnesota Alumni Association* magazine, Vol.10, No.1/Fall 2010) raises some serious issues, from the increasing lack of professional veterinary care for tens of thousands of farmed animals in some counties, to the ethics of public funds being used (along with some from the pharmaceutical industry) to recruit veterinary students into to this sector of veterinary practice.

The fact that most veterinary students have no farming background is surely beside the point unless we regard a dairy operation with some 7,000 cows as a farm and not an industrial system of animal production. Few veterinary students who care deeply for animals can accept the conditions and standards of dairy, beef, pork, poultry meat and egg production on these so called confined or concentrated animal feeding operations (CAFOs). Animals suffer varying degrees of crowding, restriction of movement and frustration of normal behaviors, and succumb to stress-related diseases. The relatively high rates of morbidity and mortality compared to those seen in less intensive animal husbandry systems are treated as production cost write-offs, such problems being cheaper to accept under the economies of scale rather than invest in changing the systems of production for the sake of the animals.

These CAFOs have become the epicenters for viral epidemics and food-born illnesses associated with overuse and misuse of antibiotics creating resistant strains of bacteria harmful to man and beast alike. CAFOs are point-sources for air and surface and groundwater pollution, (along with the chemicals in their wastes from over-fertilized and pesticide sprayed, genetically engineered corn and soy being grown to feed these animals). CAFOs have also polluted and impoverished rural communities by contributing to the extinction of the diverse nexus of smaller family farms which were once the back-bone of sustainable agriculture across the Midwest—and a renewable source of veterinary students and agronomists.

So why should state and federal public funds be provided to veterinary students who pledge to work in this sector of CAFOs for an agreed number of years—like military service—when it is in the best interests of society to phase out all CAFOs as a failed venture which cannot be rectified simply by more regulations, drugs, vaccines, and, (as is being proposed in the UK to deal with similar CAFO problems in the dairy cow sector) by better stockmanship and veterinary expertise. Instead, fostering the adoption of more humane, healthful and ecologically sound and sustainable farming practices would be a win-win situation for all, especially the animals. Providing state and federal funding and subsidies to encourage such farming practices would give long-term security to veterinary students who elect to work in the food animal sector, and enjoy a more viable and fulfilling/meaningful future by participating in the renewal of rural America.

But this may be another pipe dream of mine, to be dispelled, perhaps, by the disturbing

cloud above me that gathered as I read a review of the annual gathering of the American Association of Bovine Practitioners (In the *Journal of the American Veterinary Medical Association*, October 15, 2010, p.866-868) to learn that certain veterinary procedures and treatments, once the profession's exclusive service-provisions to livestock farmers and horse owners, had been legally re-classified as animal husbandry practices in Oklahoma. An attempt to do the same in Iowa did not get out of committee which is a good thing surely for the animals. Such legislative initiatives to remove routine animal care from state veterinary practice acts are indeed alarming. But this is the ultimate way of the CAFO system which organized veterinary medicine still supports to its ultimate nemesis. Stock-keepers, for economic reasons, take on a para-veterinary role in these operations, and should have some State University certification perhaps. It might indeed be wise for State Veterinary Colleges to develop para-veterinary courses in animal husbandry, behavior, health care and welfare to certify the operators and animal care supervisors working in CAFOs, certification being mandatory 3-5 years after such state and federally funded initiatives are implemented

That pig, poultry and cattle producers, along with other non-veterinary trained persons, including CAFO executive boards, investors and managers, or their designated proxy, be it a drug salesman or equipment demonstrator and distributor, (like the "stock-still" electronic livestock immobilizer from Australia, the paralyzing charges of which company salespersons allowed me to personally experience) are converging to exclude the veterinary profession except for their expertise as teachers and consultants on farmed animal health, disease prevention and welfare is good business for them. Being occasional performers of life-saving surgery, life-giving obstetrics, and life-respecting treatments of animals, veterinarians in the food-animal sector have vital animal health and welfare expertise that no economic system should exclude. Very few, without veterinary education and in-field, on farm work, are sufficiently qualified, be it by education or experience, to execute: except at the behest of those powerful influences, financial and ideological, that market ever more directly, their drugs, vaccines, animal sperm and genotypes, and patented GM seeds.

The penultimate paragraph in this cover story in the University of Minnesota magazine has the featured, Diet Pepsi drinking veterinarian, driving an average of 134 miles per day with snacks on pastries in his truck, lunching at McDonalds. I wonder how soon this hard-working and well-intended man will finish up at the Mayo Clinic in Rochester, where a couple of decades ago I gave a talk at the University of Rochester about the problems of CAFOs, and found that the University had got the word out to the local book stores not to carry any of my books addressing these concerns!

5.3.4.2. *Consumer Health & Safety*

An example of valiant public assurance is exemplified by the excellent *Star Tribune* feature article "The fight to keep your burger safe from E. coli" (September 12, 2010) which details what Minnesota-based multinational agribusiness corporation Cargill Inc. is doing to rectify this one of many dysfunctional aspects of the industrialized farm animal production, including the use of a vaccine being manufactured by the Willmar-based EpiTopix company to control this particularly lethal to humans strain of *E. coli*. 0157:H7. But there are other harmful *E. coli* strains on the way, which could mean the federal government will next mandate the irradiation of beef and other animal products, giving the public every assurance that the benefits are far greater than the risks.

Applying computer technology information matrices as a very costly digital system to speed up unsafe food recalls (as per P.J. Huffstutter's *Los Angeles Times* article, published in the *Star Tribune* October 20, 2010). This new application, which some big food companies like Dole Food are developing and applying, is integral to implementing the Bioterrorism Act of 2002, safe food provisions. But no matter how more efficiently, immediately and successfully future food, including pet food recalls may be implemented, the first wave of food poisoning will be the first unstoppable alarm which could have been avoided and never need switching off; along with the millions of tons of nutritious, but contaminated and spoiled foods that are discarded every year.

As a graduate veterinarian with doctoral degrees in medicine and ethology/animal behavior, it is my opinion that neither the veterinary profession nor the medical and related professions can be purely science-based and value free. Values based on the bioethics of compassion and respect for life, which are ecologically centered and socially just rather than money-driven, may be the simple and yet elusive antidote to such problems raised in this cover story from a land-grant university. The original mission of such institutions, under such legislated funding as the Hatch Metcalf Act, was to benefit rural communities. One may sympathize with those producers who have invested in capital intensive food animal and commodity crop production, but their continued presence, expansion and consolidation under publicly funded state and federal subsidies, and tax write-offs and feudal corporate hegemony, does not serve the best interests of civil society.

5.3.4.3. *Protecting the Environment*

Ironically the *Star Tribune* published a lead article (September 22, 2010) about a University of Minnesota vice president of University Relations "in hot seat over film" that was a university-produced documentary about farming, pollution and the Mississippi River, which she blocked from being shown. Her ruling was subsequently overturned and public viewing of this film "Troubled Waters: A Mississippi River Story" was rescheduled.

Putting corporate and other vested interests before the public good is a problem of the times. But the deeper rationalizations and denial, especially with regard to the plight of the animals in CAFOs, and the hidden cultural, socioeconomic, public health, animal welfare and environmental costs of the agribusiness food industry, call for censorship: A censorship not simply of land-grant colleges and their mission and allegiances, but of the kind of society we have all created and continue to support with our dietary choices, tax dollars and donations to alumni and other 'non-profit' associations and organizations, both secular and religious.

Brad Schrade's front page article in the Oct. 24th *Star Tribune*, entitled "State lags on fixing farm pollution" is a devastating documentation of the almost total failure of a 10-year, 2000-2010, state funded program under Minnesota's Pollution Control Agency to significantly reduce lake and stream pollution caused by the animal waste run-off from beef feed-lots and dairy cow operations. There should be a public registry of which states are polluting the headwaters, tributaries and wetlands of our great rivers like the Mississippi, Crow and Minnesota, which are under the stewardship and trust of state land users for the benefit of all beyond their immediate communities of vested interest, especially in those lower states receiving spoiled river water from the north. Clean-up time for U.S. Army Corps of Engineers, from the Everglades to the Great Plains, is also long overdue, along with prairie, wetland and forest/watershed restoration.

The costs of sustainable agricultural recovery must be born by all, with a carbon 'footprint' and environmental impact tax on all consumables, revenues being directed toward ecologically regenerative, non-GM biofuel and biofood research and development.

While organizations like the Cato Institute press for long overdue reforms in federal spending, noting that "Far from 'saving the family farm', federal agricultural subsidies are environmentally destructive corporate welfare, with more than 70 percent of aid going to the largest 10 percent of agribusiness", the assault on reason continues. One shining example is the solipsistic journalism by Greg Breining (*Star Tribune* Sept. 19, 2010) whose article entitled "The Big Picture Environmentalist", dismisses environmentalism as "romanticism" if it does not embrace genetically engineered crops, dismissing organic farming as "a minitrend at best"

Cargill Inc. again made the news in a report in the *Star Tribune* (Sept 14, 2010) about public protests over this company's links with the an Indonesian palm oil exporter responsible for the wholesale clearing of rainforests—critical wildlife habitat for several endangered species including the tiger and orang-u-tang—to produce more palm oil for export to the U.S.

Agribusiness apologists use scientific half-truths to further their agenda under the rubric of reason and concern about 'feeding the hungry world' to misinform the consumer public. Yet it is this same food industry that has necessitated more research into why there is an obesity epidemic in such epicenters as Minnesota, with public funds being used to address this one of many facets of main-stream dietary and agricultural pathology. I termed this predicted outcome of industrial agriculture '*Agricide*' in a book of the same title, published over two decades ago, and which was banned in the book stores in Rochester MN.

5.3.4.4. *Genetically Engineered Crops & Foods*

The *Star Tribune's* decision to publish an Associated Press article on October 7, entitled "‘Good neighbor’ corn fights borers at home, nearby", I found especially disturbing. Perhaps its publication was justified by the fact that the senior author of the research cited came from the University of Minnesota. Five other co-authors of the report (Hutchison, W.D. et al. *Science* 330:222-225, 2010) have direct ties with big food and agri-business companies, including Minnesota-based Syngenta and General Mills from which part of the funding of this widely publicized research came in addition to State and Federal funds from public tax coffers.

The conclusions of this study, claiming that the planting of corn genetically modified (GM) to produce its own pesticide to kill corn-borer moth larvae actually benefits farmers growing conventional varieties of corn, and vice versa, is an example of inverted logic and scientific reductionism. Another way of interpreting these conclusions is to see confirmation of *collateral damage* from GM corn crops that now make up a reported 63% of the U.S. corn harvest particularly in mid-western states. No mention is made of genetic contamination of conventional and organic corn crops by the pollen from GM corn.

Other than the corn borer moth, which has become a serious pest with the dedication of vast acres of land to conventional hybrid corn production, there are other insect species, many beneficial, some probably helping control the corn borer, and also providing food for birds and other wildlife, that fall victim to this killing 'halo' effect. Herbicides used on herbicide resistant GM crops harm soil microorganisms and interfere with plant uptake of nutrients, the economic, ecological and consumer health costs of which were not computed in this study.

It is noteworthy that the scientists' original report stresses that planting conventional corn varieties helps reduce the population of another corn crop pest, the corn earworm, which

quickly evolves resistance to Bt toxin when corn fields are 100% GM and produce the Bt toxin. GM crops accelerate the evolution of resistant strains of insect pests which monoculture, commodity-crop production systems foster.

To reason that since Bt insecticide-producing corn lowers the population of the corn borer larva population, which benefits conventional corn crops, is still a flawed and biased argument to justify the planting of Bt producing, genetically engineered corn. I see such reasoning as the proverbial last straw left to justify the planting of GM crops that have no place in sustainable agriculture or a sane society. Yet their planting, especially in the Midwest, continues to expand, the 'corn mafia' having secured a legal mandate in Minnesota that gasoline must contain 10% ethanol from their corn, which means increased feed costs for state pig farmers: And wholesale gasoline blenders get a tax credit for using corn ethanol that makes it cheaper than pure gas, according to reporter Neal St Anthony (*Star Tribune*, Oct 16, 2010), who notes that the left-over waste is a high-protein distillers grain that is used in animal feed, and that corn "Ethanol is the *transitional* fuel to 'cellulosic fuels,' such as prairie grasses and waste products being pursued by research universities and the ethanol industry." (italics mine).

A vision of human progress beyond the profit motive is called for, within the enlightened bioethical vision of not harming others, be they human, animal, micro-organism or plant, each living in their bioregions that celebrate in their presence and participation the biological and cultural diversity of a viable life community on this planet Earth. The alternative, plant-based economies of future energy/fuel, food and fiber, even medicinal botanicals (that are not GM) are emerging, as per the rapid development of the Corn- Ethanol industry. To the Mayans and other pre-Columbus indigenous peoples of the Americas, corn, or maize as they called this life-sustaining plant, was a sacred gift of the gods. They found many uses for this plant other than as a food or animal feed, which they cultivated for millennia, along with a host of different varieties of beans and other pulses and native, once wild foods, notably the potato and squash. But now their maize has become a patentable commodity for those who live in the absence of the sacred in a world made profane by the market-driven imperatives of world trade and scientific hubris of the industrial age. Some of their heirloom varieties have been genetically contaminated from the drifting and insect-born pollen from neighboring GM crops.

As for the widespread use of herbicides like Monsanto's Roundup (glyphosate) on GM-herbicide resistant soy and the 'mystery' of Minnesota's deformed frogs reported some years ago, new research has shown that this herbicide does cause birth defects in frog and chick embryos at doses far below the maximum residue levels in products presently approved in the European union, and may be linked to the high rate of human birth defects in rural areas in Argentina where Roundup resistant fields of soybeans are regularly sprayed with this herbicide from airplanes. (Research reported in *Acres USA*, Nov, 2010, p 10).

In its Fall of 2010, Minnesota agriculture was put in a tail-spin by a federal judge barred the planting of GM Roundup-resistant sugar beet until the U.S. Department of Agriculture does a full-scale review of the seeds' environmental impact, according to reporter Mike Hughlett (see *Star Tribune* Exclusive article, "Already Beat?" Oct 17, 2010). The Obama administration approved the planting of these seeds, and now 95% of all sugar beets are GM, and according to reporter Hughlett, stocks of conventional seed are old and insufficient to meet next year's needs. This is the underbelly exposed of the major multinational seed, drug and chemical companies like Monsanto, Syngenta, DuPont, Bayer, Land O'lakes, Dow Chemical and Limagrain, that have bought up small seed companies in order to monopolize

and control what kinds of are marketed globally, namely, their own patented GM varieties.

Surely it is time for the human species to become a creative participant and not a blight or parasite to the Earth community whose origins we do not know beyond what religion, philosophy, science and poetry may intimate, and whose future is now in the hands of the powers that be.

Incomes are generated by dysfunctional systems to find solutions, which are illusory if the systems themselves are never changed. Einstein's observation that the problems we face today cannot be changed by the same consciousness that created them in the first place is something for institutions like the University of Minnesota to take to heart: And to take the initiative to bring change where corporate sponsors may fear to tread, if not decry until there is enlightened self-interest in the creation of win-win possibilities for all.



Figure 5344-1. Typical US Midwest Cattle Feedlot (M.W. Fox)

5.4. *Evolution Agriculture & Urbanization*

There seems to be an evolutionary trend towards the control of ecosystems, especially artificial ecosystems like agricultural fields and cityscapes.

5.4.1. *Evolutionary Conjecture*

By Paolo Soleri

Observations on the American Empire followed by observations on the human condition that the U.S.A. is typifying. Then, how this may impact human evolution. A conjecture about a possible split along a Dionysian-Apollonian fissure, eventually resulting in two separate arms of evolution and the total estrangement between the two: Apollonian-Dionysian man and Apollonian man.

5.4.1.1. American Empire Today

In about 300 years the vast and sparsely populated North American continent has become a nation of about 300 million industrious people: Empire U.S.A. It has been a stupendous, exhilarating, self-contradicting self-creation, full of joy and suffering. Pride of *Homo faber*–*Homo sapiens*. Five powerful drives are endangering the Empire:

1. GREED. Lifestyle saturated by low-grade opportunism (hermitage generated).
2. MATERIALISM. The pursuit of wealth at the expense of worth (hermitage confirmed).
3. TECHNOCRACY. Iconized technology.
4. XENOPHOBIA. ‘The U.S.A. as the greatest empire that ever existed.’
5. IDOLATRY. Worship of idols: Sun gods, Brahma, Yahweh, Christ, Buddha, Mohammed, and others.

In a minor key: the Mighty Dollar, Guns, Automobiles, and Trivia.

5.4.1.2. Self-Creation

The cosmic dust generating from the Big Bang, not being totally homogeneous, causes the ever-changing space geometries witnessed in the cacophony of cosmic reality. When microbags of cosmic dust acquired the faculty of volition and binding (*religo*), in these immensely complex-miniaturized zillion specks of agitating geometries, the first organisms came about, and the self-creation of life began its evolutionary adventure. All life is partaker in this astonishing feat. The bug, the fish, Fido, you and me are members of it, and as self-creation and creators we are eternal. Since self-creation cannot undo itself, as the past itself cannot, all events down to their “infinite” minuteness are not undoable, that is, they are “forever.”

5.4.1.3. Homo Multiplex

Here I list thirty or so *Homo* variations, all comprised in two kilos of furiously animated matter, our brains. I think all of us are possessed by all these faculties in different dosages. *Roba da matti*, we say in Italian: “crazy stuff.” Only through the Darwinian rules of survival (the law of the jungle) can we glimpse into the marvel of self-creation. This is a fragmentary and incomplete list of what is in each person from conception throughout life and death. It is a minimalist way of presenting the exhilarating and frightening ways of the self-aware hominid:

the persona.

Table 5413-1. Developmental Sequences of *Homo sapiens*

atrocious man	<i>homo atrox</i>
cannibalistic man	<i>homo hominibus vescus</i>
capable man	<i>homo habilis</i>
convivial man	<i>homo hilarus</i>
creative man	<i>homo creator</i>
cruel man	<i>homo crudelis</i>
demonic man	<i>homo daemonicus</i>
despairing man	<i>homo exspes</i>
dramatic man	<i>homo scaenicus</i>
envious man	<i>homo invidus</i>
erotic man	<i>homo amatorius</i>
erring man	<i>homo errans</i>
esthetic man	<i>homo formans</i>
family man	<i>homo familiaris</i>
hedonic man	<i>homo voluptarius</i>
idolatrous man	<i>homo idololatres</i>
ignorant man	<i>homo inscitus</i>
innocent man	<i>homo innocens</i>
inventive man	<i>homo faber</i>
knowledgeable man	<i>homo sapiens</i>
legal/forensic man	<i>homo forensis</i>
libidinous man	<i>homo libidinosus</i>
loving man	<i>homo amor</i>
maleficent man	<i>homo maleficus</i>
miserable man	<i>homo miserabilis</i>
moronic man	<i>homo stolidus</i>
mysterious man	<i>homo clandestinus</i>
noble man	<i>homo nobilis</i>
opportunistic man	<i>homo male moratus</i>
playful man	<i>homo ludens</i>
predatory man	<i>homo praedatorius</i>
rapacious man	<i>homo rapax</i>
trivial man	<i>homo trivialis</i>
.....	

5.4.1.4. Idolatry: From Icon to Idol—The Monistic Position

I position early man/woman in a mysterious and often overwhelming environment. As survivalist animals coupled for the sake of offspring, and as first class opportunists, we propitiate “mother nature” by engaging in endless dialogues with her. From her we carve out icons: the bee, the rock, the cloud, the seasons, the volcano, the tides, the rose, the sequoia, the ancestor, the fire, the moon, the tyrant... But, the dialoguing is monologing and this simple fact is why iconizing eventually becomes idolizing, whence idolatry is born and is attentively cultivated.

Caveman, engaged in the dialogue-monologue, dealt with the interlocutors, himself and the identity he addressed. The spider, the lizard, the bear, the tornado, the water spring, the moon, the starry sky, they were all responding in their way and power. From this unending illusion developed a world of imagination not governed by any rational, logical contextual coherence. It is pure invention, as such can reach into poetry and passion, reach into dramaturgy and the inspired intensity it feeds upon. The icons become instruments necessary to the performance. The icons become idols, the invented gods, a pantheon of loving, capricious, homily, regional, universal, brooding creatures, disposable most of the time, but often tyrannical and vengeful: the notorious gods of rage and destruction (Moses' God).

This elementary and creative sequence full of imagining and emotion is soon invested by cunning and parasitism: *Homo invidus*, *Homo praedatorius*, *Homo rapax*, *Homo voluptarius*, and so on generate the opportune vehicles from where lifestyle and cultures succeed one another: theocracies, pseudo-Darwinian cultures, Vaticans, Meccas, Wailing Walls, Lhasas, Ganges, are most tenacious today, determinant and predominant, an unfortunate quirk within the portent of self-creation.

My minimalist-monistic take on the phenomenal theological imbroglio pleads for redemption of the idolatry it finds there. The redemption is inscribed, or one could say, incarnated, in the estheto-passionate nature of the whole of it. Theology is dramaturgy and as such is a creational sequence making the human inroad into knowledge and grace a transcendence of life original spark of volition-“religion” (intent and binding). As self-creation seems unstoppable and as much as it is not predesigned, it defines the trueness of its own self-creation and as it becomes it has to count on its conservatism, the basso continuo of its music.

5.4.1.5. Apollonian Rationality and Dionysian Passion

If the technocrats are right in believing that soon they can generate thinking, so-called artificial intelligence, that is, volitional machines, then frictions will develop between technocrats and humanists. Given that the humanists are the creators (fathers/mothers) of the technocrats, and given as historical fact that the gratitude of offspring is short lived, the initial friction will develop a not so generous confrontation. We are already in that minefield. Optimism suggests that *Homo sapiens* evolving into *Homo sapiens sapiens* will reach new levels of knowledge and grace to cope with the ruthless offspring. One alternative is to accept the inevitable: the evolution in parallel of *Homo* humanist and *Homo* technocrat, maintaining perhaps instrumental connections and all the expediences necessary to succeed.

Reality might have room for two evolutionary strands, in the extreme case that the initial divergence between the two would result in two separate realities. The vastness of space allows for radical estrangements. New sets of myths could trace back in connection to the once single human reality, both sets belonging to the roots of self-awareness emerging from living awareness. A cyborg evolutionary phase could be a bridge between the two.

The evolutionary split diagram acquires merit only if and when silicon, or equivalent, develops Apollonian faculties of self-creation now only possible in the carbon cycle of space geometries, that is, through the knowledge and passion present in *Homo sapiens*, *Homo amor*, etc. The evolutionary process now guided “by the hand” of reason (Apollonian) and passion (Dionysian) is possibly emerging into an unheard-of branch of passionless reason, anticipated in the virtual realities developed by new computer-science technologies. In other words Dionysian life, “debugged” of passion, may generate a new evolutionary branch of reality, the

purely rational Apollonian branch.

All the while rational-passionate man, the carbon arm of its own evolution, has developed in parallel with science two fictional fields of endeavor: the theological fiction and the esthetic fiction. The theological fiction is an unintended fiction. The esthetic fiction is intended fiction. Theological “truth” is delusional, under the spell of idols we have invented by the thousands through our long peripatetic, dramatic history, dropping them by the hundreds when “convenient.” (See *Homo* list.) This congested pantheon, based on a creator-creature dualism, promotes the crucifixion of *Homo sapiens*.

But in reality the theological fiction is a reticent part of the esthetic arm of *Homo dramatis*, the most telling aspect of *Homo sapiens sapiens*. In fact the liturgies expressed by all cultures constitute the esthetic treasure of *Homo sapiens*, contextualizing in the arts, treasures that glorify evolution. The esthetic fiction covers all media: from stone to paper, from ground stomping and howling to music, from grunting to love poems, from dabbling with pigments to frescoes...and the new technological media infiltrating them all. Mixed in among the fictions called “great religions” are also numberless trivial private gods and their idiosyncratic themes manifest at art fairs.

5.4.1.6. An Evolutionary Split?

Taking for granted the self-generation of inanimate reality, and nested in its 13 billion years, the 5 billion years of self-creating life, evolution has put her eggs in the volitional-religious nest. The rule of survivability made so evident by Darwin, has been indented by the self-aware character of the hominids. The hominid has been evolutionarily creating itself by “inventing” itself **as** a rational-passionate phenomenon.

This evolutionary achievement, possibly the greatest in all creation, has generated in itself the possibility of an evolutionary split. *Homo faber*–*Homo sapiens* is now presenting to itself the possibility of a sapience not in need of passion. Rational-passionate man is prompting, of its own volition, the advent of purely rational intellection. This would mean evolution splitting in the rational-passionate self-creation and the rational self-creation purged of passion.

The Apollonian-Dionysian distinction of the clairvoyant Greek brain contains the prediction of a long marriage and conflict between reason and passion. We are now on a sort of divorce incline. Could it be an amiable separation or a separation of divergence? An evolutionary bifurcation?

Would the evolutionary split be in parallel or would it be in divergence? Given the spatial enormity of reality, explosively enlarging itself (many selves?), divergence might mean absolute estrangement. The enfeebling of reciprocal “familiarity” would be in the memory of a past where reality generate the carbon phenomenon that in turn generates silicon...that in turn might work at making the carbon as part of the museum of self-creation: from the minerality of the universal space to the detailed generation of the carbon cycle, creating itself and in turn sparking the silicon cycle now “filling the waves” (keeping mindful that anything that happens is immortal: it cannot unhappen).

If this were to be so, the task of the Dionysian, the flesh, could have been the indispensable go-between: the meaningless cosmic reality generating a meaningful becoming, but no longer dependent on the Dionysian passion: the Apollonian transformer of meaningless into meaningfulness and the grace that it implies. What of Dionysius, the evolutionary process

lodges between the meaningless and the meaningful via the flesh? By the end of the biosphere life has to migrate to another hospitable “terra firma.” If it can do so it will be courtesy of the Apollonian knowledge and its technologies embroiled for now in the passionate branch of evolution.

Carbon intellection versus silicon intellection. The great divider and/or victim? The passionate. Given the “implausible” nature of the passionate, the carbon cycle is fragile, brittle at times. This is disadvantageous vis-à-vis the sequentiality of the logical impassionate (silicon cycle). The female as creator of new life might be the arbiter if the “confrontation” results in complete estrangement. In other words the female cannot survive the withering away of Dionysius.

Parenthetically this is where hermitages acquire evolutionary significance: the early hermitage as the gymnasium of loneliness, attempts, as the equivalent of pumping iron, of muscle building (and binding), to anticipate the Apollonian arm of evolution.

The medium of carbon intellection is the city, the Urban Effect. The medium of silicon intellection can be the universal hermitage. Packets of passionless intellection scattered across reality. But the Urban Effect indispensable to carbon evolution is unnecessary in the hermitages of silicon evolution. Lack of passion in the silicon formulas is at present fundamentally the obstacle to the purely Apollonian (silicon) branch of evolution.

The degree of complexity in and of the organic (carbon cycle) is for the moment immensely greater than in the inorganic (silicon cycle). Billions of years of exertion in self-creation remain an unequaled experience to date. With respect **to** miniaturization, silicon is for now a pale emulator of its formidable parental premises (carbon). In addition, it is an instrumentality in search of context that probably only the grace of passion can deliver. The elegant instrument (silicon domain) is not yet capable of esthetic transcendence. The first logical machine, serenading whatever, will be the threshold into a new grace. Will it be able to do that non-passionately?



Figure 541-1. Paolo Soleri at a Youth Panel at Arcosanti

5.4.2. *The Split & Reapproachment between Urbanization & Agriculture* (Being edited)

5.5. Regional Design Factors: Urbanization & Civilization

A city is a place where a large number of people live permanently. The classical city-state was a place where the citizens depended on and maintained the whole, which cared for and outlasted the individual. The Stoics declared the cosmos to be the great city “of gods and men.” The citizen became related to the cosmos as a whole, in the same way. For those in Mesopotamia, the whole city, and not just the temple, was conceived as an earthly imitation of the cosmic order, a sociological middle cosmos, established between the macrocosm of the universe and the microcosm of the individual. Through the priesthood, the one essential form of all was made visible. The early Sumerian temple tower, with a hieratically organized city surrounding it, became the model for the Hindu world mountain Sumeru, for the Greek Olympus, for Aztec temples, and even for Dante’s Purgatory. The Sumerian city was organized in the design of a quartered circle. This design has been a favorite for cities and utopias, as well as for many cosmologies.

5.5.1. *The City as a Regional Ecosystem*

The city was an adaptive exploitation of shifting environments. It was an adaptation to an ecological niche and a cultural niche. At first, cities allowed for the coexistence of hunters and herders with the local farmers and residents of the city. The city is exploitation of a geographic site, which has a multilevel history from geology to plants and humans. The structure of a city might be like a cell, a specialized structure with a transmissible memory in the nucleus. Or like a sponge; the city cannot use sun to get energy, but must use surrounding environment (plants) and other organisms in the water. Sponges must circulate food brought in, using energy from that food. A city has own metabolism, that is, a network of circulatory structures used for exchanges. Water and wood (energy) are carried by channels to cells of organism (homes in this case). Channels also carry wastes.

As an ecosystem, a city has fewer plant and animal species. Many factors influence its balance with its environment. Water flow is a factor affecting the landscape. Household wastes are another factor. A network of corridors perforate the landscape; the number of small patches increases, and there is a reduction in other kinds of patches and corridors. Flows include energy, information, people, materials, and pollution. The net productivity of the city ecosystem is negative, due to massive imports of food and energy.

The size of a city grows, apparently without limit. During the mass migration from 1800 to 1991, urban population in developed countries rose from five percent to seventy-three percent. A mass migration in less-developed countries, from 1940 to 2004, the city population rose from three percent to over fifty percent. As cities increase in size, there is less flexibility for change. Land use planning and design becomes more important.

This size expansion has caused problems, effects, and side effects—that is, main effects that are unwanted or unanticipated. Villages lower connectivity to the landscape by increasing patches and corridors. Agriculture gets more homogenous, decreases fallow areas. Stream corridors are destroyed by environmental degradation. Connectivity is lowered, the matrix is minimized. The nutrient mineral cycles are disturbed. The atmosphere is disrupted, resulting in drought and storms. Microclimates change, with heat islands and dust domes. There is lower photosynthesis and productivity, with lower diversity leading to homogenization

(with cosmopolitan species) and inefficiency of use of energy and materials, and decaying infrastructure (roads, sewers, buildings, houses).

Urban ecosystems and agroecosystems, however, are less resilient than natural ones, due to the constant expenditure of human and fossil energy to maintain them. Cities need the environment for resources, food and water, and they tend to spread over several ecosystems, sometimes dominating an entire landscape with structures and the support network. People in cities tend to organize the environment by controlling markets and transportation on which the agricultural systems depend. Cities also produce large quantities of waste that have to be absorbed or sent to other systems out of sight (in quantity, wastes become an artificial, eutrophic ecosystem or an artificial system that cannot be broken down by natural processes). Cities pollute air and modify climate. They are heat traps by absorption of solar and the production of heat, creating heat islands.

5.5.2. Changes from City Living

The benefits of agriculture led to a series of innovations, such as specialization, where some people worked only to make tools or build granaries. Another early innovation was the standardization of measures, to distribute grain equally to those who specialized. Writing was developed to keep track of accounts (or sometimes ancestry or astronomy). As people settled in one spot, usually near water, surrounded by fields, housing became more densely packed. The unorganized ensemble of people transformed itself into an organized structure that sorted information and used more energy. Eventually, by attracting more people, villages grew into cities, and new specialists started to lay out houses and streets on a grid, sometimes bringing in water to each house and carrying wastes into separate channels. As space in the city was organized, so was time, so that specialists would not need the same resources simultaneously.

Life changed in predictable and unpredictable ways. People had permanent, stable houses in a denser area—there were impressive public buildings and monuments nearby. People could acquire more property and trade for some luxury items. They had leisure time for doing nothing; intoxication was literally on tap, as every house had a still for making ale. Some changes, however, were less desirable. There were more people and more crowding, with a greater threat of violence and disease. More work was required, in new professions, also, so there was less overall leisure. The distribution of wealth became skewed. Records were kept of every transaction. Styles of art were limited by royal or public choice.

Despite advantages and disadvantages, the city provided a critical mass for inspiration and invention. The number of people multiplied the number of connections between them. The city evolved with regular intervals and new phases of complexity, although the evolution was discontinuous over generations, as cities collapsed from environmental change or social failures, and people returned to hunting or herding until conditions became stable again, and crops could support dense settlements again. Each advance was based on previous accomplishments, so cities did keep growing and becoming more impressive.

Cultures and families were changed by city life. The nuclear family stayed important, but the extended family was replaced by a network of professional acquaintances and friends. Individuals became responsible for decisions to start a family, or to buy or sell possessions, or to move to another city. The prescribed behaviors of traditional culture were replaced by uniform laws and guides that applied to everyone.

5.5.3. *Discussion of Cities: Ideal or Trap*

Is the city a human ideal? An environmental ideal? It can offer ideal environments, as well as different kinds of physical environments, from streets, and squares, to religious monuments and parks. What is it about a city that commands awe? Increasing populations can lead to intensification of production, through labor or mechanization. Is the city a trigger for intensification? Interdependence becomes overconnected and then a trap. First cities were of bricks and concrete. John Thackeray thinks that cities are held together now by human attention spans, which may be more gaslike than solid. The technology that dominates attention, such as the wireless infrastructure, just adds a new layer, as people still live in brickworks. Certainly, the city has always been an incubator of new forms and ideas. And, the medium for cultural transmission has been ideas, more than genes or bodies. And, there may even be standard units of cultural transmission by imitation, such as memes (Richard Dawkins' phrase for the unit of transmission; see section 7.8 for a more detailed discussion), of which cities, agriculture, and fashions are examples.

How did cities start? Was a town formed by neighboring villages? Thucydides used the word 'synoecismus' to refer to the union of several towns and villages under one capital city. Was the city a result of technology—The wheel, cart, or metallurgy? According to Rod Brooks, cities started from a subsumption architecture of organization, where higher levels of behavior subsume the roles of lower levels to take control (also called bottom-up organization). So, people start with villages, and get the kinks worked out; who lives where? Who does what? This fits with the idea that cities were adaptations to permanent siting, slow overpopulation, and changing environmental conditions.

When the villages are working, you can make a few towns. Coordinate the logistics of streets, sewers, water, lights, and law. When the towns are successful and reliable, you can make a capital city, adding a layer of law, taxes, schools, maybe trading and heroic institutions. The cities can be combined into a state or empire, which has new responsibilities, such as taxes and international affairs and defense. The empire subsumes the other levels, but lets them operate independently. Of course, there are advantages in the group. And there are further emergent structures. Especially international trade and forms of education. Of course, at some point, the cities are no longer adaptive to the environment.

How do cities end? Abandonment? Collapse? If the top level collapses, the others can continue to function. This is what happens with certain kinds of collapse. How does civilization steer? Does it push or pull? Pushing can result in a backlash or revolt. What is best for the individual is not always best for the species. What is best for the person is not always best for society.

Is it possible to have cities without states or vice versa? A city is an adaptation to keep economic surplus in one place. A state is a political unit governed by a central authority. Like a city, a state has to delineate rights and responsibilities for citizens, regulate social relations, e.g., marriage and family, support a religion or ideology, integrate networks of communication and transportation, control redistribution, control punishment, and have a monopoly of police, military forces, and weapons.

How is size important? Is centrality important? Ancient big cities included Uruk (10,000 to 40,000) and Harrappa (20,000-25,000). Mohenjo-daro of the Indus Valley Civilization was one of the largest, with an estimated population of 41,250. Later, Nineveh and Carthage each had 700,000. Alexandria was large (~400,000 by 32 CE). Rome had an

estimated population of 1 million by 5 BPE. Baghdad exceeded a population of one million by the 8th century PE. The largest cities now include Tokyo (28,025,000), Mexico City (18,131,000), Mumbai (18,042,000), São Paulo (17,711,000), New York City (16,626,000), Shanghai (14,173,000), and Lagos, Nigeria (13,488,000).

The best cities are no longer the largest. The best are considered Vancouver, Zurich, and Copenhagen, which are usually less than 2 million. For a long time cities required larger numbers of people to be intense enough for stimulation and creativity. But, now new technology provides the stimulation and could allow cities to be significantly smaller, perhaps only 10 or 20 thousand. A growing population creates environmental resistance to itself, in the form of reduction in the reproduction rate as the population approaches carrying capacity. Due to various time lags, e.g., to increase when conditions favor or to react to unfavorable crowding, the density can overshoot the capacity. Human population is controlled to some extent by self-crowding. The overshoot has to be on a local scale, never on a global scale. The Russian geochemist S. Vernadsky concluded that the property of maximum expansion is inherent in living matter as it is for gas expansion or heat distribution (and ideas in cities?). The pressure of life can be measured in terms of velocity. For cities, immigration can increase fast and cause overshoot and subsequent oscillations. But, what if all cities were to overshoot simultaneously?

Is there a trend to larger cities? Should it be continued? Should arcologies replace unplanned cities? What about limits or nesting into optimum size groups? The degree of aggregation, as well as overall density, which results in optimum population growth and survival, varies with species and conditions (this is Allee's Principle); undercrowding, as well as overcrowding may be limiting. Aggregation can enhance group survival. Fish in a school may tolerate higher doses of poison than individuals. Bees can create more heat to survive than individuals. Applied to humans in cities, aggregation is beneficial, up to a point. But, bee or termite colonies can get too big.

How important is connectivity? Cities are unavoidably entangled in global nets, now. Cities used to be limited by the local carrying capacity. With global nets, self-correcting feedback can take too long. Localization makes feedback visible and more immediate. It would make more self-reliant cities.

How can we look at humanity? First we were wolves, catching animals and eating them. For thirty thousand years. Then we were cows, standing in places eating grasses, for ten thousand years. Now we are termites, swarming over everything in furious dances of labor and status, for the past five thousand years.

Are we urban by nature? Have we changed from hunting to urbaning? Of course, we may be preadapted for cities. We are clever social animals. We prefer edge habitat so as to move between other habitats. Urbanization is a characteristic of an edge species. Civilization produces edges that people like. Wilderness is fragmented into islands and patches. So, there is no more deepness, no more interior to wilderness. What are other edge species? Raccoons, coyotes, crows, and rats.

We are foragers and predators. What are the needs in human nature that a city answers? Perhaps the city is what wilderness was, according to E. Eisenberg, a place of passage, a place to be brave and test yourself. Humans have always worked to abstract their specialness. The city seems to be another myth of separateness and independence from nature. The city is the laboratory of human creativity, kept apart from the mother of nature. Lewis Mumford saw city

life as a compromise between the hunting stage and the farming stage. The female principle of home is wed to the male principle of predation. Perhaps the city is a throwback to hunting. People are more likely to wander, and are less attached to a place?

Are cities unnatural? Is urban living a preadaption? We are of course social animals. We prefer edge habitat. We are hunters and foragers. Why is the city growing everywhere? Especially Africa, South America and Asia. Manchester and Detroit are being abandoned.

Are cities declining? Certainly, there has been a decline in the quality of living spaces, irrespective of energy or resource use. Some cities have declined in population as areas of a city are deserted. The decline of cities due to the replacement of creative architecture by architecture that lacks organic order and connection, may be due to a declining interest in planning, as a result of economic values, suggests Eliel Saarinen.

Are cities the ultimate creation of civilization where people can enjoy culture free from want or physical extremes? Or, are cities a gross alteration of nature that destroys human life and dignity—a gross ecological error. As long as cities grow without negative feedback, the second will occur. When ecology helps the city ecosystem fit in the surrounding ones, then the achievement is worthwhile. The city depends on its environment.



Figure 54-1. Paolo Soleri's Design for a Lean Linear City Arcology

5.6. Regional Design Factors: Civilization & Industrialization

By the end of the 1200s, the Mongols brought China into direct trade with Europe, and they developed paper money to make the trade easier. Their empire had its own transcontinental highway, as well as sea trade routes with the Chinese. At that time, the European cities were being changed by guilds, trade and gothic architecture. Colleges were beginning to replace monasteries as centers of knowledge; local languages were replacing Latin. By the mid-1300s, there was an economic downturn in Europe and China, which was related to plagues across Asia and then Europe. The regions were linked if not interdependent enough to influence each other. After a series of local disasters and political changes, China unplugged from the trade system, even abandoning its magnificent tribute fleet in 1425. Did population growth prevent a Chinese industrial revolution? China had many advancements around 1000 BC: Papermaking, moveable type, paper-money, guns, powder, compasses, underwater mining, umbrellas, hot-air balloons, rockets, and laws of motion.

Then European commerce began to flow past local boundaries. But, the commerce had to be protected from pirates, so laws and agreements were needed. There was a slow transition to regional commerce. Specialization went beyond nations. The Dutch East India Company followed economic goals rather than political ones, although it was closely linked to political powers and may have become a tool for political objectives.

5.6.1. Industrial Intensification

There was an intensification of tool-making in the past 3000 years. Population increased and new areas were exploited. The agricultural revolution was a technological revolution. The industrial revolution, by definition, was a technological revolution, which resulted ultimately in men being replaced by machines. Only the Luddites faced this limitation, unsuccessfully. Human labor is increasingly dispensable. Industrial culture confuses mechanical with personal power. According to W. I. Thompson, industrialization is really an intensification of civilization.

Industrialization is really an intensification of civilization, which is still an ektpropic process. In each case of cultural absorption, there was an attendant process of miniaturization. The forest was miniaturized in clumps of trees; animals were miniaturized in artistic image; time on a lunar tally stick; plants in a garden; women in a household; nature by culture in 1800, under the glass roof of the Crystal Palace; and now by the new consciousness surrounding the old. What is intensity?

Intensification brings cultures together faster. Conversion increases, technology and industrialization increase. Intensification is a gigatrend that could lead to violence. For instance, intensification leads to urban living, which increases creativity, as well as some kinds of illness, which leads to physical weakness, which leads to changes in population, which leads to intensification of resource use, which leads to the potential for conflict, which can lead to dislocation and violence.

Urbanization concentrates people in a smaller area. Does that leave more room for wilderness? Just squeezing in does not mean better conditions. There has to be enough energy, sanitation, water and other things. In cities, industrialization, in the form of increased wealth, can bring about a demographic transition. As health and wealth increase, people have fewer

children. What is the actual trigger? The desire or opportunity for self-actualization after reproducing heirs?

The industrialization process has led to a dramatic extension of cities and buildings, as well as growing extents of machines and increases in energy use. Furthermore, people, property and machines are much more mobile, which requires more pathways and more energy. This has increased the impacts and pressures on ecosystem productivities. Design has not been able to effectively deal with this kind of runaway process.

5.6.2. *Regional Problems of Industrial Civilization*

Our modern problems reflect an unbalanced and immature image of the earth, the earth as a machine, for instance. People sometimes constructed their worlds from preconceived notions, and many of these worlds did not survive, because they could not adapt to the environment. Our modern cultures are defective for this reason. The modern attitude toward nature as a resource has resulted in pollution and depletion of resources. It has allowed humans to overpopulate their habitats. Recent productivity studies indicate that the optimum sustainable human population is far below the current world population.

Even worse, decisions regarding resources are still made exclusively on short-term economic rationalizations and lead to material shortages and environmental degradation. The crises of environmental degradations are crises of cultures. Monocultures of the industrial kind lead to 'dedifferentiation,' that is, the decomposition and destabilization of complex structures. A species or culture that destabilizes its ecosystem through misbehavior risks its own extinction. Human beings make changes to ecosystems that endanger themselves.

Industrial society is constantly mobilized for emergencies, in the battles against, noneducation, poverty, diseases, and terrorism. Industrial development has never been nonviolent or respectful to people. Industrial production has its own unique style and scale.

One emergency in industrial culture is the production of flatscapes, the flattening of four-dimensional diversities. Our attempts at social improvements have proceeded without order, without sufficient insight and perspective, without sufficient confidence, without a comprehensive plan, and without a great dream. Our politics has been corrupted by special interests. The structure of our civilization comes from anonymous builders and mediocre designers, minimal engineers and rapacious financiers. We work within the rules as they have been for decades, rejecting any alternatives as too utopian. The rules themselves have been shaped by centuries of social metaphors and utopian ideals. They do not exist in place, either a human place or an ultrahuman place. They are designed to be no-place, without weeds, storms, or hard ground. Because they are nowhere, flatscapes, like demented unplanned utopias, lack any reference point.

Physical laws create patterns in space, as well as in human history. There are simple kinds of patterns. A linear pattern tends to be interpreted as progress or regress. This is the dominant concept of modern history, unending progress. Despite the chaos of individual events, there does seem to be a direction of gradual improvement. Marquis de Condorcet suggested that civilization will always move in a desirable direction (1795). People become frustrated when it does not, and there have been collapses.

5.7. Regional Problems: Ecosystem & Cultural Collapse

Ecosystems and cultures share many properties, perhaps since cultures emerged from being in place in ecosystems or perhaps because they are both complex systems. They also share stages of development, which always end in collapse.

5.7.1. Collapse

Collapse is the rapid, significant loss of an established level of complexity after some catastrophic event. By this definition, ecosystems can collapse during climate changes, and cultures can collapse after social or environmental changes. For an ecosystem, collapse can mean less complex food webs, fewer species and decreased diversity. Ecosystem collapse is a regular process, often precipitated by environmental change. For a culture, collapse can entail the loss of centralized control and regulation by elites, decreased flow of information between center and periphery, less trading and redistribution of resources, losses of complexity in organization and stratification, drops in economic specialization, and reduced investment in the complex physical structures. Many cultures have collapsed and disappeared, often without being remembered or documented. The known collapses range from the Old Kingdom of Egypt (2181 BCE) and the Harappan in the Indus Valley (1750 BCE) to Rome (476 CE) and the Khmer in Cambodia (1431 CE). Recent collapses include the Kachin of Burma (1950 CE) and the Ik in Uganda (1970 CE).

5.7.1.1. Kinds of Ecosystem Collapse

An ecosystem can mature through a series of stages, described as succession, to old-age and dissolution. Pierre Dansereau delineated four general stages of succession (modified here): pioneer, consolidation, mature (Dansereau's subclimax), and closed (Dansereau's climax). A fifth unmentioned stage is collapse, where the system reacts to a disturbance by dropping to an earlier stage or by completely collapsing. Eugene Odum characterized the pioneer stage as having a linear food chain. A typical pioneer stage might have lichens, mosses, and annuals. The consolidation phase may have perennial forbs, grasses, mixed herbaceous plants, shrubs, and a few shade-intolerant trees. The mature stage might have shade-tolerant trees. The closed stage would have emergent trees and a mixture of plants and animals that resist exotic species, in effect closing the system to further colonization or invasion. In the mature and closed stages, complex food webs are dominated by decomposers. For animals, body sizes increase and life-cycles and strategies become more complex. At this stage, the system has learned the cycles of the environment. Throughout this process of maturity, according to R. Margalef, there are changes in productivity, efficiency and nutrient cycles. Diversity increases and trophic structure becomes more complex, with added numbers of consumers and decomposers, and more specialized niches. During a collapse the networks and webs fall apart, the system can drop to any earlier stage, and individuals and species disappear or disperse to another system.

Catastrophes (used in the mathematical sense meaning a down-turning), such as storms, fires, glaciers, and clearcuts, can set back stages of succession or change its direction. Stages do not necessarily begin in order or progress uniformly; they can begin anywhere and overlap. Nor are they exclusive, as life forms in one can occur in another, for instance, when lichens appear in all stages in a coniferous forest.

A mature ecosystem can collapse when internal overconnections between species make it fragile or incapable of being flexible enough to respond to environmental change, either large changes or new patterns. Climate change, especially drought, long or short-term, has caused the collapse of many natural ecosystems. For instance, the change in temperatures and moisture patterns at the end of the last ice age replaced many forests with grasslands, and many species could not adjust to the change and were extinguished.

5.7.1.1.2. Regional Ecosystem Collapse: Mesopotamia

By the end of the last ice age, the storm tracks had shifted north from Africa to Mesopotamia, and brought moist air masses. The ecosystems switched from being boreal to being temperate. Grasslands and deciduous woodlands expanded.

Around 8200 BP, there was a sudden cooling that may have been caused by the collapse of Lake Agassiz, which had formed over 4000 years of melting, after the ice wall collapsed and the lake suddenly discharged through Hudson's Bay or the St. Lawrence Seaway (and may have changed the salinity of the north Atlantic and caused the thermohaline circulation to alter or shut down). Temperatures and snow accumulation dropped dramatically. It affected North America, Greenland, and Europe, as well as western Asia. The regional climate adjusted, and things became colder, drier, and windier. Lakes in Africa dried up, including a large one in the Sahara, which never reformed. In western Asia and Mesopotamia, ecosystems dried up and were replaced by desert ecosystems on desert soils. Some systems in the mountains survived.

There were subsequent coolings in 5200 BP and 4200 BP. The first event caused a drought that coincided with cultural collapses in southern Mesopotamia along the Euphrates and Tigris rivers. Although irrigation canals brought water to fields, a weakened river flow would have reduced irrigation and yields, so people may have had to switch to drier crops or abandon the effort entirely. Settlements in the interior of Arabia were abandoned around this time. In the second event, the westerly winds bringing moisture to the Mediterranean and Mesopotamia failed. Precipitation fell 30 percent. Hot winds contributed to drought. Some of the cities, such as Tell Leilan, were deserted; many villages were abandoned. Between 4200 and 4100 BP, Mohenjo-Daro and Harappa, around the Indus River, declined suddenly.

5.7.1.1.4. Discussion

If a catastrophic event is total but localized, plants and animals can recolonize the ecosystem. If it is total and regional, ecosystems may disappear. If it is partial and regional, many ecosystems can recover over ecological time. Certainly the subtropical ecosystems on the northern Yucatan peninsula disappeared immediately at impact, which not only changed the rock substrate, but also dramatically altered the soils and topography.

5.7.1.2. Kinds of Cultural Collapse

Cultures seem to mirror human growth, development and aging. A fragile or old culture may collapse at the end of its cycle. The stages of a culture could be described as: Origin or Renewal, growth, maturity, collapse, and dispersal; this might be a rough parallel to the stages of an ecosystem: pioneer, consolidation, maturity, closure, and collapse. After closure, the ecosystem either collapses or is bumped to a lower stage by some disturbance or interference. Lance Gunderson and C.S. Holling, in their book *Panarchy* (2002) present a stylized representation of ecosystem functions—exploitation, conservation, release, and

reorganization—that they use also as a four-phase heuristic model of institutional dynamics and other applications. This representation will be related in a different section.

Joseph Tainter uses several models to describe cultures: In the Runaway train model, a culture is impelled on a certain path without the ability to change directions; although it is dynamic, its course is fixed, as when the Aztec continued to ensure the rising of the sun with sacrificial blood. The House-of-cards model stresses that a culture is inherently fragile, with little ability to respond to stress; perhaps the dramatic decline of Rapa Nui is an example. The Dinosaur model suggests that a culture is a lumbering colossus with a big investment in one environment, but too static and maladaptive to adapt to any change. One might suggest other models that still might result in collapse. The Fungus model presents culture as an adaptive, problem-solving, intensive social structure that, although it can respond to many environmental challenges, can still fall apart with scale or be overwhelmed by large events.

Cultural collapse can entail any set of many factors. The rapid loss of an established level of sociocultural complexity may be first expressed as a breakdown of central authority. Provincial provinces or villages may break away. Revenues to government may decline. There may be foreign challenges over territory or resources. The upper hierarchy may start to claim resources for themselves. Ordinary people may become disaffected. The military may be ineffective. Continued central direction may not be possible. The center may lose power. Distribution of goods may suffer. Trade may decline. The city center may be ransacked and abandoned. Small states may start to emerge in the same territory. People may lose the protection of the law. Public art and monument construction may cease. Literacy may be lost. The small remaining urban populations may reuse the architecture and subdivide rooms. Palaces, government buildings, churches, and storage facilities may be abandoned. Technology may revert to simpler forms. There may be a great reduction in population size and density. Peripheral ecosystems and animals may recover, although not always.

Generally four concepts leading to collapse can be identified (J. Tainter 1989 and J. Diamond 2003): Cultural systems need energy to be maintained; increased social complexity results in increased costs per person; the investment in complexity reaches a point of diminishing returns; and, the cultural system fails to react to very large, slow or invisible catastrophes. Of course the culture could respond to those challenges. At some point, all energy income is used for maintenance and none is left for other problems, such as starvation of classes of people. Cultures often know how to deal with resource uncertainties, but do not know how to reduce populations to reduce pressures on scarce resources (although they allow disease and war to lower populations for a time). Cultures also seem to know how to deal with regular catastrophes, but do not seem to know how to minimize them or avoid them; catastrophic fires or floods could be minimized by relocating buildings or replanting native trees—perhaps the people grew tired of the increased costs. Cultures also seem to know how to provide and control labor, but they cannot reduce management levels (and this applies to royal classes as well).

Collapse can occur as a result of other reasons or combinations of circumstances, from invasion to social dysfunction. Such reasons include: Resource depletion, establishing new resources, catastrophe, insufficient response to environment or change, intruders, conflict mismanagement by class, social dysfunction, religious or mystical factors, chance series of events, and economic failure. An example of social dysfunction is class conflict. In the Mayan lowlands, class conflict was complicated by militarism, overtaxation, and land degradation.

These contributing factors may have been solved, except that three long droughts weakened the Mayan cities further until they collapsed. Group conflict, deforestation, isolation, and population increase contributed to the collapse of Rapa Nui.

Economic inefficiency was a contributing factor to the collapse of the Ottoman Empire, which had to support an expanding population and an expanding government and military. Their agrarian system was unproductive, the influx of Spanish gold hurt the economy, and the economy was also by-passed by new oceanic trade routes.

5.7.1.2.2. Regional: Diseases in North & South America

When European people started to explore and colonize North and South America, they came in contact with large native populations, many of which welcomed and helped them. Almost immediately, native people started dying. Entire villages and tribes were wiped out. Survivors often moved in with neighboring tribes, mixing belongings and cultures. Epidemics spread from tribe to tribe, often well in advance of the Europeans themselves. European explorers commented on how empty the land was. Some disease-devastated or abandoned villages were overgrown by vegetation; a few were noticed by the explorers. The pre-Columbian native populations were reduced to 5-10 percent of their original levels by the epidemics. In North America the original population may have been 10 million; in Central America, over 17 million; and, in South America 25 million—even these estimates are being revised by research.

Insects, diseases, and animals, more than being simply agents of mortality, are native components of complex food webs in ecosystems, and they contribute to the selection of species. The domestication of animals from Mesopotamia to Asia and Europe exposed people to animal diseases, which transferred to the human populations. Epidemic diseases originated in domesticated animals. Measles, smallpox and tuberculosis came to humans from cattle, flu came from pigs and ducks, and whooping cough came from pigs and dogs.

In North and South America, only the dog and lama were domesticated, with less disease transfer. American peoples did not have epidemic diseases or immunities because they did not have the domesticated animals that gave rise to the diseases. Europeans, however, were exposed to syphilis for the first time.

Disease was even more important than horses or guns in the European subjugation of the Americas, according to Jared Diamond. Disease not only reduced the numbers of native peoples, but it wrecked havoc on their cultures, so that the enormous competitive advantages enjoyed by societies with horses and guns were more effective when they were used. Diamond recounts how Spanish conquistador Francisco Pizarro used 62 horsemen and 106 foot-soldiers to destroy thousands of Inca soldiers on one day, November 16, 1532. In hours, Pizarro's small band captured the Inca emperor Atahualpa, leader of South America's largest and most advanced state, by panicking the emperor's 80,000 guards.

5.7.1.2.3. Discussion of Cultural Collapse

In the Sahel and Mesopotamia, the argument was that overgrazing and human population caused the droughts. Exposed soil contributed to a changed albedo and hot air, which did not permit rain-forming clouds. Recent research indicates that, for the Sahel, a single variable made most of the difference—rising sea surface temperatures of the Indian Ocean, from greenhouse gases, was responsible for most rainfall decline. Despite the fact that we often focus on political and behavior causes, environmental changes or catastrophes are critical factors.

5.7.1.3. Coterminal Ecosystem & Culture Collapse

Cultures and ecosystems produce co-effects on each other. In some areas, such as Mesopotamia and Central America, the synchronization of plants used for crops can increase conflicts over food. The simplification of complex ecosystems for agriculture usually causes the collapse of the native system. Overuse of a wild ecosystem can cause it to collapse. Even targeted removal of keystone species can cause the system to collapse into a simpler system. English forests, for instance, changed after large predators, such as wolves and lions, were eliminated; deer and goats reduced the germination of trees, so grass or scrub lands expanded.

5.7.1.3.1. Regional: Mediterranean & Mesopotamia

As the ice age was ending, stands of grasses grew in the Zagros Mountains, and people started living in permanent settlements nearby. Goats, sheep, pigs, deer, and wild asses inhabited the area; in addition to the wheat, barley and oats, there were oak, maple, hawthorn, pistachio, and apple trees. Plant collecting was vital, although hunting and gathering were important. People started planting grasses closer to their settlements and trading surplus grains to those on the steppe-lands south and the Tigris-Euphrates alluvial plain. Then, the Younger Dryas event, between 12800 and 11600 YBP, brought a long, 1200-year drought and people went back to hunting and gathering. With later warming, people went back to collecting grasses and living in permanent settlements. By 8400 BCE there was another shift in the northern hydrological cycle, likely from the collapse of the ice wall containing Lake Agassiz in North America. This brought another cycle of droughts to Mesopotamia. In the alluvial plain, people brought the rich grasses from the north and planted them around permanent settlements near the rivers, which were used to flood canals through the fields.

Some settlements became cities, such as Uruk, which began building monumental buildings, including grain storage buildings. City society developed stratified classes, with religious leaders, military, administrators, craftsmen, farmers, and slaves. Some of the cities grew to 10,000, perhaps as many as 50,000 people, and created an intricate network of irrigation canals. Crops increased with sunny weather and plentiful water. However, evaporation from the sun increased the salinization of the soils and crops were shifted towards barley, which could tolerate higher levels of salt. Eventually, there was too much salt, and no crops could be grown. People in the cities had to rely on stored grain, trade for more, or attack other cities. Many cities were abandoned and people returned to nomadism, or more rarely, to hunting and gathering. Abandonment of the fields, however, allowed the soils to recover as the rains and rivers washed out the salt. As people returned after generations, they rebuilt the cities and canals and were able to depend again on agriculture.

This cycle was repeated several times. With each collapse of a city, the residents dispersed to other cities or returned to herding animals; the soils were renewed in the absence of stress. Sargon conquered many cities and established the Akkadian Empire in 2370 BCE. When that collapsed, power moved north to Babylon by 1800 BCE. By 1300 BCE, the cities were weakened and collapsed again. Even with drought, the land renewed itself. The Achaemenid Empire (600 BCE-650 CE) renewed cities with public works and roads, but the cycle turned again and people dispersed. By 700 CE, new canals were dug and Arabian Baghdad flourished. But, salinization increased, and cities weakened. By the 1200s CE, the area was conquered by Mongols. Then, there was a massive collapse and the population dropped from 1.5 million to

150,000 by 1500 CE. People returned to nomadic lifestyles. Cities were reinhabited again and the population grew, especially with trade. Currently, 200 million people are supported on 10 percent of the land by intensive agriculture and intensive imports from trading oil.

Each collapse allowed the native ecosystems to recover and renew the soil. Each renewal allowed people to return and reestablish an irrigated agriculture.

In the Minoan civilization of Crete, the earliest palaces were built after 2000 BCE. Although they were regularly ruined or destroyed by earthquakes, each was rebuilt more splendidly, with a sophisticated knowledge of architecture, engineering, hydraulics, and drainage. The Palace of Knossos was more luxurious than anything in Egypt, especially with water-flushing latrines.

The palaces were administrative and trade centers, but also warehouses. Knossos for instance had the capacity to hold 240,000 gallons of olive oil. There were craft production rooms for potters, weavers, and metal workers. Written records show how goods were directed to the palaces and redistributed from there. Scenes on widespread frescoes on the walls were generally peaceful. The palaces were not fortified.

In 1500 BCE, a powerful earthquake precipitated major destruction and widespread changes. Knossos started to dominate the other palaces. The Mycenaean Greeks competed with Crete for sea trade. They introduced new kinds of warfare, with new weapons and horses. About 1380 BCE the palaces were all destroyed, and the civilization collapsed. Parts of Knossos were rebuilt and a reduced administration carried on for a while but even that ended by 1200 BCE. The early script Linear A was replaced with Linear B, which was Greek.

The Mycenaean Greeks themselves inhabited a hilly topography with good forests, rugged semi-arid regions with small alluvial valleys. Villages dependent on domesticated plants and animals appeared about 6000 BCE. The core of Greek subsistence was small scale farming. Agrarian success led to increased soil erosion. This civilization began to develop around 1650 BC. It reached its height about 1400, around the Minoan collapse. Central and southern Greece was divided into independent city-states. Mycenae seemed to be the most powerful. It had 16 administrative districts, each controlled by a governor. Each was an economic center for distributing goods and foods. Aqueducts were built to carry water and roads to carry people and goods. The cities had massive walls with major structures. Palaces had frescoes and bathrooms. Under supervision of palace authorities artisans cut gems, worked metals, and threw pots.

After 1200 BCE, palace after palace was destroyed. The artisans seem to have vanished. Writing disappeared, and art became much simpler. Cities became more fortified and dug into their rock bases for water. The number of settlements dropped from 320 to 40. Athens survived but suffered a political collapse. Overall population declined from 75-90 percent. Some people migrated to the southwest Peloponnese. Elsewhere, around the same time, after 1200 BCE, the Hittites in Anatolia, and the Vera basin people in the southeast Iberian peninsula collapsed—deforestation of uplands, and a shift to barley monocropping, were made worse by the desiccation and many Vera basin villages were abandoned. Egypt experienced troubles. There were also local collapses in the western Pacific, for instance, on Kangaroo island off Australia.

A shift in westerly winds brought long droughts to the entire eastern Mediterranean. Some hypothesize that this abrupt climate change may be related to a supernova, bolide activity, comet or asteroid impact, volcanic activity, El Nino event, or earthquakes. Cities were

not able to survive on reduced crops. Populations dropped; people returned to herding or foraging when possible.

5.7.2. Discussion of Collapse

Combined cultural-ecological collapses are probably the most common kind of collapse. That is, every cultural collapse seems to have an ecological component, and every recent ecological collapse seems to have a cultural component. This should not be surprising, as people are embedded in ecosystems and tend to use them and transform them. Combined with the human propensity to multiply to fill in every niche, the sum of human activities puts strong pressures on ecosystems.

There seem to be two basic problems in living in ecosystems: Perceptual and managerial. Often, we do not perceive the system in its complexity. We depend on initial observations and ignore a wealth of details. We tend to make general responses to complex, detailed challenges. We may make general models of the environment for thinking about it. We also tend to transfer generalities from one ecosystem to another, without being attentive to critical differences. Assumptions by immigrants on entering new ecological zones shape their perception. The earliest aborigines must have thought the herds of diprotodons stretched forever. The first Americans may have thought mammoths were numberless. The Maori may have thought the moa were limitless. Hunting would have been easy and successful. Deception is also a problem. Europeans thought that America and Australia were *terra nullus*, empty lands, or under-utilized ones. Deception can turn to disillusion as resources disappear.

Managerial problems can arise from difficulties with communications and assignment for responsibilities. With more than one level of management, the response to a challenge might be delayed or entirely inappropriate. Furthermore, with each level of management, there is a degree of detachment from the participant. These two problems can lead to poor recognition of challenges and to poor, untimely responses.

Of course, our perception of challenges is improving with advancing science and increased communications. Climate change is only one of the challenges to ecosystem or cultural health. Other threats can be summarized briefly as global or local problems. The local problems include such things as the removal of key elements, species, resources, and productivity; the disruption of natural cycles; the introduction of novel elements (as the result of inappropriate technologies); the human take-over of habitats for human purposes, often the result of simple population pressures, but also of greed and sloppiness; and, the extinction spasms in general, but specifically, for example, the decline of amphibians worldwide, due to habitat loss, pollution, and fungal infections (exacerbated by atmospheric heating). The global problems include such global things as global warming; ozone depletion (chemical caused); disruption of global cycles; and, contaminations (nitrates, mercury). The words global warming are used instead of atmospheric heating to indicate that the heat content of the planet is also a factor in climate change.

Any one of these threats, or some combination, can cause ecosystem collapse. Ecosystem breakdown happens as a result of stresses, singly or grouped, that relate to interference patterns in the system, most of which are caused by the human species now, although the potential for asteroids, volcanic eruptions or prolonged droughts remains.

Collapse is often part of physical, biological and cultural cycles. Collapse can happen when a culture is too static in a changing environment. It can happen a culture selects growth

to try to overcome certain environmental obstacles. Sometimes the collapse is thought to be the result of internal moral or technological failings, as well as conquest or some other external influence. Cultures are adaptive systems that have to integrate a number of challenges, opportunities and pressures, from drought to invasion, and then reconcile them to changing economic and political situations. Collapse can happen by bad luck, chance that is, or just a coincidence of bad leadership, bad images, cultural problems, external social pressures, and environmental degradation.

5.7.3. *Patterns of Collapse: Recovery & Renewal*

There are many ranges of collapse. In some cases, the population collapses, but there is not much loss of cultural complexity. Ireland, for instance, lost half of its population, during and after the potato famine, because of its reliance on that one crop; due to English rule, the government continued. The population stabilized at a new lower level, under three million. After 1960, with the development of industry and then membership in the European Union, the population has been increasing to six million (less than the eight million in the 1800s).

In other cases, there has been a tremendous population loss, along with a political crash and complete loss of organization. The Maya collapse eventually led to the complete abandonment of the cities and the urban way of life. The population dropped dramatically. Some parts of a culture may collapse, such as the Southern lowland Maya, while the Northern upland culture continued to survive for several generations before collapsing. As part of a cycle, after people disperse to return to older styles of living, the local ecosystems can regenerate, without the pressure of use or overuse, and recover.

In still other cases, local city states may collapse for a generation or two, and then be rebuilt in place, as the local ecosystems have experienced some level of renewal, perhaps at a lower level of complexity themselves, where the forests and woodlands may be gone, but the grasslands have recovered. Mesopotamia civilizations recovered numerous times, as new states were able to benefit from the natural process of desalinization of soils after the hundred years of rest for the soils.

Of course, some of culture may survive and be used by new or other cultures. The ideas produced by a culture may spread and reproduce. The culture of ideas continues through people leaping to other places. Lower levels may survive with many of the ideas of the larger complex. So, the Roman Empire collapsed but not parts of Italy or France. The Germans were able to return to chiefdoms.

5.7.4. *Potential Collapse*

Elman Service uses a biological analogy, where social organizations are modeled as plant or animal species that are initially successful because they are adapted to niche, but later become overadapted and less flexible. In this model collapse is part of an unalterable natural cycle. Adaptation denotes a systemic homeorhesis in which a range of variability is activated in response to various environmental and social perturbations. Service believed that complex systems were profoundly maladaptive since their responses to stress became less flexible.

This argument does not consider weed species or the maturity of the system. In a systems model, collapse is part of stochastic process, which implies that civilizations will die, but not necessarily within a definite time frame or for specific reasons, such as overconnection. Perhaps one reason for cultural collapse is due to overconnections, between

trading groups and social classes. This could be a problem with modern globalization, in the 1990s, as well as with simpler regional connections, such as in the 1300s in Asia and Europe. In the general system model, complex systems are hierarchically composed of many stable lower and intermediate orders, strongly connected horizontally, but less so vertically. The problem may be more one of scale than complexity.

Human cultures tend to fill all available space, carrying capacity space, even though some of the spaces are occupied by other species or other cultures. This makes them prone to crash after sudden changes. They have adapted to marginal environments with behavior and technology, such as that for water storage and grain storage, to buffer themselves against the known changes of the environment, but when an unknown change happens, such as a nine-year drought, they fall apart. Few people have the luxury of moving to an open area.

Global climate change has been established by many scientists as a real threat to the public health and safety of cultures. Examination of Paleolithic records establishes that climate, far from being benign and uneventful, has been dramatically unstable for local or regional patterns. Droughts can start abruptly and continue for tens or hundreds of years, far beyond the ability of the adaptations to them, such as urban living, to cope; agriculture is disrupted and the technological innovations, such as immense grain storage buildings, cannot continue for the duration or amplitude of change.

Now, global warming is related to human activities. Human contributions of carbon dioxide, methane, and water vapor contribute to a much faster temperature rise. Natural factors, such as the eruption of Mt. Pinatubo, may temporarily mask the effect of global warming, as may technological factors, like jet contrails. Still, if the trend continues, global atmospheric temperature increase could develop deserts where croplands exist, dramatic sea-level changes would flood low-lying areas, and shifting rainfall patterns would affect crops and fisheries. Global warming could lead to reversal of ocean currents, unpredictable redistribution of rainfall, and other unpleasant, chaotic, deadly effects.

Because people live in groups having unique cultures, they react differentially to diseases and stresses, even war. In crisis, people tend to pull back to smaller groups. Smaller populations can adapt faster to smaller resources. This was appropriate as a response to local catastrophes, but it may not be the best way to deal with global ecological threats or coterminal collapses. Dispersal to other healthier ecosystems is no longer an option for most cultures. The problem is scale and it has to be addressed on a larger scale.

Science can create models that can be used to anticipate future changes—not exactly or definitely, but in terms of probability and eventuality. Models of climate change can map climate change and perhaps even accommodate unexpected nonlinearities. And, models can provide the information to design strategies to give cultures more flexibility in responding to change and challenges. With international cooperation, the risks can be shared and vulnerable cultures can be helped with minimal disruptions.

5.8. Regional Problems: Culture & Bad Images

No culture has developed a perfect balance of human and situational needs. Some do better than others, but all cultures change and age. As a culture ages, it may become abstract, indifferent, self-centered, and forgetful, suffering rigid rituals and cultural amnesia. If the contradictions become too great and maladaptive, however, then the culture dies.

5.8.1. Cultural Transformations

Cultures emerge from groups of human beings living in places. The variables of the environment influence cultures in a number of ways. For instance, A high Net Community Productivity (NCP) can allow larger annual crops, or, a low number of sunny days can contribute to psychological depression. Cultures have been unique programs, using local materials and ingenuity, for satisfying basic human material and spiritual needs.

Cultures develop over time as the groups change and always seem to grow larger. Cultures are influenced by climate, resources, and of course by human ideas about their places and themselves.

There may also be larger patterns of human culture. For instance, reproductive success and overshoot of resources may always occur in the development of a culture. The asymmetry of sex and violence, ecosystem conversion, and limited time horizons are also things that seem to develop.

How does this happen? Culture does not fit together into a perfectly integrated whole. A culture is a loose-fitting patchwork of ideas, relationships and things. In that sense it is parallel to species adaptation to an environment. There are discontinuities and contradictions. Humans can tolerate inconsistency and operate with contradictory beliefs: soldiers fight for peace; ministers save the unborn for starvation. If the contradictions become too great and maladaptive, then the culture disappears.

According to most theories of cultural adaptation (or integration or evolution), resistance to change is normal as a cultural process. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. On the other hand, resistance to change itself is an adaptive mechanism. According to Betty Meggers, it works as a successful “cultural isolating mechanism.” Isolation remember is what allows a culture to develop in the first place. But, then does it force a culture to become stagnant? Thought experiment. If we found a way to live in the forest, using solar power and eating only farmed algae in small arcologies, would the pygmies adjust to that?

As place changes, a culture changes. As people change, under the influence of each other and other cultures, a culture changes. Culture does not fit together into a perfectly integrated whole. A culture is a loose-fitting patchwork of ideas, relationships and things. In that sense it is parallel to species adaptation to an environment. There are discontinuities and contradictions.

William Thompson identifies six major shifts in the transformation of human cultures. The first he calls the feminization of primates; females abandoned estrus and became open sexually (200,000 YBP). In observing synchronicity between bodies and nature, women established system of symbols and notation (art 50,000 YBP). Then women discovered that

they could collect enough cereals in three weeks to last the entire year, more than a hunter could kill; but it required storage. Agriculture gave a surplus; that and crop failure and excess property lead to excitement of war (Agriculture 9000 YBP). Civilization became the domestication of women, according to Thompson. This emphasized a patriarchal structure (Civilization 5500 YBP).

Industrialization (200 YBP) is really an intensification of civilization, still an ektpropic process. In each case of cultural absorption, there was an attendant process of miniaturization. The forest was miniaturized in clumps of trees; animals were miniaturized in artistic image; time on a lunar tally stick; plants in a garden; women in a household; nature by culture in 1800 (206 YBP) under the glass roof of the Crystal Palace; and now by the new consciousness surrounding the old. Ratio becomes logos. Measuring becomes pulling in, and perhaps shaping. Planetization, along with miniaturization (48 YBP), contributed to the idea that the planet was an organism, that it could maintain itself in the environment of the solar system, and that it could balance its atmosphere with living communities. The photograph, from the Moon of the Earth in space, became the symbol of the change. Our survival depends on the capacity to remake the image of the world from within, phoenix-like. The planet is wild beyond our imagining, and we need a wild image that can capture that.

5.8.1.1. Patterns & Renewal

Nature consists of moving patterns whose movement is essential to their being. As a rope makes the knot visible, so the body is a pattern made visible. The body is a movement that maintains a topologically stable pattern; it is a vortex but not the water. The thing, the pattern, is a cross section cut through the movement. The mind is an invisible knot that is capable of recognizing both visible and invisible patterns, that is to say, a rope is not always necessary for the demonstration of a knot. Culture is also this kind of pattern. Culture can be analyzed into smaller blocks; the pattern of the whole organization is reflected at every division in differences of organization on either side of boundary.

The mode of operation of nature consists of a rhythm of dissolution and reformation. Perhaps this process applies to cultures. Often the elements of a culture will simply be rearranged by a succeeding culture. A new culture can only be made from the heritage of the old. The wholeness of the character of a culture is reflected at every level. Patterning relates symbolic meanings in the context of a cultural system as a whole. The patterns form another level of meaning that has to be addressed in understanding a culture.

There are patterns of interactions of cultures, which arise out of several possibilities: Indifference, trade, competition, cooperation, conquest, or respect. Some archaic cultures seemed to be limited to indifference, that is, they ignored one another, and to trade. Competition and conquest may have accelerated with the acquisition of territory for agriculture. Cooperation and respect seem to have occurred under some circumstances of trade or unification.

5.8.1.2. Challenges & Traps

Sometimes, rearrangement leads to a position of not being able to rearrange further. In many cases it is hard to tell if the destructive use of land preceded ecological problems or followed from efforts to maintain production after an ecological challenge. Cause and effect are hard to separate. The same environment that challenges a culture with some kind of change, also offers

opportunities with the change. New resources can stimulate economic activity and increase the level of living.

Cycles that do not operate with the right kind of feedback function as traps. Thus, on an elemental level, phosphorus becomes trapped in an ocean sink, and can only be recycled by long geological processes or by specific harvests through human activity. At the human level, Karl Marx contended that humans live in cages, partly natural and partly of their own making. However, human actions can modify the situation. The word cage is a metaphor; it implies being trapped. It is however, a metaphor that can be expanded with a description of space as a four-dimensional box. Perhaps the trap is a better metaphor, since we depend on nature and society as a foundation for life.

Traps function in different ways. The use of resources by a people, where the replenishment rate is constant and the rate of use exceeds it, is a serial trap. This trap results in ecosystem degradation that is less reversible. The industrial age mistakes the rate of discovery for the rate of recovery.

Agriculture is an energy trap, because it allows a higher concentration of energy, that is, higher yields, but then it requires more energy be put into the system to maintain it. The system has to produce more energy than it uses to be sustainable, with a surplus for trade.

Permanent habitation, or sedentism, is a trap. As the population of sedentary communities increased, the wildlife numbers decreased. The productivity and narrowness of food increased. Thus, there was less possibility of returning to the foraging lifestyle. People became committed to the new lifestyle. Intensity was no longer an option either; it had to be pursued. Habits were set. One problem of sedentism is that the individual cannot simply move away to avoid conflict. People are tied to a particular place and have to communicate to adjust to sharing places.

The city is a different kind of trap, one that offers intensity and opportunity, but requires massive imports of supplies to survive. The size and scale of cities create the dual centers of attraction and despair. As key parts of culture, language and art can function as traps—Language because one is limited by words; art because one is limited by styles or demand. Even if cultural attitudes are appropriate, they can trap a people if there are no longer functional reasons for the practices. The Nembu of Papua New Guinea may be trapped in their system, making stone axes with difficulty, when thousands of cheap steel ones are available.

Global capitalism can lead to a consumption trap. Capitalism claims to serve the wants of the people, but it spends half its income creating more wants in people. Not many of those wants are real, or as real as cereal and roofs. Few of the soft services satisfy real psychological needs. Markets advance individual desires and not social goals, by offering running shoes, not inner city restoration. Instead of being free from economic want to develop their potential as creative human beings, people are trapped in a consumer cycle. Self-actualization is postponed for self-gratification. Furthermore, capitalism can undermine traditional cultures by offering consumerism in the place of guides for behavior. Social roles seem irrelevant by comparison, if the good life can be bought without effort.

Being in a trap means much-reduced flexibility and fewer choices. Climate can drown whatever is in the trap. That is, being in a trap makes one vulnerable to many other changes that could be avoided if one was not in a trap. When the weather got colder, then hunters and gatherers could move south. Cities could not. Civilizations are more fragile and more

vulnerable to smaller climatic changes.

Addictions, such as those to foods or oil or money, make it difficult to escape from a trap, a trap being a kind of energy well or gravity well. Addictions can amplify some emotions, such as fear or hate, especially as they relate to the possible end of the addiction or the threat of that end. Addictions can justify illegal behavior, especially those that seem necessary to continue the addiction. Of course, many cultures are addicted to the illusion of control and power. The U.S. is trapped in the belief that only it, among nations, can bring prosperity and peace to other nations, through gifts or violence. Eventually the trap is escaped, or more likely destroyed or collapses with its victims. Paul Shepard suggests that the entire Neolithic revolution has trapped us in behaviors that only end in madness. The feedback is inevitable.

5.8.2. Problems Facing Individual Cultures & a Regional Culture

Problems of individual cultures include: Lack of Resources; environmental change; conflict and violent relations; environmental degradation; species habitat diversity loss; introduction of exotics species and artificial elements; cultural exhaustion; human limits; and human inequity. Many of these problems arise from other activities, such as: Competition; take-over; cooperation; trade; exchange; clash of images and metaphors; differing ethos or ethics; trends or gigatrends; and random changes or changes in luck. And these activities and problems can result in the problems of overshoot, reproductive success, ecosystem conversion, stupidity, violence, or stagnation.

In Mesopotamia by 3000 BCE, for instance, a stratified class society had developed. Slaves at the bottom. Peasant farmers, craftsmen, then the elites of administrators, religious and military. As problems developed, temporary military leaders became permanent hereditary kings. Palaces were built and staffs numbered thousands. But, the fields could not keep producing wheat and barley. Many of these problems like salinization are long-term problems and do not become evident for several generations. They are also very difficult to reverse. For a society than needs surpluses to continue, with growing dependents and growing people, there is little flexibility to change. The only way to avoid the problems was to let the land be fallow for long periods until the water table fell. This was impossible due to food demands. So, the land and the society collapsed.

Our cultural images, our worlds, do not have a close match to the organization and complexity of nature. Various images of the world have failed; our myths, from progress to science, are no longer effective in dealing with regional or local changes.

A regional culture would have emergent problems far more complex than any one individual culture. It could be crippled by hyperadaptivity (success and overshoot), since humans can adapt to poverty, bad diets, crowding, stress, and other unhealthy practices. There might be homogeneity of forms, from a loss of diversity, which could make the global culture more fragile. The global culture might exhibit a lack of flexibility, which could lead to stagnation and collapse. Other possible problems of a global culture include: Hyperpersistence of error (stupidity or violence); lack of consciousness and planning (ecosystem destruction); the limits of capitalism, or any single system, as a global economic strategy; the acceleration of interactions beyond the human social or political ability to keep up with them; and, a breakdown of boundaries and limits, especially ones that control productivity.

5.9. *Designing Cultural Units Based on Primary Cultures*

Our dream of civilization, in modern industrial culture, is the dream of order and beauty. But, as Aldous Huxley notes, the dream of order begets growth and tyranny, the dream of beauty ends in monsters and violence. Striving for the good life for many has left us with crowded roads and regimented jobs; trying to build beautiful cities has given us gigantic boxes and neighborhood violence. Trying to fulfill our dreams of comfort and security has provoked global threats and local nightmares.

There is a way to dream consciously so that the nightmares are diminished. The solution is to permit a political anarchy, based on traditional cultures, coordinated by a global 'regulating' body, based on the United Nations. There are 500 million indigenous peoples in 15 thousand distinct groups, such as the Uighur in China or the Kuna in Panama; and, there are over 2 billion people in hidden nations within massive political structures, such as the Azerbaijanis in the Soviet Union or the Tibetans in China. Furthermore, there are regions in some countries, such as the Pacific Northwest in the United States or Wales in Britain, that may prefer independence to forced membership in a confederation. At the invitation of the United Nations (or other international body), any indigenous people with a traditional culture could become an independent nation without fear of conquest or compromise by existing political states. The benefits would outnumber those of a global monoculture and the negative aspects would be more manageable.

5.9.1. *Begetting Problems & Erasing Cultures*

There have been great cultural transformations over the past 20 thousand years. Primary cultures, previously called 'primitive or archaic,' regard the relationship of human beings to nature as one of kinship; all neighboring beings fall within moral consideration. These cultures observe the synchronicity between their bodies and nature and understand their culture through mythical explanations. They employ hunting, gathering, and shifting agriculture.

Secondary cultures analyze and deduce the operations of nature; rituals become more stylized. Cultural innovations permit larger human populations; ecological limits are raised by agriculture, although they are not eliminated. Moral consideration is reserved for human beings and sometimes other conscious beings.

Tertiary cultures (in fact, the real meaning of a third world: twice removed from nature), are based on mechanical images that objectify nature. Drastic changes in the production of goods forces other psychological and social changes; human relationships are based on economic allegiances instead of kinship and exist in societies instead of communities. Money becomes a symbolic representation for the value of labor and land, which are considered mere commodities. Social stratification and the specialization of labor become fundamental characteristics. Orders are rearranged during the process of urbanization. Moral order, for example, becomes subordinate to technical order.

This last transformation of culture is not the only one in existence, however. There are hundreds of others, although around 1900 there were over 1000 unique cultures (perhaps as many as 3000) and 3000 languages (roughly equivalent to the number of natural biogeographical provinces, subprovinces, and habitats on earth).

The images and diseases of secondary and tertiary cultures had immense repercussions

on primary cultures. American cultures had no resistance to diseases bred in European cities. Many cultures could not compete with more aggressive groups. Many primary cultures have lost 60 to 99 percent of their populations. The Tasmanians, for instance, lost over 98 percent of their population; this much stress on a culture usually results in extinction, as happened to the Ona and Yahgan in Tierra del Fuego. About one third of the known groups in Brazil were gone by 1957.

Some cultures are simply wiped out. The Herero people in southwest Africa were exterminated as a culture by German forces. The Yanomami and others in Brazil are facing threats from prospectors and ranchers, now. Other cultures subside or intermarry out of existence. The Birale people in southwest Ethiopia have only 89 remaining members—and only 19 of them speak the tribal language, Ongota.

Industrial culture is wrongly considered to be the evolutionary successor to primary cultures and is displacing them rapidly. Scholars once plotted an evolutionary trend of cultural types, from primitive through historic, modernizing, and modern; they speculated that later developments were more adaptive than earlier ones and should replace them. It was assumed that the modern view culminated from earlier ages; thus, the 'superior' modern cultures were justified in exploiting or removing 'primitive' cultures.

There is no evolutionary trend of cultural types from the primitive to modern. Later developments have not proven to be more adaptive than earlier ones; nor do they necessarily replace them. Ethnic groups are not anachronistic stages that point to Switzerland or Japan; they are equally valid ways of living. Any culture is only one of many possibilities, one way of living in a unique place—there is no single correct way.

Industrial culture, depending on its expanding market system, is becoming unstable—worse, it is attempting to become a global system at the same time. We know that cultures can destroy their ecological basis, but we do not know how to extend their existence without a working ecological basis.

5.9.2. *Redefining Culture*

Much is known about the dimensions of cultures. Culture is everything created by a group, society, or nation, physical or ideal, past or present. Thus, culture embraces cookware, arrows, and turbines; art, books, and legal codes; images, values, and social structures.

Culture is a codification of reality, a symbolic system that transforms physical reality into experienced reality, which can be preserved and transmitted through many generations by language. The uniqueness of the place of a culture is exhibited through language. Language is not only a medium to express thought, it is a major element in the formation of thought. Different languages recognize events differently, therefore no culture can be considered apart from language or entirely apart from place.

The difference between cultures is not due to the number of phenomena taken into account; it is due to a difference in the basic postulates of thought. Nor is the difference really a matter of truth or falsity. Truth and falsity are less important than relevance. Primordial water is no less true than six-dimensional phase space or primordial ylem. Each group views and reconstructs the world through their experiences and values. Codifications are true to reality; they represent different facets, not exhaustive catalogues. The inconvenient truths of one culture, like the germ theory of sickness or the vengeance of Coyote, are usually disregarded when they conflict with the direct beliefs of another culture.

Although the capacity for culture is innate, culture itself is learned. Culture provides the framework and boundaries of reasoning as well as the basic ideas of discourse. Culture provides kinship rules, obligations, and entitlements, the values that determine behavior. It also defines the means of production, kinds of livelihood, and the ways of distribution. Culturally determined values and ideas are the basis of political behavior; these ideas determine the kind of institutions and their ability to change.

Culture is an active way of living for a group of people in a unique place, a set of behaviors that allow survival in one place. Culture is a dynamic whole. It is not simply a matter of territory or human ancestry or names; it is a living organ, like human skin, that allows the interpenetration between the human and the natural. Every culture has strengths and weaknesses, however, that may color and distort human perception, or limit and expand human adaptation to the environment.

5.9.2.1. Saving Languages

In the past 500 years, it is estimated that about half of the known languages on the planet have died. In the thousands of years before that, probably thousands of languages died, including: Etruscan, Cretan, Sumerian, Egyptian, Meroitic (Sudan, 800 BC-300 AD), and Cumbrian; many languages died out without leaving any re-corded traces. Many languages once spoken in Europe have become extinct. A list includes only those languages for which there are names, such as Alanic, Burgundian, Dalmatian, Etruscan, Prussian, and Yassic. Recent losses include Mbarbarum (Queensland, died 1972, with last speaker), Manx (Isle of Man, died 1974, with last speaker), Cupeno (Cal, US, died 1987, with last speaker), Wappo (US, died 1990, with last speaker), Ubykh (NW Causasus, died 1992, with last speaker), and Catawba Sioux (US, died 1996, with last speaker). Some languages are now endangered, often being spoken by less than ten native speakers. Australian aboriginal languages are disappearing perhaps at one every year; nearly extinct languages include Arabana (with 8 fluent speakers) and Biri (with 5 fluent speakers). In the US, only six languages have more than 10,000 speakers, including Navajo, Cherokee, and Mohawk. Fifty-one languages, such as Penobscot, have fewer than 10 speakers; another 35 have between 10 and 50; and 79 languages, such as Pomo or Yuki, have most of their speakers over 50 years old. Africa is estimated to have 1995 languages left from over 2500, but 116 are endangered and 54 will be extinct soon. Languages become lost as ways of life are abandoned, as happens when the young move to cities.

Each language is shaped by the environment, a people's world, and then shapes the world with words and grammar. Living in different ecosystems, and having a language suited for that system, may have allowed humans to progress more rapidly. Language helped people adapt to the environment by naming all the pieces and how they were related. Language is an important part of a culture. Culture is a codification of reality, a symbolic system that transforms physical reality into experienced reality, which can be preserved and transmitted through many generations by language. The uniqueness of the place of a culture is exhibited through language. The Inuit may have over 17 different words for snow, while the Taureg may have 11 words distinguishing the kinds of blown sand—and Americans recognize 94 shades of lipstick and 22 kinds of road surfaces.

Some languages that have become extinct, such as Cornish—the last speaker died in 1777—are being reinvented and taught. Members of that ethnic group have brought it back recently so that there are reported to be a number of people under 20 who use it as first

language, 1,000 who use it as their everyday language, and 2,000 others who speak it fluently. They have evening classes, correspondence courses, summer camps, children's play groups, and it is taught in some schools. There are languages that have been able to recover wholly or partially from being endangered; Hebrew is now estimated to have over 5 million mother tongue speakers in the world. Hawaiians have started total immersion schools, adding one school year each year, and now grades one through twelve are taught in the Hawaiian language. The total immersion schools are growing in number. Many parents are also studying the language so they can talk to their children at home in Hawaiian. The University of Hawaii now has a graduate program in Hawaiian Studies, which includes a concentration in the Hawaiian language. By comparison, Irish was rapidly expanding by 1000 AD; later it was banned by the British. Currently, it has the backing of the state and is taught in schools, but it is not used as a business language and is rarely used at home. The 9000 remaining speakers might pass it on to their children, although they might not use it. Of the possibly 6700 languages remaining today, possibly only 2300 will exist in 100 years.

There is an emphasis on an international language now. At the moment it is English. Of course it used to be Chinese, Latin, or French. And a common language has some advantages for international business or international politics. What if English were the only language? What would happen? Would it increase words? For snow and plants? Would people learn all the words? Would it start to fragment? Or would it just become impoverished with no new sources of words and ideas? We know from other languages, like Latin and Mandarin, that they become impoverished over time.

5.9.2.2. Restoring Cultures

Usually when a culture collapsed, the people lost critical knowledge of it. However, often the people went back when they could, to an earlier stage of complexity, such as herding or gathering. Sometimes they kept some of the culture, especially language and social rules.

Cultures could be rebuilt or restored, much like ecosystems, by applying general knowledge of their operation and components, especially those that are redundant and replaceable. Special attention would be given to the health or harmony of a culture. One approach would be to use properties, principles, standards, and practices to describe how. Cultures have properties very similar to communities and ecosystems. One unavoidable property is participation in habitats and cycles. Another property is manipulation of natural systems. Every culture uses an economic filter to screen the environment for resources. Every culture addresses the equity of its members. And, every culture has to deal with interior or exterior conflicts and violence.

Cultures are based on principles that are derived from the interactions in a specific environment, although the principles may be more comprehensive than a single environment. The first principle may be stated as 'self-preservation;' every culture strives to survive the challenges of existence, and often prescribes behaviors in the self-interest of the culture itself, before the self-interest of one individual. This leads to another principle, that the culture should strive to be healthy, that is, to maintain optimum levels of vitality and interest. Each member has to contribute to the health of the community and to the health of surrounding natural communities. Members have to respect the principle of ethical behavior. Another principle is that members have to recognize the intrinsic value of other beings, as well as their connections and patterns. Members have to work to increase the self-realization of

others through identification with them, the idea of the 'larger self' as part of that principle. Finally, at least for this rough list of principles, members have to act responsibly as part of the community.

Cultures, unconsciously or intentionally, create standards to maintain themselves in a balance with their surroundings. One standard is to present healthy, inclusive, positive images of the planet and universe. Another standard is to address basic human equality, especially of opportunity or value. There is a similar standard for granting opportunities for other living beings; other animals and plants should not suffer, be interfered with, or be pushed to extinction as a result of untenable human desires or ignorance. Another standard is the adjustment of population or consumption impacts below the limits of the ecosystem. Human populations do not seem to have any psychological limits on size. The limits have to be culturally explicit, and this is what can be made through standards.

One set of practices is related to cosmologies and metaphors; a culture has to provide and use appropriate images, as well as interpret them. The cosmology, the world-image of a culture, may need to be restated regularly, every generation, to reflect changing challenge and increasing knowledge. Another set of practices has to do with economic and social justice; a culture has to have ways to share wealth, to set limits on demands and needs, and to be perceived as acting fairly. The language of a culture is usually dynamic, adding and dropping words and concepts with each generation. Where the language has withered totally, as with Cornish, or just been abandoned informally, as with Gaelic, it may need to be relearned and used regularly until the habit of the language is recovered. Behaviors also may need to be sorted out in terms of effectiveness, or at least in terms of harm. Many traditional behaviors can be maintained or adjusted, giving the culture important continuity. Rules and taboos can be observed or introduced. Once people act together with language and common practices, they will be rebuilding a culture. It will be a new interpretation, of course.

5.9.3. *Summary: Nightmares & Wisdom*

Our dreams have become nightmares, which are symptoms of rotten images and unbalanced ways of living. Our ecological, social, and political problems do not have simple technological solutions; a single industrial culture cannot solve all problems in every place. The problems are cultural and polycentric.

Industrial cultures have two great myths, progress and nationalism, originally successful, that are reducing our fitness to the environment. Progress has been described by Aldous Huxley as the theory that one can get something for nothing, that the gain in one field is not even paid for in another. Progress assumes that all consequences could be foreseen and that ideal ends justify any means. Primary groups, it was thought, only obstructed the march toward paradise and could be murdered or assimilated if necessary. Nationalism is the theory that one state is the only true god; all other states are considered false. Conflicts over prestige or power, as crusades for the true state, still lead to human and environmental destruction. The cure for progress lies in the responsibility of small nations for their own environments; the cure for nationalism is a holocultural framework of small nations.

Nations have embraced a dominant industrial culture for the benefits they perceive that it gives them. But this monoculture tends to displace local cultures, such that the local knowledge and traditions—the ways of living in unique places—are lost. Nations have tried to assimilate their indigenous cultures, but many of the cultures consider themselves to be

independent. Indeed, there are over 100 separatist movements in half that many nations, from Lithuania to Slovenia, fighting for their independence, for the right to speak their own languages and teach their own traditions to their children.

The right to self-determination is listed in covenants of the United Nations, but the right has been limited to states and not primary nations. The UN, by promoting a holocultural framework, could produce a dialogue of cultures to avoid the crippling extremes of uniform homogeneity or tribal insularity. Corporations, nations, and trusts have legal rights, but cultures, and ecosystems, have been denied rights so far. The UN can rectify this oversight.

There are signs that some nations may be recognizing their indigenous populations. Peru recognizes two indigenous languages, Aymara and Quechua. Nicaragua has a regional autonomy plan for 100 thousand Miskitos, Rama, and Sumus. Some groups, like the Shuar of Ecuador, have formed legal federations to acquire title to their lands. Australian Aborigines are asserting their traditional culture and independence in the Outstation Movement, with 148 decentralized communities.

A regional (or global) framework for cultures should have few adverse effects on traditional cultures. Sometimes the widening of a culture results in a creative, explosive radiation, as when medieval Christian culture made contact with the ideas of Greece and Rome and with the achievements of China and India. Then people have more opportunities. The ideal images intensify human experience and widen its potential. We need to consciously direct our creative explosion without consuming the creativity of every other species. A framework for cultures can help initiate a true global culture. A culture is a process of continuously self-creating, but the process now needs to be consciously guided to avoid disaster. Let us restore the political power of cultures, which are bounded by their nature and limited in their activities. These small cultures can practice restraint in terms of production and resource use. They are authentic and timed by natural rhythms.

Cultural traditions, however, describe what we may be and helps us become what we are. The world tends to become how we imagine it, as a spaceship or garden, as a global monolithic state or a loose confederation of cultures. So we must create the images carefully. Kenneth Boulding offered the perfect machine metaphor for the operation of the earth—as a spaceship. As a metaphor, the spaceship suggests the limits of the earth and the value of a limited life-support system; unfortunately, it implies that the earth is a human creation that can be controlled and fixed by a conscious captain and crew. The use of the word ‘ecology’ by Ernst Haeckel implied that the natural world was a house, a place to live, rather than a machine. This image is more compatible with all cultures, from hunters to industrial corporations.

Equilibrium is needed between self-restraint and self-expression, between exponential growth and precipitous decline. The myths and metaphors of a culture are modes for conveying ecological wisdom; they are less concerned with bare survival than the survival value of a good fit to a place. Wisdom is the new kind of fitness; it is guidance by a knowledge of the whole interactive system, which if disturbed can change catastrophically.

Wisdom cannot be dependent on perfect knowledge; that does not exist. Humans must act “as if” they were wise, according to Hans Vaihinger, as if this earth were the ultimate reality and as if our human time were unlimited; we must act with caution and respect. Wisdom, as defined by Jonas Salk, is the art of disciplined use of the imagination in respect to alternatives, exercised at the right time and in the right measure. The time is now and the measure is primary cultures.

6.0. Designing Domiture

The early discoveries of science seemed to confirm that there was a real dualism between humanity and nature. New scientific research in quantum physics, psychology and ecology, focusing on anthropogenic effects on nature, suggest that the perceived dualism is erroneous. Nature is no longer a separate realm that we can look at from outside. Although the old dualism is a common misconception, human actions are embedded within human-dominated matrices, which are embedded with massive biogeochemical cycles and wild matrices.

Our level of interactions in many places suggests that human processes are significant drivers that affect the function, organization, and composition of many ecosystems (Turner et al. 1990). As the degree of our influence on the entire biosphere increases, especially interference with global cycles, we need to work to fit our actions into the limits of those cycles and systems, or risk having them collapse and require human restoration and control.

6.0.1. *Nature Itself*

G. Spencer Brown understands a much wider concept of the self. In describing the conception of form, Brown notes that the self constructed boundaries in order “to see itself”. But, in order to do so, it must divide into one state that sees and another that is seen—it must become distinct from itself. In this sense, the world has divided and subdivided itself. Whenever another division is made, a self—Brown says a “universe”—comes into being. The skin of an organism only cuts off an inside from an outside. But, the skin is permeable.

The earth has innumerable modes of being that are not human modes. Our direct intuitions of nature tell us that the earth is infinitely strange; it is alien, even when gentle and beautiful. It seems often mysteriously impersonal, unconscious, immoral, hostile, and awesome. J.B.S. Haldane recognized the strangeness of nature. “I have no doubt that in reality the future will be vastly more surprising than anything I can imagine. Now my own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose.” Perhaps the queerness results from sheer complexity. George Perkins Marsh believed that the equation of animal and vegetable life was “too complicated a problem for human intelligence to solve, and we can never know how wide a circle of disturbance we produce in the harmonies of nature ...” Barry Commoner echoes them both: “not only is nature more complex than we think, but perhaps more complex than we can ever think.” In its immense complexity, nature seems wholly other, nonhuman, or ultrahuman. Nature consists of moving patterns whose movement is essential to their being. The holomovement enfolds and unfolds in a multidimensional order that is undefinable. Nature seems distant and unknowable, so it is feared as unfathomable and uncontrollable. Nature seems contradictory and sinister, shaped by death, which we fear. We fear to understand, to be compassionate. So, we try to dominate and control nature, to overwhelm it before it can overwhelm us.

6.0.2. *Culture Itself*

Culture as a filter to keep the details of nature from overwhelming us. Culture feeds back into what nature is, as ecosystems and species. As people learn a language, and as they learn from the collective store of memories and experiences, they contribute to their own change and the historical change of a culture. People, like termites, beavers and birds, modify the environment

to improve their chances of survival. The modifications and changes become cumulative, so that houses change, ways of generating energy change, without having to be reinvented. Our general cultural ability, rather than specific biological improvements or specific adaptations, give us a greater survival potential. The accumulated cultural knowledge and their meanings as they are transmitted, is a semantic environment. The limits of this environment limits how we can design future environments. This environment needs to be redesigned before the overall environment can be redesigned. When experience is distilled in norms or laws, these secretions, as Anatol Rapoport calls them, change the semantic environment, in a way parallel to toxins or nutrients in the biological environment, encouraging or inhibiting actions.

Most cultures are multiracial and multilingual. Nations are even more diverse in peoples, customs and life styles. Culture forms an integrated design. Elements are fit into the design and related. A traditional culture integrates these relationships in a coherent whole, according to cultural values. By virtue of its integrative potential, culture provides an ideal framework for public and private decision-making. Order is a cultural problem. Order provides stability and security. Cultural order is necessary to deal with the redistribution of wealth and power. Furthermore, justice, ethics, freedom, and truth are based in culture. The study of cultural ecology—human adaptation to nature—has been neglected. The dilemma of the planet reveals the extent of this neglect.

Our minds are not only nature dependent, but culture dependent as well. As the wind, trees, and birds are sources of signals and symbols, so are gestures and words. A community is a place where a group of experiencers share ways of experiencing or the same experiences. This enables an individual to go beyond a finite view, to see the embedded culture as one of many ways of relating the self to the universe. Culture evolves from the interactions of humans with nature; both are in a constant state of flux. The development of cultures may be thought of as parallel to the development of species, where memes or ideas in a culture have the similar function of genes in a body.

Nature needs a place to play, without being controlled or converted. Culture needs a place to play, without being forced by nature. Nature is an extension of the field, Culture is an extension of nature through human existence.



Figure 5713-1. Overgrazing & Erosion in Africa (M.W. Fox)

6.1. Domiture: The Coevolution of Nature & Culture

Domiture is the entire field of extensions as a unit of study, rather than the reification of something new, perhaps divided among the studies of natural history, ecology, human ecology, and cultural ecology. Domiture, a neologism made from the Greek word fragments for ‘home’ and ‘again,’ could do that. The system of culture is embedded in nature; domiture is a larger term to enclose the previous nature/culture dualism. It has to include human reason and human emotion, rather than simply putting them on opposite columns, as with order and chaos, higher and lower, linear and cyclic, as well as agriculture and wilderness. Nature and culture need places to play. Domiture envelops both concepts, giving them room to play.

Nature and Culture are systems. Domiture is the combination of those two systems. Culture was once called a “Second Nature,” but human culture has expanded so dramatically that the two systems are better identified as one hybrid wild/developed system, now. The fitness of human systems are intimately related to the fitness of species and natural ecosystems. The human attachment to place is critical to understanding why people live where they do.

Domiture is the system of culture embedded in nature; it has to be a larger term to enclose the previous nature-culture dualism. It has to include human reason and human emotion, rather than simply putting them on opposite columns, as with order and chaos, higher and lower, linear and cyclic, as well as agriculture and wilderness.

Table 610-1. Changes between Culture and Nature over Time

Humans as part of environment	Second nature is equal to environment	Second nature exceeds natural environment
Wild ecosystems	Agroecosystems	Urban ecosystems
Natural environments	Cultural landscapes	Built environment
Dependency on natural environment	Modification of the environment	Major impact and control of environment

Even where the culture may be good, the scale of the culture results in conversion of wild ecosystems into limited human ecosystems. This is part of a large-scale problem of interference, not just in artificial systems, but also in wild ones. Landscape change is about intertwining ecological and cultural processes. Because we are humans and have cultural ideas and images, and because we have impacted ecological systems for ten thousand years, culture is part of any restoration. Environment is the natural; the landscape is cultural. But, it’s the same thing. It is not environment or landscape—It is domiture, which includes all agriculture, cities, geospheres, and wilderness.

Stewart Brand thinks that the levels of a healthy society move at different rates. Each operates at its own pace, with the lowest and slowest sustaining the others. Culture moves at the pace of the “long now,” according to Brand, at the pace of language and religion. Nature moves slower than culture. Culture is the work of whole peoples.

The study of domiture requires a Pan Ecology, that is human ecology combined with ecosystem ecology. Design has to consider the rates of change of culture and nature, as well as those of emotion and technology. Nature evokes feelings of beauty and terror, joy and sadness—we can observe the wild or feel rewarded by the experience of nature. Nature is

fun. It invites play. Ecology can be fun. It invites play. No matter how tiresome or frustrating ecology as a science can become, there is always the potential to enjoy it. Who cares if nature is not natural anymore? It is only human words and ideas. Nature is healthy, and that is what makes us healthy. Who cares if culture is claims dominance? Hurricanes, tsunamis and other events are agents of cultural humility.

Nature becomes more complex through filtering, combining, dividing, and mixing. B. Mandelbrot suggests that nature is not made of three simple dimensions. Things can have 1.63 or 2.17 dimensions. Regular simple dimensions are imposed on nature by culture, which has its own odd dimensions of complexity. Euclidian nature is a fantasy. But, nature has gotten more playful with fractals. But, fractals too are necessary fictions. Thus, everything becomes a human fiction. Still, that fiction is based on the 'wisdom' of the wild planet, and we are compelled to ask questions: Does nature exist? What is the role of humanity in the destiny of the planet? Who knows? Let's play.

6.2. *[Empty Topic]*



Figure 5713-2. Masai Herding in East Africa

6.3. *Cascadia: A Regional Forest*

Cascadia is a name given to a region dominated by the forests of the Cascades Mountains that run near the coast of the Pacific Northwest. At present the greater ecosystem is thought to be large enough and healthy enough to sustain all its native species, communities and ecological processes. But, it is under a variety of threats for settlement and exploitation. Traditional kinds of political and commercial management (particularly of forests) are not adequate to address or adapt to the distinct regions and subregions. As Richard Hart notes, the patterns that support the diversity in decomposed granitic soils are not of the same configuration that support the distinct diversity found in high elevation volcanics or clays, yet similar silvicultural prescriptions, logging systems, and timber volume tables are used to exploit these areas. A good forest design strategy would allow decision makers to look at the fabric of intelligence gathered within a biome and let that very site-specific information determine how human activity would affect its well being. This path would utilize monitoring and integrated evaluation to determine the ecological merit of implemented projects, to develop relatively benign alternatives, and to use adaptive management techniques to improve continued use and restoration.

In the Pacific Northwest, in the first half of the 1980s, timber harvests on industry-owned lands exceeded the sustained yield by 25 percent—by 61 percent in national forests (sustained yield, remember, is a small subset of sustainable ecological forestry, since it refers only to stocks of wood and not biological diversity and environmental services of the forests). Part of the problem is that few planting goals, and almost no permanent goals for coverage, are ever set. Thus, Pacific Northwest coast forests are being logged out in the United States and Canada, exemplified by increased logging for pulp in Canadian regions and logging in coastal temperate rainforests by U.S. timber companies. Logging causes deforestation (and high prices drive logging). Of the old growth forests in the Pacific Northwest, almost no inventory exists. The Wilderness Society estimates an 89 percent decrease in area in historical times, most of it coming since 1945.

Larry Harris applied island biogeography theory to the management of old-growth forests, which are being reduced to a few small isolated areas by current timber harvesting practices. He proposed a management scheme that would link old-growth areas in an archipelago (chain) of habitat islands, thus providing a means for species migration and wildlife movement. Harris describes the application of the theory: “Mature and old-growth forests provide primary habitat for 118 species of vertebrates, of which more than one-third do not find primary habitat outside this forest type. Seedling-sapling stages of succession support more species than old growth, but many of these are common species in other habitats. About forty-five species will not occur in second-generation short-rotation forests that do not contain abundant snags, broken-top trees, and fallen logs.”

Harris notes that Old Growth has been virtually eliminated from privately owned lands and lower-elevation sites. Old Growth from public lands is expected to provide the major timber supply in the immediate future. A severely skewed area distribution of existing stands of timber portends reductions in the abundance of game species as well as nongame old-growth wildlife as old growth is further reduced and present regeneration acreage reaches mid rotation age. Although old growth Douglas fir still occurs on about 25% of national forest lands west of the Cascades, it has been reduced to only 3.3% of the Siuslaw National Forest. Remaining

patches of old growth are small and isolated.

Harris states that Island Biogeography theory predicts that remnant patches of old growth salvaged from much larger, continuous stands will support greater numbers of species than will comparably sized replacement stands developed in isolation from contiguous old-growth forests. He concludes that this prediction provides incentive to conserve existing old growth rather than depend on the development of replacement stands.

The absence of immigration has caused a progressive loss of boreal mammal faunas of numerous Great Basin montane habitat islands, as well as from Mount Rainier National Park. He suggests, from a long-term perspective, a well-integrated old-growth island system consisting of a large number of islands interspersed throughout the matrix of managed forest is probably a better alternative for keeping such species. The number of possible islands increases geometrically as average size is decreased, and the average distance to the nearest neighbor island is reduced geometrically as the number of islands is increased.

Although the authors of some forest plans (unnamed for their protection) mention several costs of preserving old growth, they, and we, have always assumed that it is right to consider lost opportunities as costs. Yet, we are not losing logging jobs in old-growth areas because we never *had* logging jobs in old-growth areas; what the industry is losing is a chance to extend its unsustainable rush for low-cost fine wood to the few remaining old-growth areas. The jobs lost *are lost due* to automation and extensive ecosystem destruction, not because of *not* cutting forests that have been set aside for nonhuman purposes. This kind of economic fantasy is the result of market economics logic.

All members of an ecological community contribute to the integrity of the whole, which is vital to maintaining what we humans consider important: Visible animals, pharmacological sources, a moderate climate, and clean air and water (in a sense, nature has meta-economic values). Until old growth is recognized as a vital organ in the functioning of ecosystems, as important as a heart is in the functioning of bodies, it will continually be assaulted by the logic of economics, and it will not be safe until economics is placed on an ecological basis.

Other authors suggest that the expense of managing old growth is too great. The idea that old growth needs to be managed is based on the myth that all of nature is a resource to be processed. As Aldo Leopold pointed out, the weakness of relying on economic motives to determine value is that most members of an ecological community, such as fungus or songbirds, have no economic value—and those beings with no economic value can be labeled as weeds or pests and destroyed so that crops and animals with short-term advantages for human ends can be substituted. Until people are educated about the importance of old growth, about the real costs of industrial forestry, about the immense losses of forests, and about their role in ecosystem dynamics, forests will have to be protected politically, by laws and duties.

Having discussed the long-term ecological and cultural value of old-growth forests, the question remains as to why corporations liquidate them rather than keep them as long-term capital. The answer might be provided by recent economic history. Corporations were no longer efficient enough to expand production out of sale-generated income and took on additional debt. Corporations borrow more or liquidate some of their assets, which is probably why Burlington Northern and others allow massive clearcuts: Cash flow needs due to long-term inefficiencies and massive short-term debts. The impulse to save an incompetent corporation may override the need to save old growth forests that make Cascadia unique and valuable.

6.4. Regional Problems: Conversion & Interference

We exploit resources, plants and animals too fast for natural renewal. We exploit minerals and fossil fuels too fast for the wastes to be integrated in cycles. We create novel substances and use them too fast for the substances to be integrated in natural cycles. There is a conversion of planet from wild to urban ecosystems. System used to be wild with wild humans, now going towards one domestic urban system.

6.4.1. Cultural Conversion of Places

Agriculture converts ecosystems into simplified ecosystems that have to be maintained with large amounts of human labor to keep the system from diversifying and maturing. Even modern forestry tries to convert wild forests into single-species managed plantations.

6.4.1.1. Conversion of Land with Fields

In North America, which held the largest extent of forests on earth, forests were considered wilderness, to be tamed and converted to agriculture—although no one really expected the conversion to be so rapid or dramatic. Since the first agriculture, 10,000 years ago, forests have been cut and burned to create fields for food crops. The invention of iron plows speeded up the process because they could break up soil too heavy for wooden plows. Much later, the invention of the horse collar allowed horses to pull plows and loads with greater strength. Technological innovation, combined with accelerating population growth, lead to clearing of many forests for agriculture.

Traditional agriculture proceeds by substituting selected domesticates for wild species in equivalent niches, or by manipulation of the ecosystem, whereas modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. Margalef pointed out that all agricultural systems are laid out for low maturity, to increase production per unit. Traditional agriculture changed the pattern of ecosystems. Modern agriculture simplified those systems dramatically. From the perspective of a balloon or airplane, agricultural fields are easily identified, as circles, squares, rectangles or parallelograms, with a more monotone color and texture than surrounding wild areas.

To achieve even greater efficiency, we have increased the speed of our activities, converting materials and cultures into new designs without consideration of the meaning of, or need for, efficiency. The speed of our economy is too great for many cultures to adjust to; and the thoughtless transformation of cultures may result in great, irreversible mistakes. The speed of our conversion of wild habitats to domesticated lands is too great for many species to adapt.

Although our behavior may not be qualitatively different from our remote ancestors and the worst pathologies of wild animals, which usually result from miscommunications under certain circumstances, it is quantitatively different. More and more activities affect larger and larger parts of the planet; many problems have global effects now.

In tropical areas in the past, people practiced land use that permitted the vegetation to maintain itself despite human exploitation and the constraints of soil and climate. With population and production pressures, tropical areas everywhere are rapidly being exploited. The consequences may be disastrous.

Size is almost always the greatest threat. In spite of the fact that many Buddhists planted

trees regularly, the Buddhist traditions of wooden temples and funeral fires contributed to the denuding of large areas of forest. It is our misfortune to live at a time when the accumulated effects of the conversion of nature for human ends are becoming obvious and cutting into the survival potentials of many other species.

Modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. The application of modern agricultural techniques in tropical areas disregards the local realities, and is socially and ecologically disastrous. Traditional ways have operated successfully for thousands of years, although not without serious problems of their own. But, these problems may be overcome, unlike industrial problems, which have fundamental flaws and cause rapid conversion.

We exploit resources, plants and animals too fast for natural renewal. We exploit minerals and fossil fuels too fast for the wastes to be integrated in cycles. We create novel substances and use them too fast for the substances to be integrated in natural cycles.

The myth of a return to earlier rural times is only a myth; the soils have been destroyed. We must learn to create bioshelters that sustain us and provide us with shelter and more. The soils are starving for organic matter. Waste and manure need to be returned to the soil. Soils, like animals and plants, can be domesticated. European soils bear little resemblance to wild soils. American soils bear even less. Smaller farms could fertilize by crop rotation and manure. Build up soil, choose better seed stock; make hedgerows for birds to control pests.

Agriculture works best where it is least perfect: that is, the farmer still hunts and gathers, keeps many kinds of plants and animals, produces little surplus, uses no chemicals, grows adapted crops, and has wild lands. That situation may be ecological and durable. Successful agriculture depends on artificial climax or sustained successional state. A pioneer is self-sufficient in more than material.

6.4.1.2. Conversion of Land with Cities

There is a conversion of planet from wild to urban ecosystems. System used to be wild with wild humans, now going towards one domestic urban system. Cities convert ecosystems into cityscapes, a special artificial ecosystem with fewer plant and animal species, disrupted water flow as factor, household wastes as factor affecting the landscape, a network of corridors that perforate landscape and cut off wild flows, an increase in the number of small patches, and a reduction in other kinds of patches and corridors, woodlot, stream, golf. Flows include energy, materials, information, people, and pollution.

In a converted ecosystem, there are three imposed ecosystems with minor linkages: (1) a natural system of primary productivity based on depauperate system with few trees and layers, a simple trophic structure of birds, squirrels; (2) a human system, with imported food and water, smaller system of carnivore predators, such as fleas, lice, and bedbugs, and decomposers, such as bacteria, fungi, and gulls; and (3) a distant support systems for food, materials, and energy, but also smaller emotional support system of pets, such as cats, canaries, and fish.

The daily inputs for city, in terms of sunlight, atmospheric deposits, water, food, fuel, manufactured goods, new buildings, roads, and infrastructural support, is tremendous. The daily outputs, including heat, water, sewage, solid waste, and pollutants, are likewise tremendous, although they are skewed to unusable wastes, including heat.

These extra inputs and outputs have effects, side effects, or rather main effects that are unwanted or unanticipated. By thinking in terms of side-effects, we have been unable

to manage the side-effects of our massive technologies. They are in fact unmanageable in a mindset that thinks of them as side-effects. A holistic rationality or neologic might be better to use, where everything is an equal effect, and we manage out technology to have all the effects. Land is taken over and covered, but then idle land may total 9-28 percent of the urban area.

Villages lower connectivity to the landscape by increasing patches and corridors. Agriculture gets more homogenous, decreased fallow areas. Stream corridors are destroyed, environmental degradation. Connectivity is lowered, matrix is minimized. And, these things happen: Disturbance of nutrient mineral cycles. Disruption of atmosphere, drought, storms. Changed microclimate, with heat islands and dust domes. Lower photosynthesis/productivity. Lower diversity leading to homogenization, with cosmopolitan species. Inefficiency of use of energy and materials. Decaying infrastructure, roads, sewers, buildings, and houses. Disruption of supplies, due to social and political actions, e.g., strikes, breakdowns, attacks. Budget crisis from loss of tax revenue. Increase in violence, sickness, drug use, crime, and impoverishment. Increase in mental and physical illness from stress. It is almost as though human beings are major agents changing the planet into something else.

6.4.1.3. Industry & the Artificial

Artificially created environments are cultural environments. Nature thus acquires characteristics from agriculture and social institutions as well as from geology and climate. The practices of environmental conservation must be complemented by careful policies of environmental creation. Societies have images of the future that influence their policies, and those images can be shaped by knowledge and persuasion. Human beings can and have created new ecological values by collaborating with, or following the laws of, nature.

Many ecosystems in the temperate zone are artificial. The tame character of ecosystems in England, for instance, results from human intervention. English parks are based on an imperfect understanding of natural systems, and on their potentialities, as well as on a series of happy accidents. Much native vegetation is a social artifact. In Scotland, for instance, forest cover was reduced from 55% of the total area to 5% by primitive stock-keeping and agriculture; moors decreased by half, but meads increased eight-fold. The soil was more fragile, so the accidents were not happy and the forests did not grow back. Some forest plantations have been started. Dubos mentioned Kentucky, Western Europe and Japan as examples of radical conversion from the native fauna without disorganization.

6.4.2. *Conversion & Interference*

Humanity is exploiting nature recklessly, by converting ecosystems without paying minimal attention to their health. Many ecologists, such as Eugene Odum, have observed that complex communities have existed for thousands of years in relatively stable environments, even though these environments are characterized by regular disturbance and constant exploitation. As a result of our growing population and increased use of technology, these environments are now vulnerable to human *interference*, which is a different thing from disturbance or exploitation. Disturbance, by definition, is an event that can be caused by climate, biological entities, or other actors. Exploitation is the normal use of a resource or of a species by another species, including the human species (this ecological definition differs from a sociological definition, which means 'selfish or unethical use,' although it may suffer from negative connotations due

to the latter); in fact, ecological exploitation has a rejuvenating effect on populations.

Interference is an activity that can degrade, destabilize, or destroy entire ecosystems. Interference is not a form of disturbance, exploitation, or competition; it is destruction without gain to any species. Sometimes it is caused by planetary events, such as volcanic eruptions, but in the case of human interference, it is the destruction of the structures and processes of evolution for a large-scale, one-species, short-term gain. Interference behavior that characterizes the nonecological activities of the dominant human, industrial culture. The heavy dominance of ecosystems by humanity is related to the biological and cultural characteristics of the species. Ignorance and indifference are identified as major reasons for continued interference.

Although rare large-scale or novel disturbances can interfere with ecosystem processes, the term 'interference' is reserved for constant large-scale or novel effects. The destruction of ecosystem processes in nature by the action of one or more species is rare; any species that did so would become extirpated or extinct, unless it was not dependent on a single ecosystem, as is the case with wolves. Many commentators have accused mammals, wolves for instance, of overkilling their prey. It is fairly well established now, by David Mech and others, that wolves will take prey in excess of their immediate needs. This behavior has been interpreted as useful in maintaining not only the wolf but also secondary predatory and scavenging populations, for example, foxes and ravens. Indian informants are aware of this aspect of the wolf's excess kill, but they attribute to the wolf sufficient foresight to kill an excess of caribou near the den site in order to have an adequate food supply when the caribou are absent. Regardless of the wolves' intent, excess kills of caribou by wolves seem to be linked to the pup-rearing part of the pack that follows behind, as well as providing some food for the reverse seasonal migration—wolves can eat the remains of kills that are up to a year old.

Like wolves, human beings interact with the individuals of other species or with entire species. Like other mammals, humans change their habitats to suit themselves. Humans have modified animal and plant associations in a different way from other mammals, simplifying patterns of energy and chemical exchange and solidifying themselves at the end of many food chains as a dominant species. (A dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the character of the habitat.)

Human populations have increased exponentially, with billions in giant urban ecosystems. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of fertilizers and pesticides. Dams have been built all along rivers, and riverine forests have been cut, altering rivers and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population. We dominate entire ecosystems.

6.4.2.1. Pandominance of Humanity

This pandominance—that is, dominance of every system—has major effects on ecosystems: Transient perturbations in energy relations, from oil spills or burning, for instance; chronic changes and shifts of systems, from dams, irrigation, or chemical wastes; species manipulation, from the import and export of exotics; and, interference competition with wild species. None of these effects are exclusive to humans as a species, but they are excessive, rapid, compounded, and very large-scale. Humanity has upset the balance of nature in favor of its own needs. Animals, plants, and habitats are being destroyed because of short-sighted, short-term

economic interests.

Human beings have contributed to the extinction of species and to the destruction of ecosystems. Human hunters are hypothesized to have wiped out the most of the large mammalian species of the Pleistocene through overhunting—not for future food, but rather from the style of hunting—by driving herds over a cliff. It is possible these populations were vulnerable due to changes in climate and food sources and may have become extinct without help. There are other instances. In the 1880s, soldiers and cowboys slaughtered buffalo as a political strategy to reduce the resources of native peoples. Farmers and loggers destroyed the dense forests of Ohio and other states. Settlers and industrialists in the Amazon are destroying vast tracts of rainforest, as part of a political strategy to move peasants out of cities. Industrial forestry in the Northwest America is content to take a high percentage (well over 90 percent) of a forest for wood and pulp, destroying the basis for the continuity of the forest, as well as all beings that depend on the old-growth, fungi, and physical properties of the forest to live.

The biomass of the human species probably exceeds the biomass of any nondomestic mammalian species, and that biomass is supplemented by the tremendous biomass of domestic animals, which is far greater than the human biomass and consumes much of the same food as humans, including milk, fish, and grain. The domination of humanity is related to other characteristics as well—its large annual population increase at over 2 percent, its high structural organization of information and matter, and its high energy use, which is globally 13 times the total of all other mammal equivalents.

Human exploitation at the tremendous physical scale that occurs in industrial states is different from exploitation by other species, because it results in the destruction of the entire system, the very basis for renewal of a system that human beings, as well as other species, need for life. Human actions are damaging global biogeochemical cycles, such as the carbon or nitrogen cycle. For instance, deforestation, burning, wetland loss, and industrial processes are releasing massive quantities of carbon dioxide into the atmosphere, which disrupts the carbon cycle. Although the destruction of large species, from whales to frogs, has a dramatic effect on ecosystems, the destruction of microbes, which generate oxygen and recycle nutrients, has a critical impact on the entire food web. These actions are global, like a large volcanic eruption, but, unlike a volcanic eruption, they are constant and hourly. These predominant human activities are best referred to as interference, and may be related to our industrial style.

6.4.2.2. Industrial Style

Humanity is calculated by Norman Myers and others to be using over 40% of the ecosystem productivity for the entire earth—and this increased to 56% by 2004, according to Stuart Pimm and others. Humanity influences virtually every ecosystem to some extent, destroying some, interfering directly with many, and exposing the rest to exotic chemicals and materials. Species normally use a percentage of system productivity without disrupting the processes of production. The human species interferes with the processes.

Interference has been a rare phenomenon on earthly ecosystems; it has happened in the past as the result of global catastrophes, such as meteor impacts. Now, interference, as opposed to more limited and predictable disturbances or exploitations, is threatening the stability of all ecosystems. It is dangerous to interfere with the processes of ecosystems because it disrupts the communities on which other species, and ultimately human communities, depend. Furthermore, in the deepest sense, it violates the idea of living together with other species on

the planet. The proper relationship of humanity with nature should include competition and exploitation and mutualism, but not interference.

We kill millions of animals in laboratories to insure our safety, we kill billions of plants and animals for food and clothing and products, while indulging in the sentimental preservation of some individuals of other species. Animals do not need to be saved from natural death, a great regulator of life, but from unnecessary suffering, experimentation, and premature extinction. The world would not be a better place without sharks, silverfish, rats, cockroaches, or hyenas. They need their own places. The places need to be saved. If we diminish variety in nature, we debase its stability and wholeness. To save ourselves, we must preserve and promote the variety of nature. Perhaps we should reconsider our unconscious role in nature as agents.

6.4.3. Humanity as an Agent of Change in History

Large forces have shaped the history of the planet and life; these are geological processes, as well as solar system effects, such as the output of the sun or meteorites. For civilization, we should include the environment, such as climate and the distribution of resources. Especially important are human impacts on ecosystems, such as deforestation, identified by John Perlin as very important, perhaps the reason for the decline of the Hittites, Babylonians, Romans, and others. Another impact is desertification, according to Uwe George and others. Disease patterns, according to W. H. McNeill, are crucial. To disease, Jared Diamond adds steel and guns as forces that have shaped human history and societies. Then, there is simply luck, the position of a culture in the stochastic chaos of nature.

By their activities, human beings change the places where they live. Much of the change is easily incorporated in the cycles of renewability of the ecosystems. However, humans often change the directions of such systems by simplifying or degrading the systems. In this case humans act as agents of interference.

6.4.3.1. Humanity as Biological Agents

Humans have had a great impact on nature, and should be considered themselves as a force of nature and history. One could consider humans as special agents. One analogy of humans as special agents is as a parasite: A consumer feeding on another living organism, usually inside, drawing nourishment and weakening the host. States acted like macroparasites, according to William McNeill, but becoming less violent or unpredictable over time, as they adjusted to their host populations.

As crowding increases competition, there is more pressure on remaining reserves. Humanity parasitizes nature. Humanity becomes an autoparasite, a new pseudo-species. Technology enlarges the number of niches for us; tools fit humans to different habitats, displacing other species. We steal from animals and plants, from the earth, from our own descendants. Thomas Hobbes foresaw such a war of each against all. The systematic destruction of human beings and animals is not an isolated peculiarity. A fat parasite often kills its host and then dies itself. Perhaps, humanity is an agent of a different sort, a systems agent that encourages only positive feedback.

Perhaps human expansion is like a cancer. Alan Gregg compared the world to a living organism and the explosion in human numbers to the proliferation of cancer cells. He sketched other parallels between cancer in humans and humans' cancer-like impact on the

world. Cancer cells proliferate rapidly and uncontrollably in the body; humans continue to proliferate rapidly and uncontrollably in the world. Crowded cancer cells harden into tumors; humans crowd into hardened cities. Cancer cells infiltrate and destroy adjacent normal tissues; urban sprawl devours normal open land. Malignant tumors shed cells that migrate to distant parts of the body and set up secondary tumors; humans have colonized just about every habitable part of the globe. Cancer cells lose their natural appearance and distinctive functions; humans homogenize diverse natural ecosystems into artificial monocultures. Malignant tumors excrete enzymes and other chemicals that adversely affect remote parts of the body; humans' motor vehicles, power plants, factories and farms emit toxins that pollute environments far from the point of origin.

It is not in a tumor's self-interest to steal nutrients to the point where the host starves to death, for this kills the tumor as well. Yet tumors commonly continue growing while the victim wastes away. A malignant tumor usually goes undetected until the number of cells in it has doubled at least thirty times from a single cell. The number of humans on Earth has already doubled thirty two times, reaching that mark in 1978 when world population passed 4.3 billion. It is over six and a half billion now. After thirty-seven to forty doublings, at which point a tumor weighs about one kilogram, the condition is usually fatal—that would be the population equivalent of 5.4 billion people. We have exceeded that; the question is if it has been fatal—large complex systems may take a long time to collapse—or if the system has more flexibility than an organic body.

The metaphor of cancer may be more appropriate than a footprint. After all, a footprint can stimulate some kinds of ecosystems, such as short grass prairie. What humanity does is transform the ground under the footprint into a new human system.

6.4.3.2. Humans as Ecological Agents

Every species exploits its environment to the extent that it can, with no regard to consequences. Usually, each species is checked by another, because there are so many competing for the same food, and equilibrium is maintained.

Partial knowledge and technology has allowed us to exploit our environment beyond what is desirable for us or for other species. While continued, moderate exploitation is necessary to live, massive, unbalanced exploitation is unwise. A wise use of resources would not make the world less habitable. We are part of the system and must protect its health as a whole.

By distorting the equilibrium, we have destroyed whole species and favored many others, many wild as well as domesticated. Rats and mice have been carried to all parts of the world and live in direct competition with humanity, invading our buildings for food and shelter. Crows and coyotes have also profited from their human association.

Basic principles need to be examined in relation to human ecology. Populations are maintained at optimum levels demanded by the ecosystem; this maintenance is achieved by the production of excess young and the elimination of the weaker, the least fit to survive; mating and parenthood are denied to the young, by instinct in most species, until a territory sufficient to raise, feed and protect offspring has been acquired. If the population becomes excessive, glandular conditions are activated to induce stress and complications, which reduce the population.

6.4.3.3. Humanity as a Geological or Climatic Force

No single change is exclusive to humans as a species, but they are excessive, rapid, compounded, and large-scale. There is movement of soil, but also massive erosion. There is movement of minerals, but also disruption of mineral cycles. There is the addition of novel elements into the atmosphere, but there is also a massive release of carbon.

When people use more of the earth's supplies in a certain period than can be replenished in the same period by the sun, they are eating into the natural capital. Humans have caused the extinction of hundreds of species. Rhinoceros, buffalo and crocodiles are disappearing. Getting timber for fuel and construction, clearing land for agriculture, has destroyed whole habitats. Demand for timber has been insatiable, for houses, ships, paper, and fuel. Trees have been cut from vulnerable watershed sites, with resulting floods, erosion, and diminution of rainfall and water table. Domestic animals inimical to growth were introduced, such as rabbits and goats. The introduction and maintenance of sheep in Spain, Italy and Cyprus has changed whole ecotypes.

Sixteenth century Spain, under Philip II, experienced unprecedented growth; shipyards flourished; gold was brought from South America; wars were fought. But, every year it cost thousands of hectares of centuries-old forests to build and maintain the fleets. By the end of the seventeenth century, the rich Iberian forests had disappeared. After the soils eroded away, there were famines.

Vegetation holds soil in place, reduces wind speed at the soil surface, and improves water absorption and transport in the soil. Erosion destroys soil and makes it difficult for plants to be reestablished. Recovery, if it occurs, may take decades. Erosion is an ecological catastrophe on a planetary scale, causing thousands of higher plant and animal species, and countless lower species, to be lost forever. This is what is planned in Brazil and South America. It is not known how massive deforestation through overgrazing, firewood collection, and timber exploitation will affect terrestrial and atmospheric systems. Perhaps we should just accept erosion. Erosion is picturesque. Cezanne's paintings of France are striking. The abstract terrain of Greece is pleasing to many.

Israeli scientists doubted the theory that Arab methods of cultivation were responsible for spread of desert in North Africa and Middle East; desiccation on that scale is beyond even modern technology. They concluded that deserts are usually created by a relatively small change in climate. However, grazing practices could cause a small change in climate and thus contribute to desertification.

Only in the nineteenth century beginning with G. P. Marsh, did people start to realize that humanity has done as much to change the environment as the environment has done to mold human history. Marsh, the first U.S. ambassador to Italy, was one of the first to study the role of humans in changing the face of the earth. When he visited the near east, he was shocked to find deserted cities, silted harbors and wastelands instead of flourishing civilizations. He concluded that ecological errors had led to the deterioration of agriculture in Mediterranean countries. He advocated agricultural conservation practices.

Environmental factors have shaped the course of human history to a greater extent than had been realized. The decline of Rome is a study in forest ecology. There were previous and later catastrophes in the Tigris and Euphrates valley, Greece, Khmer, Maya, Midwest United States, and the Australian outback. Many people did not change their behavior in time to solve the problems. Worse, the current civilization is global, not local; so, there will not be a

migration to unaffected lands. Ecologists have not unraveled most mysteries of ecosystems, so the long-term consequences of most human interaction can be predicted generally.

6.4.4. *Practicing Noninterference*

Exploitation, in the ecological sense, is necessary and beneficial to biological populations. A machine metaphor approach, with its assumptions of interchangeability and quantity, apparently has difficulty distinguishing between exploitation and interference. An ecological metaphor, that is more receptive and reverential, may be more appropriate to understanding organisms and nature in general. Such an approach would stress noninterfering observation rather than controlling manipulation.

Applied to nature, human intelligence could discover the significance of natural rules of interaction and exploitation. The reverence for beings as they are could result in a rule of noninterference (Wittbecker 1984). A rule of noninterference states that human beings ought to avoid behavior that disrupts essential ecological processes or destroys biotic communities. As Paul Taylor states his rule of noninterference, it requires a “hands-off policy” for whole ecosystems and biotic communities; the rule stated here is concerned with limited and sustainable exploitation of ecosystems already shaped to some extent by human activities. Many other ecosystems would be reserved by law for predominately natural ecosystems or adapted first nations. Noninterference also means “letting be” (after Martin Heidegger), or “letting alone” in the words of E. O. Wilson. Noninterference is not indifference, which is diffuse. It is caring.

We need to practice the rule of noninterference so that all beings can enhance their lives and habitats. Noninterference can be derived from nonviolence (or taoistic nondoing, a metaphoric expression for the nonbeing of nature) or even from English Common Law, which is well-established in Western law; it includes a precept: “Use what belongs to you in such a way as not to interfere with the interests of others” (*Sic utere tuo ut alienum non laedas*). This rule could be defined by positive laws and by negative restraints on behavior. This attitude would entail using what is necessary, exploiting some ecosystems completely, changing a place to fit human aspirations, and killing plants and animals for sustenance. But, it would also mean limiting humanity and its technological effects, limiting human use to local impacts, and letting other beings live without interference. It is not necessary to dominate or to terraform the earth completely. Humanity could contain itself to a small percentage of the planet’s surface and ecosystems and only visit or ignore the remainder.

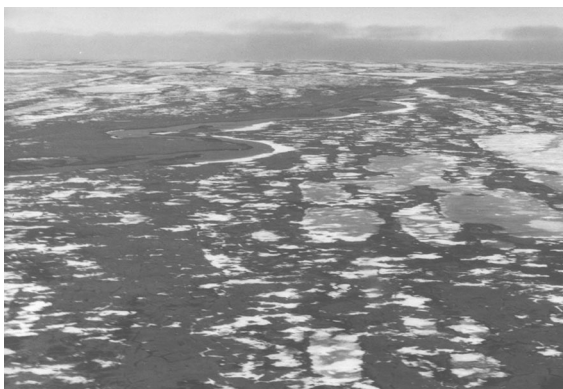


Figure 650-1. Aerial of North Slope (from M. Lynch’s Cessna 1984)

6.5. Designing a Wild Region: The North Slope of Alaska

An inappropriate time scale, its shortness and urgency, is a cause of many problems in the exploitation or design of large ecosystems. For example, although boreal ecosystems in the arctic are considered renewable resources, they are slowly renewable, requiring hundreds or thousands of years to renew from catastrophic disturbance; this time is far longer than any economic plans, and really is nonrenewable on a human life scale. This has important implications on sustainability.

Scientists, designers, and planners have started to address regional scales. Ian McHarg created a layer-cake model of design that synthesized many environmental and psychological factors in design. Frederick Steiner took the McHarg survey technique and applied it, with modifications, to human communities. Steiner concentrated on how human communities could identify specific goals for sustainability. His approach allows planners to analyze the problems of a region as they relate to each other, the landscape, and various political structures. Steiner defines ecological planning the use of biophysical and sociocultural information to suggest opportunities and constraints for consensual decision-making about the use of the landscape. Reed Noss proposed an ecological planning process to approach the issue of sustainability from natural communities. Noss based his process on the protection of all ecosystems.

The McHarg model placed great emphasis on inventory, analysis, and synthesis. Steiner placed more emphasis on the establishment of goals, administration and public participation. Many community planners, such as Herbert Gans, advocate goal-oriented planning. One recent example of goal-oriented planning is Oregon's mandatory land-use law. But are the goals generated at local level or higher government? What about regional goals?

Robert Bailey completed a land-capability analysis of ecoregions to develop controls that would consider environmental limits and impacts. The Nature Conservancy has shifted to an ecoregional basis, from a single species approach. Loomis and Echohawk found that 23 of 35 ecoregions have less than 1 percent protected and 7 regions have no land protected as wilderness. Many ecoregions, such as the North American Great Plains, have a cycle that combines growth and decline over long periods, as populations flow in and out of the region. For such regions to be protected would require very large areas.

That raises the question of how we could maintain functional integrity in ecoregions. Thinking ecologically makes us aware of interrelationships. Design is recognizing these regional processes and contexts. The task of ecological design is to create patterns deeply adapted to place. It cannot do so, however, without considering an ecological ethic. The ethic proposed by Aldo Leopold was supported by Lewis Mumford and B. MacKaye, who were influenced by P. Geddes and E. Howard.

This design for the North Slope Region considers these models and ideas and recommends a series of goals and limits in a comprehensive design for wilderness based on the biohistory of an ecosystem, the cultural values of the people, and knowledge of the limits for sustainable development. This approach makes the limits explicit and sets equitable goals within the limits. Its synthetic framework provides for the health of the ecological system as well as for human health.

The design relates wilderness to resource use by the cultural values of an optimum human population within a home ecosystem, although that system is connected to others by trade for some necessities or luxuries. Cultural goals are keyed to the traditional idea of physical limits. Five general steps are followed from a comprehensive plan (Wittbecker, 1992). (1) A place is identified within its natural boundaries. The North Slope Region is a uniquely identifiable ecosystem with recognizable boundaries and a unique history and character. (2) An optimum amount of wilderness is calculated to preserve the natural cycles indefinitely. If the current area is less than the calculations, the difference is restored and set aside as a reserve. (3) The remaining areas are zoned for appropriate use, including conservation, preservation, and artificial areas. (4) Resources available for human use are identified, including raw materials and the usable biological productivity of the areas. Productivity is used to calculate a base line population. (5) Cultural modes—where culture is an ecological activity—set limits on the use of technology and resources. Cultural values drive changes in the ecosystem. As part of the formulation of a design, it is necessary to examine the natural and cultural histories.

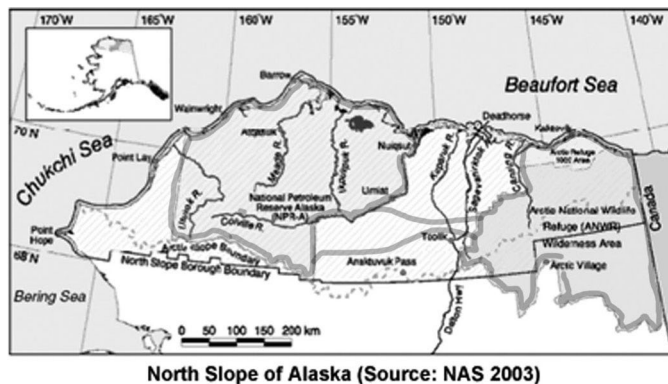


Figure 650-2. North Slope Map

6.5.1. Biohistory of the North Slope Region

The arctic coastal plain is a physiographic province in the Arctic, covering 200,000 square kilometers, extending 129 kilometers from the foothills of the Brooks range to the Arctic Ocean. The coastal plain is composed of marine, fluvial, alluvial, and aeolian deposits from the mid to late-Quaternary Age. The sediments were produced by a series of marine transgressions that encroached on the plain. Large elliptical lakes cover 40% of the land surface (over 60,000 square kilometers) in the northern part of the plain. Relief is low, with river terraces, polygons, and occasional pingos (single conical hills); the slope is only 1 centimeter per kilometer. The coastline (1,800 km) relief is only 2 to 5 meters, although some bluffs along rivers and streams can exceed 20 meters. The 75 meter contour is considered the boundary between the plain and the foothills. Only the Inaru river lies within the plain; other rivers originate in the Brooks range or foothills and flow through the plain to the arctic ocean.

Off the arctic slope are the Chukchi sea and the Beaufort sea, divided by Point Barrow. The shallow Chukchi covers part of the continental shelf. The Beaufort covers a narrow shelf dropping to the deep (2,400 to 3,600 meters) Canada Basin. Water circulation is dominated by a north then east flow. Beaufort coastal waters have a limited amount of nitrogen and phosphorus; with low light levels, there is low annual primary production.

As light increases in the spring, algae blooms provide nutrition for zooplankton and pelagic crustaceans—copepods, amphipods, shrimp, which support whales—beluga and bowhead, seals, and birds. Millions of birds come in the spring—loons, geese, terns, and gulls;

puffins and cormorants nest in colonies. By summer, arctic cod and sculpin come close to shore; cisco and other anadromous fish also travel along the shore.

The climatic zone is arctic, with long, dry, cold winters and short, moist, cool summers. Winter lasts from October to late May; summer is cool, cloudy, and short. With only 12.5 to 37.5 centimeters of rain, the slope is basically a cold desert. Day length varies from continuous darkness to continuous light.

Because of the low temperatures, the depth of ground that freezes in winter is greater than the depth of ground that thaws in summer, resulting in permanently frozen ground, the permafrost, just below the active layer (freeze-thaw). The permafrost is a complex, dynamically balanced, historical system, with interacting vegetation, substratum, topography, solifluction (soil flow), and animal activity.

Twenty percent of plant growth is eaten by mammals (there are few plant-eating insects). About 80% of the annual tissue growth returns to the soil when plants or parts die. This material is eaten slowly by microorganisms and fungi, which are fed on by mites, larvae, springtails, and enchytraed worms, and these are preyed on by birds.

Tundra plant associations are identified by the frequency of the members of a small, specialized flora. There are three major categories of associations: Wetlands, dominated by grasses, sedges, and rushes. The arctic coastal plain has many almost pure stands of marsh grass. Drier mesic areas may be characterized by cotton sedge tussocks interspersed with lichens, mosses, ericaceous shrubs, and dwarf birch. In the more rolling topography, the tussocks offer havens to small mammals. The fellfields are made up of wind-eroded, frost-heaved, crustose lichen-covered rock fragments, with mats of black lichen and colonies of *Dryas*.

There are 574 taxa of vascular plant flora, only 8% of which occur in the plains—90% are found in the foothills. There is low species diversity: 189 species of birds, 24 species of terrestrial mammal fauna (only 5 endemic to tundra), with slightly more species of marine mammals. The largest land mammals include caribou, moose, bear, fox, and wolves.

One basic characteristic of boreal food webs is flexibility in the food habits of animals. Boreal feeding niches are broad and flexible, and without the extreme specializations seen in tropical and even temperate food webs. Boreal food webs, being made up of so few species, are also fragile and undergo dramatic shifts (violent cycles of populations). The tertiary consumers, humans, wolves, and jaegers, depend on three basic primary consumers of vegetation: microtine rodents, ground squirrels, and caribou. Steller's sea cow and the Alaskan musk ox were hunted to extinction. The sea otter and walrus were extirpated in some of their ranges. Rare and endangered species include five species of whale, the Arctic peregrine falcon, Eskimo curlew, and several species of plants.

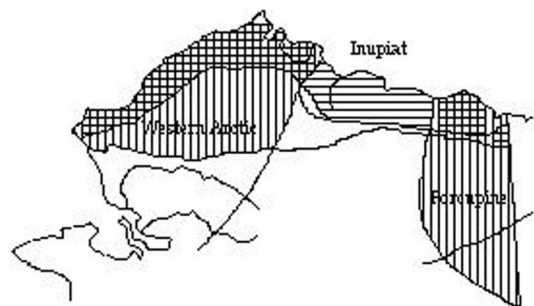


Figure 651-1. Inupiat Territory
& Caribou Herds

6.5.2. *Human Cultural History*

The first boreal hunters were primarily Mongolian in origin. From Carbon 14 dating, they have been here for at least 27,000 years. Hunting on the coast tundra has occurred for at least 6,000 years, probably 12,000. Boreal humans were limited by the seasonal progression of harvests: Caribou, moose, seals, and fish.

Hunter-gatherers lived in bands; local bands formed part of a larger linguistic and breeding community. Local bands gathered regularly into larger groups for ceremonies or food-sharing. Trade between Inuit groups had been constant, so that the Inupiat had knives, metal vessels, beads, and tobacco before direct contact with Europeans.

The language of the Inuit of the tundra is Inupiaq, derived from a Proto-Inuit language. Although Inuit culture is fairly uniform from Alaska to Greenland, there are differences in tools and hunting techniques, as well as social customs. The primary unit of social life is the nuclear family.

The Inupiat group is a subculture of the Inuit centered on the arctic slope. All native inhabitants of the North Slope Region are Inupiat (a single inhabitant is an Inupiaq; Inuit refers to more than one group). Nunamiut means inhabitants of land (inland people); Tagiakmiut means inhabitants of the coast (sea). Inuit bands identify with geographic areas. Around Barrow are the Nuvukmiut; west, east and inland are other groups.

The Inuit developed a culture that allowed them to survive in an arctic environment. The arctic small-tool tradition was their technological base. Inuit weapons were fashioned from bone, ivory, and driftwood; all hunting tools were engraved with magic images to encourage the animals to be killed. The Inuit killed caribou, bear, wolves, and other animals. They collected over 2.5 million pounds of meat a year from over 9000 animals, mostly caribou and seals. They fished, and hunted waterfowl and seals from kayaks. For hunting whales and walrus, crews of Inuit hunted in an open-hulled vessel, umiaks, covered in walrus hide.

In the Inuit world all beings, humans, animals, plants, and stones, have an inner soul (inua) that can transform into other life forms—a walrus might become a seal or a seal a human. The spirit of a slain animal remained alive in the bladder, which was returned to the sea, to be reborn in another animal, during an annual bladder festival.

Traditionally, production was not separated from the domestic functions of families (Sahlins, 1968). Activity was home-based. House types were determined by the composition of a household and the anticipated length of residence. For a nuclear or extended family, a caribou skin tent (iccellik), dome-shaped over willow branches, was traditional (requiring 20-23 hides). Snow and moss were packed around the sides. Sod houses were also employed for winter settlements. The snow-block house was built as a one-night shelter. Sleeping bags were made with caribou skin.

For clothing (Hoffman, 1976), each adult needed about 20 caribou skins, eight skins for a complete outfit, including parkas (2 each), pants (1), boots, mittens, and gloves. A hunter's kayak took 12 skins; others were needed to cover caches, sleds, and walls. For food, shelter, and tools, each person needed at least skins per year.

The north was first invaded by Europeans in search of right whales, then walrus, bowhead and blue whales. In the 1860s whalers were trading rifles, ammunition, flour, liquor, tobacco, and molasses for caribou meat and furs. Fur traders came later to take their own beaver, wapiti, bear, and musk ox. Explorers also decreased populations of caribou, musk ox, bears, and walrus

to feed their expeditions.

Starting with the gold rush and continuing through the oil rush, hunting rush, and tourist rush, human populations have increased far beyond the carrying capacity of the land to support them. Large permanent supply lines, sometimes inadequate, are needed to support population levels. The Inuit today have been invaded by a consumptive culture, which is so far unable to adjust its urban industrial world view to environmental limits—refusing to acknowledge many limits.

There are now eight fairly large, year-round villages in the North Slope region: Kaktovik, near the refuge, Barrow with over 3,500 people, Wainwright, 161 km southwest, and Point Hope, another 161 km southwest; also, Anaktuvuk Pass, Atkasuk, Nuiqsut, and Point Lay—most with less than 300 people.

As a result of the 1971 Alaska Native Claims Settlement Act (ANCSA), Inuit received 17.6 million hectares (44 million acres—10% of the state). Each eligible native received 100 shares in one of 12 corporations (a 13th held emigrants rights). These shares were to be eligible for sale to non-Natives after 1991, later extended to 1993. The tundra area, including the National Petroleum Reserve (NPR) and Arctic Wildlife refuge (ANWR) is controlled by the Arctic Slope Regional Corporation (ASRC); they filed a 23.2 million hectare claim to control the land.

As a business, the Arctic Slope corporation lost \$6.9 million in 1982 because of a settlement and decline in construction at Prudhoe Bay and the NPR. It has created subsidiaries: Arctic Slope Alaska General Construction Company, A. S. Consulting Engineers, Eskimos, Inc., which operates gravel pits in Barrow and rents heavy equipment, and Tundra Tours, which owns a hotel and provide bus service to schools. In 1985 Chevron, BP, and ASRC drilled an exploratory well in the refuge; since then, especially after the Exxon Valdez spill, the refuge has not been open to further exploration.

The 12 regional native American claims fit native cultures to their ecosystems. They are natural groupings that arose from long-term dwelling. But they only represent the commercial interests of natives. The North Slope region however, is congruent with an intermediate level of Alaskan government, the North Slope Borough. Often the boundaries of boroughs conform to natural geography and seek to interrelate cultural and economic activities. This encourages reliance on regional resources.

Unfortunately, ANCSA did not resolve the issue of native subsistence. The state still asserted its jurisdiction over fish and wildlife. In 1980, the Alaska National Interest Lands and Conservation Act (ANILCA) increased the size of national parks to 42 million hectares (104 million acres). ANILCA was not able to resolve the subsistence issue either.

Even at low numbers in the arctic, humanity is a pandominant species—a dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the very character of the habitat. As pandominant, humanity overkills, clears, depletes, and wastes at a level that threatens the stability and existence of many systems. One of the ecological consequences of human activity on important areas, such as Teshekpuk Lake or the Utukok uplands, is the degradation of wild habitats for human developments (food, housing, and recreation) and the introduction of novel elements into the biosphere—elements that have not been harmoniously worked in over time.

This dominance has major effects on the North Slope Region: transient perturbations in energy relations (from oil spills, burning); chronic shifts of systems (from dams, irrigation,

chemical wastes); species manipulation (from the import and export of exotics); and, interference competition with wild species (as opposed to exploitative competition, which can be stabilizing). None of these effects are exclusive to humans as a species, but they are excessive, rapid, compounded, and large-scale. With a comprehensive, ecological, long-term design, changes and impacts can be anticipated and directed.

6.5.3. *A Design for the North Slope Region*

Wilderness is the critical factor in this region. In planning for wilderness, it is necessary to consider an optimum human presence within ecosystem restraints, as well as air and water quality, genetic minima, nonrenewable resources, appropriate technological innovation, the importance of cultural frameworks, adventure, research, beauty, uniqueness, and other intangible experiences. Because it will always be subject to human influence and revision, wilderness cannot be considered apart from human population growth and human activities.

The wilderness of the North Slope Region is a sum of areas related to land area, ecosystem cycles, productivity, technology, culture, and an optimum human presence. An optimum human population is calculated by adding the total annual productivity (in Kcal) to the total annual resources (in Kcal), multiplying that sum by technological and cultural modifier fractions, and dividing that by the annual per capita requirements for food and resources. The available area is obtained by subtracting wilderness areas, conservation areas, and other areas to be reserved from the total area. A technological modifier, based on the use of technology in extending or contracting the food or mineral productivity. And a cultural modifier, based on the application of cultural values in determining area and productivity are applied to calculations. For the total figures for all essentials—food, shelter, clothing, transportation—energy is converted to Kilocalories and placed on an annual budget (averaged over 1, 10, or 100 years). Calculations are used for the purpose of illustration; they are not conclusive or binding.



Figure 653-1. Design for North Slope

6.5.3.1. Wilderness Reserves

The Inupiat have no word for wilderness; for them the land is peopled with reasoning, speaking beings. At low population levels and high dependence on the resources of the land, it is unlikely that the Inupiat would destabilize the North Slope by their hunting activities. However, with cultural invasions and changes, it is necessary to make land use definitions explicit. Wilderness, however, is not a simple thing; at least 8 kinds of wilderness must be

distinguished (Wittbecker, 1985): (1) Sacred spaces (traditionally holy and unused lands, e.g., Badlands of Dakotas), (2) Foundation areas (for self-managing natural cycles, e.g., the Antarctic), (3) Reserves (for traditional human use with very low impact, e.g., the Miskito home land in South America or the Inuit), (4) Preserves (requiring active human intervention to maintain the character, e.g., the tall grass prairie in Illinois), (5) Restoration areas (recovered from human degradation, e.g., West Virginia mining areas, and left to develop), (6) Neopoetic areas (started by human impact but self-maintaining, e.g., California grasslands), (7) Conservation parks (for preserving genetic heritage of species lost from other areas, e.g., wolves in the Boundary Waters Canoe area), and (8) Wild Resource systems (for harvesting a limited number of species in a sustainable way, e.g., Yew trees in Washington).

The North Slope Region is already divided into major areas. The National Petroleum Reserve, established in 1923, covers 96,000 square kilometers. None of the Petroleum Reserve has been designated as wilderness. According to the NPR-A Task Force, fewer than 300 tourists visit the Reserve per year (outside of Barrow, as of 1978). The Reserve would not support much recreational activity anyway because of the fragility of the tundra and its long recovery rate from insult. Much should be saved as wilderness itself, as a symbol of cultural heritage. Although tourism is a commercial industry in Alaska, the potential income from North Slope tundra is probably very small. Furthermore, tourist and hunting activities could interfere with migrations and subsistence activities. The current primary use of the Reserve is subsistence. Teshekpuk, Utukok, and Colville River have been designated as “special areas” by the BLM. The Utukok uplands are “critical area” by Alaska Fish and Game Department.

The Arctic National Wildlife Refuge in the far northeast part of the state comprises 76,000 square kilometers. The mission of the Arctic National Wildlife Refuge is to safeguard sufficient land to meet people’s needs for an area where the entire spectrum of human benefits associated with wild creatures and wild lands are enhanced and “made available.” The objectives include protection for calving grounds for 100,000 caribou in the porcupine herd.

If both these areas were reclassified as wilderness reserves (Type 3), then whole ecosystems could be protected by the people who depend on them. Ecosystem reservation protects entire biotic communities: genes, populations, species, habitats, associated traditional human cultures, and all the processes and interactions. To keep the essential services of nature, from atmospheric cleaning to soil-formation, large reserves are needed. Reserves are critical elements in global element cycles, also. They provide a natural base line for management reference and a unique opportunity for scientific research. Large reserves would increase representation of species and save viable mammalian populations, that is, maintain the integrity of wild gene pools. Such reserves would permit natural processes to occur without human interference. We also need large reserves to derive further benefits from understanding natural processes and direct economic benefits from species. And, for aesthetic purposes: to see and to participate in nature (these being the basis of watching and tourism).

The desired size of the reserve is a complex function of the area’s key species, quantity of suitable habitat, and minimum viable numbers of species. Large-bodied vertebrate species tend to have lower population densities, thus a reserve with self-sustaining large-bodied vertebrate populations will likely be adequate for herbivores, insectivores, and primary producers. The key mammal species in the North Slope Region are caribou, wolves, fox, lemmings, and microtine rodents.

Determining the minimum number of individuals in a population to guarantee a high

probability of survival results in widely varying minimum areas, depending on the key species selected. Carnivores are usually the least dense of species and have the smallest populations. They are also sensitive indicators of ecological integrity. Protection of the rarest elements should provide security for more dense species in an ecosystem.

Each wolf requires a minimum area, for example, as a home range. Since not all wolves in a group breed—some become aunts or uncles and help care for pups—it is necessary to assume at least 3 wolves per breeding unit. Assuming a minimum viable population of 500 (Frankel and Soule), and a requirement of about 80 km² per wolf, the minimum area for a viable self-sustaining wolf population would be between 39,000 and 78,000 km² (Frankel and Soule, 1981). According to C. M. Schonewald-Cox (1983), even reserves the size of 10,000 to 20,000 km² (1 to 2 million ha) contain insufficient habitat to accommodate a large population of wolves (1983).

David Mech (1970) observed that wolves do not exceed a biomass of 1 wolf (360 kg) per 11,000 kg of prey, without reaching a limit of sustained yield (1/30). The actual ratio was much lower (1/110). Humans in equilibrium probably did not exceed a similar biomass ratio. Burch (1972) estimates the human biomass, at European contact, at about 0.13 kg/km² in the tundra regions. Klein estimates the biomass of large herbivores (mostly caribou) on the tundra at 17.37 kg/km² (100 lbs per square mile). Thus, human use was far below the limit of sustained yield (a ratio of 1/133). The low ratio may be explained in part by the fact that both humans and wolves preyed on caribou.

Although there have been debates over whether a single large reserve is better than several small ones, the shape and size of North Slope Region wilderness is determined by habitat studies of the unique natural history and conditions. The size should be large enough so that species will not be vulnerable to “extinction vortices” caused by genetic or environmental stochasticity. In this reserve, disturbance from resource reclamation or recreation would probably be the greatest threat.

The recommendation for a North Slope Region reserve is 1 large areas, about 80,000 km², buffered by native cultures. The hunting and gathering lifestyle requires huge expanses; the reserve recommendation for native cultures is 110,000 km². The reserve would be managed by benign neglect—despite the fact that many do not list this as a management option. Natural processes, such as fire, wind, or species explosions, would be allowed to operate freely, even if they altered the functioning of the system. The large areas of the proposed reserves would be laid out on top of the petroleum reserve and the wildlife refuge. Larger areas would reduce management costs; smaller reserves in general require more intensive management and habitat manipulation. Saving 190,000 km² might be economically or politically difficult under the current industrial monolith in much of the U.S., but due to climatic and physical limits northern Alaska is not expected to be a major agricultural or resource contributor. The cost of reserves would be not be high, even in terms of lost potential, when the costs of resource extraction and transportation are considered with the more neglected costs of loss of habitat and local sustenance.

The north-south orientation for the reserves would minimize the dangers from physical and climatic changes. The greenhouse effect could drastically alter the species distributions in reserves, with the loss of many species. Placing the reserves on heterogeneous soil types and topographies increases the chances that the temperature and moisture requirements of species would be met. Simply maximizing size and number of reserves enhances long-term survival.

Animal populations vary according to cycles or unknown causes; they move and concentrate or disperse. Because animals fluctuate in such a cyclic manner on the tundra, management is even more difficult and questionable. Furthermore, the range of caribou and birds covers more than one ecosystem; wilderness designation for areas outside the North Slope must be coordinated. Simply setting aside large areas of habitat, however, will result in smaller anthropogenic disturbances and fewer ecological surprises.

6.5.3.2. Resources

A resource is defined as a form of energy or matter that is essential for the survival of an organism, community, or ecosystem. The North Slope Region is relatively rich in organic resources. Perhaps the most important resource is the living land itself, the ecosystem. The single most important system factor is climate, especially its fluctuation over the past 13,000 years.

From the land, people extract materials for food, shelter, and clothing. They put buildings and roads over that land. They dig up tons of gravel for roads. They depend on the plants, animals, resources, and energy.

6.5.3.2.1. Plants

The North Slope Region is a tundra. There are no stands of forest, although there are willows around rivers and streams and the imported decorative trees and grasses that people have planted and maintained around their homes and businesses.

Productivity is low and it varies wildly, from high, dry ridges with small scattered plants to coastal sedge meadows. The annual aboveground net primary productivity on the polar desert plateau is also low. The primary production (GPP) of coastal plain tundra at Barrow is somewhat higher.

Most of the productivity of plants is not directly usable by humans. Its importance is as support for native mammals. Agriculture has never been self-sustaining due to northern latitudes, severe climate, and thin soils. The Matanuska experiment in the 1930s and 40s was not successful. The Delta Barley project in the 1980s stalled on erodible land. Subsistence homesteaders and gardeners, however, can grow a limited variety of produce. Agriculture on the slope is not ecologically appropriate. Perhaps a family urban agriculture might be possible in larger permanent settlements.

6.5.3.2.2. Animals

The original grassland supported good numbers of mammals, from lemming and to caribou, musk ox, arctic hare, arctic fox, and wolves. During the long, dark winter, animals either migrate away (birds, fish, marine mammals), hibernate (grizzly bears, marmots, ground squirrels), or remain active (caribou, wolves, fox, lemmings, polar bear), if they have physiological adaptations to severe cold.

Caribou diet varies with place and time of year. In the spring they feed on growing buds and leaves of willow, plants uncovered by snow, and new grass and sedge shoots, but depend on the bases of grass and sedge plants in fall and winter and on fungi and lichens (not their preferred food) in the winter. There are four caribou herds using the north slope. A 1970 survey of the arctic herd, in the west, estimated a minimum population of 242,000 animals; by 1977 the population had dropped to 75,000 (Klein, 1978). The porcupine herd in the

east has been stable since 1970 at 100,000. A small herd around Teshekpuk lake numbers 500. A central arctic herd, distinguished from the west arctic, numbers 5,000 individuals. The Caribou population has changed dramatically, from 1 million in 1920, to 160 thousand by 1950, and climbing to about 400,000 in 1978.

Small mammals—voles, lemmings, ground squirrels—have a higher biomass and faster reproduction than large grazing mammals. Lemmings at Barrow reach peak densities every 3 to 6 years, declining to near zero between times. Although at each irruption, the lemmings destroy tundra grasses and mosses, they provide food for foxes, weasels, owls, and jaegers. Grazing and burrowing increases plant growth and decomposition rates, and releases nutrients.

Marine mammals, especially seals and whales, live in or migrate to the area. The arctic slope has sparse duck populations. Although there are shallow, closely-spaced ponds, they have a low productivity of plants and invertebrates. On the coastal tundra, the summer population of wading birds has been estimated (1974) at 5,500,000. In the eastern part of the Arctic refuge, 400,000 snow geese gather in late summer. Invertebrates outweigh birds and mammals. Nematodes, mites, and springtails feed on slowly decaying plant fragments (1-200 years old).

Despite a shift to a cash economy for some materials, Inuit rely on hunting, whaling, and trapping for much of the food and materials. Point Hope Inuit took 269,000 kg of game in the year 1960-61: 56% from seals, 22% from whales 19% from caribou, and 3% from fish—for 287 Inuit and 340 dogs. Adults consumed about 759 kg/yr while dogs got 407 kg/yr. One fifth of food demand was met by imported food. The NPR-A Work Group calculated 380 kg per person per year for 1976 and 566 for 1978 (for 3,612 people), averaged over 8 communities. This decline may have been because of the decline of the herds or the increase in availability of processed, imported foods.

Neither domestic animals or crops are likely or perhaps even desirable in the boreal tundra. Although the biomass of a system (its capital) can be relatively large, the rate of production (interest) is low in the Arctic. Human use of the stock is often fast. Humans also try to rechannel the energy to more easily usable forms, reindeer for instance. The introduction of reindeer has caused severe oscillations and overgrazing—reindeer do not migrate—which has reduced the carrying capacity for native caribou.

Because of the fragility of the tundra system, caribou are the best way of converting minimal solar energy to useful energy. If the caribou could return to half their primeval numbers, they could furnish 6 million kg of meat and fat annually (Kelsall, 1968). Exporting skins or meat out of the area, however, could contribute to destabilizing the ecosystem.

Most food energy goes for respiration or ends up as manure. The 95% loss is acceptable when an animal is raised on rough ground or when native populations, such as caribou, are used for food. Harvesting some wild animals may be a better alternative than food animal agriculture; it would be cheaper than improving the pasture degraded from overuse. Wild species are more appropriate on marginal soils. Raising food animals in cities could be acceptable using wastes and scraps that contain recoverable food, but not be acceptable using whole grain crops or on free range.

6.5.3.2.3. Energy

The North Slope Region has sunlight, water, and wind, but not nearly enough to provide energy to residences and industries. Hydroelectric power is not well-developed. Wind and solar energy are not abundant. The big difference between renewable energy resources and energy

use is the quantity of oil (approximately 33 trillion Kilocalories). There are large amounts of gas and oil, and there are known reserves of coal. Coal is estimated at 20% of world resources. Natural gas is a significant resource (2.9 trillion cubic meters).

The oil alone (19 billion barrels or 798 billion gallons) could last a small North Slope population (7,000), at normal rates (7 gallons per day per person) for a long time (over 44,000 years). The same oil used for the entire state would last over 700 years, but used for the entire U.S. population (250 million people at 3.5 gallons per day per person), it would only last for two years. As a salable resource, therefore, oil could be depleted very rapidly.

Energy use is increasing 3 times faster than the human population. Much of this energy is used for heating. Some energy is consumed by transportation; over 30 percent of the energy used by one motor vehicle (car, snowmobile, airplane) is from its production, and over 60 percent is used for fuel. People need access to their homes, jobs, and shopping, but the unrestrained use of oil has spread out the patterns of transportation. Attempts at temperate zone agriculture would require excessive energy. Energy generation itself consumes the greatest percentage (36) of energy. The main uses of the remaining energy are motor traffic, manufacturing, and residential and commercial heating.

Technology could be developed to tap the flow. The stock should be kept for transitional changes, rather than being burned up. In all processes in which energy is changed, some of it becomes unusable (diffused and very difficult to harness, according to the second law of thermodynamics). Combined systems of wind, water, solar, organic, and fossil fuels for energy could minimize impacts. Singly, these sources may be inadequate in the long-term, but as a mosaic they could meet decentralized needs.

Passive solar heating, combined with superinsulation, would reduce energy costs for individual buildings. Photovoltaic cells could provide back-up electricity and power for vehicles. Local energy projects using geothermal sources, winds, or the sun are preferable, since their operation does not introduce new material to local cycles. All of these sources would be characterized by a small scale. Further increase in flows of energy through technology will significantly reduce the capacity of the system to support its human population (even large-scale fusion techniques). The overuse of nonrenewable resources can destroy renewable ones.

6.5.3.2.4. Minerals

Because the North Slope Region rests on large deposits of oil, its mineral wealth is considered to be great. It does have large mineral deposits, but also high production and transportation costs. There is gold mining near Juneau, Fairbanks, and Nome. There is copper, although the Kennecott mines closed in the 30s; molybdenum, near Ketchikan; and lead, zinc, and silver near Kotzebue. The most common are zinc (24 million metric tons), iron (10 million), and nickel (100,000).

Virtually 100 percent of aluminum and manganese used has to be imported from overseas. Cobalt, platinum, tungsten—minerals used in advanced or strategic technologies (in alloys, catalysts, magnets, and electronic devices), are absent in large quantities, and must be imported from other regions in the United States or from outside. If no substitutes are possible in electronic equipment, then these minerals have to be acquired through trade.

6.5.3.3. Human Population

The population of the North Slope Region is currently about 5,700, of whom 4,560 are Inupiat. In 1828 the population from Barrow to Point Hope was estimated at 3,000, with perhaps another 1,500 east of Barrow. After European contact, the native population dropped to about 1,700. The population has been increasing until it is almost the same as precontact numbers, although mixes, concentrations and livelihoods have changed.

For the entire state of Alaska, the census bureau estimates a state population of 633,000 in the year 2,000, almost a 50% increase, with a 100% increase expected by 2020. Several trends in concentration are evident: A long-term trend of concentration to larger cities, and a more recent movement from cities to smaller communities.

6.5.3.3.1. Calculated Goals

Is 5,700 too many? Or 4,560? How many more could there be? Is this number above or below a maximum carrying capacity? (What kind of freedom do the 230,000 people in Anchorage have?) Can a large human population function in harmony with the arctic environment?

An optimum carrying capacity can be calculated for this region. The carrying capacity is the population sustainable on a long-term basis of renewable and nonrenewable resources. For humans, this capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Technology can expand the carrying capacity to some extent, with more efficient use and resource substitution, but also it reduces the capacity with unforeseen effects, from the use of pesticides, for example. As Odum (1971) points out, the optimum is always less than the maximum. Furthermore, the optimum carrying capacity decreases as the per capita use of energy and resources increases. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, aesthetic satisfaction—must be included. This introduces cultural elements into consideration, so human carrying capacity must be considered as cultural carrying capacity (Hardin, 1987).

Calculating an optimum population based on ecosystem productivity is relatively simple. Based on current caribou populations (180,000 and using maximal ratios—1/30—to simplify the calculation), the North Slope Region could support an optimum of 1,338 people (or an maximum of 6,000). Calculating a population based on seal and caribou populations, and assuming diet is 50% seal, 20% caribou, 20% whale, and 10% fish and fowl, the maximum population is 3,600 people—with perhaps 1,500 as an optimum.

H. R. Hulet pointed out that a population as a function of wood production would only be 80 percent of that calculated from food production—and the North Slope Region has almost no wood—even though 80% of the households use wood for heating. Furthermore, the population would be even smaller as a function of energy and fertilizer use rates. The rate of aluminum use would support only 40 percent as many. More importantly, these rates are not sustainable, being based on high American standards of consumption. A lack of some resources is not necessarily limiting, since the area can trade with other areas that need oil or tourism.

The current levels of population, at relatively high standards, can only be maintained through the constant takeover of natural habitats (for trade materials), or through the drawdown of fossil fuels, or by economically cheating the poor and powerless. Since wild lands and fossil fuels are quite limited, either human populations must adjust to renewable resources or technology must provide substitutes, to avoid eventual population impacts.

Samuel Eyre also devised a common denominator to consider organic and inorganic assets together. He assigned a nutrition equivalent unit to weights of metal, but this calculation depended on a dollar value for food and minerals. For example, assuming the daily standard adult human nutrition requirement of 3,000 Kilocalories, money income from minerals can be expressed in terms of annual nutrition units. Assuming that caribou meat releases 4 Kilocalories per gram and is 21 percent protein and 15 percent moisture, then 3.25 kilograms of meat yields 3,000 Kilocalories (and sufficient protein), conveniently equal to the daily food requirement of one human being. Twelve medium male caribou (averaged by weight and season) is equivalent to the annual food requirement of 1 person.

Assuming that aluminum sells for \$1122.00 per metric ton and caribou sells for \$1120.00 per metric ton (\$1.12 per kg or \$3.00 lb), then 1 ton of aluminum costs about the same as 1 ton of caribou meat (All prices: Wall Street Journal 6 December 1991). If it takes 120 tons of aluminum to meet the needs of the current North Slope Region population of 6,000 (about 0.02 metric ton per person for vehicles, wiring, and cans), then people need to trade the monetary value of 120 tons of meat to get it—enough to feed 100 people—that is 100 fewer people than the area can support if people need to have aluminum things. By the time other trade items are considered, the population is closer to 1,400 than 6,000. Similar trade-offs are possible with copper, wheat, sugar, cotton, and soybeans. Oil and lumber are more than adequate to support the low population.

The advantage of community productivity as wealth is that the wealth is sustainable—plants and animals are renewable and minerals can be recycled. The net community production (NCP) takes all of the food chain into account—the hundreds of other species. Technological production (in integrated greenhouses or algae farms) of food has not considered.

Each calculation of a population has become more comprehensive and cautious and has resulted in a smaller number. The target population for planning depends on how cautious the residents are. Should they gamble and go for more people, they might break the system. On the other hand, they might approach some minimum. The likelihood of this possibility is low. The Inupiat did not approach it at 5,000. The minimum number for genetic health, for the entire human species, could be 5,000 individuals. For a guarantee of fertility for the species, 25,000 may be necessary, and for a minimum for social contact for the species, 50,000. Humanity is not close to any of these minima.

6.5.3.3.2. Resource Use by Population

Just as important as any calculation of the population in an area is the rate of resource use by that population (and energy and wood use are high in this cold climate). People are planning to dig up metric tons of minerals per hectare. The North Slope Region is subject to disturbance of the tundra permafrost; the permafrost keeps the water in the active zone, where it can be used by animals. If it were destroyed, the land would become more desert-like due to low annual rainfall.

People are using 10 to 30 times as many resources as the Inuit did 160 years earlier, without being 10 to 30 times as happy. Indigenous peoples did not use resources at an accelerating rate. They were limited by their technology, but more importantly by their wants, as taught in myths and stories. High rates are clearly unsustainable. The difference lies in massive trade and in modern technology.

6.5.3.3.3. The Impact of Technology

Inuit technology is ingenious and elaborate. Victor Papanek claims that its design is the most sophisticated of any human civilization. Many implements were made out of bone, ivory, and stone; needles, combs, awls, spoons, cut and shaped with a rotary bow drill. Hunting weapons included bow and arrow, lances, fish spears, and harpoons. Household utensils included lamp bowls, pots, cups, bags, buckets, and storage bags. Like figurines, most all tools were decorated; this attention probably made them better tools. Many tools have been adopted by modern expeditions: dog-team sledges, snow goggles, parkas, fur boots, kayaks, and igloos.

Inuit adopt new tools when they can. Snowmobiles are replacing dog teams. The cost of owning and operating a snowmobile usually exceeds the monetary income derived from the land, however. But, since the snowmobile reduces the hunting time, more time is available for wage employment in the industrial culture. Hunting seals with rifles results in the loss of greater number of seals as they sink, and the amount of food captured remains about the same. The death of more seals, however, may change the balance of the seal population.

Sometimes the new tools are inappropriate to the Arctic. Many buildings are based on industrial temperate zone designs; many uniform commercial products are not durable or useful. Imported peaches or bluegrass lawns are luxuries. The waste is dumped in landfills.

Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Technology has greatly increased the kind and quality of materials used for buildings and machines, especially aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems. Unbridled, unconscious technology has given us benefits, but only at the cost of irreplaceable stocks of energy and environmental degradation. Instead of expecting technology to triple or quadruple our wealth, it is more likely that it has barely had a positive effect. Making technology appropriate, responsive, and conscious may go a ways to increasing its positive impact.

6.5.3.3.4. Patterns of Technology and Economy

Inuit cultures have survived for over 10,000 years. They are durable because their practices are ecological, social, and economic. They mimic the flexibility of animal and plant populations with their movements and population. The Inupiat are generalists. The generalist strategy combines low investment with high efficiency; it is conservative enough to carry people over periodic drops in available resources. Lower resource consumption rates.

The Inupiat are adaptive and have adapted some modern equipment; but these things require cash, which means selling goods or working in a cash economy. Their culture can become incorporated into a cash economy. Hunters shift from hunting to trapping, e.g., fox, to participate in the cash economy. Trapping, being much more individualistic, weakens cooperative ties and ceremonies. Having motorized transportation permits hunters and trappers to travel further and faster, and to live in fewer villages, with increased population size and density. As Inuit adapt to new economies, their subsistence and dietary patterns also change.

Energy used to be cycled within the arctic system, with Inuit as top carnivores. Much energy now flows from the south in the form of food and materials. Less energy flows from the north in the form of handicrafts and skins.

Odum points out that the human strategy is the opposite of the ecosystem strategy.

Ecosystems increase the ratio of biomass to respiration, whereas humanity reverses it—possibly leading to boom and bust oscillations. Since the arctic already has such oscillations, the superimposition of greater oscillations may lead to extinctions or collapse.

6.5.3.3.5. Choosing Technologies

Industrial cultures assume that improving human lives constantly requires new materials, machines, and techniques. But, there are no reliable measures to judge whether technologies are beneficial or harmful. Technology is not neutral or value free; there are inherent social consequences. Personal transportation, for instance, is problematical, especially motor vehicles. The number of vehicles in the North Slope Region exceeds the number of people, contributing disproportionately to physical and social problems. By allowing changes in distances and by forcing dispersed needs, the vehicle becomes indispensable. Changes in social mores and even physical health result from the embrace of motor transport.

A favorite Inupiat pastime was the telling and retelling of stories. Television also has repetition, but not the same depth of involvement. Radio stimulates images in the way books do, because neither impose images, although neither of these forms may be as involving. Improvements in technology are not necessarily improvements in human existence, but technology must be examined constantly, if people are not to lose some of the characteristics, such as empathy, that they value most highly. Some communities may wish to examine vehicles or computers, and eliminate them or modify their use.

Subsistence hunting depends on very-long-term conservation. The ecosystems have to be kept intact to preserve the full diversity on which the hunters depend. Hunting, without a strong cultural tradition and values, does not automatically result in conservation. Inupiat have learned to use snowmobiles and guns, and have access to processed food.

Where traditional ways have been adequate for 10,000 years, the Inupiat compete for resources with an industrial culture that has no common sense. If a culture cannot adapt itself to its ecosystem and abide by its limits, then the culture will perish. Disruption of ecosystem processes, as a result of excessive continuous resource demand, can lead to destabilization or collapse of the ecosystem and extinction or emigration of species.

6.5.3.4. Limits to Nature and Technology

The Inupiat had limited energy sources, but were able to change or move to avoid declining marginal productivity. In tribal societies, people live by harvesting wild food and the energy of the sun; their populations reflect the productivity of systems controlled by weather, landforms, and local cycles; they adjust to the conditions.

In industrial societies, people work to modify the environment for maximum use. Working for a maximum requires perfect knowledge and perfect action, otherwise there is disturbance and surprise in the forms of extinction, suppression, soil degradation, water pollution, and collapse. Industrial people are unable to chart the chaotic conditions that arise from snow, ice, drought, inversions, cycles, and population variation. But they pretend they can and pursue the maximum management strategy.

Most natives have adapted the infrastructure of the invading culture; they are taught and shown the patterns of consumption and use of an outside culture. They may try to maintain their cultural wisdom formed in a subsistence society that understood snow, permafrost, caribou, and whales. They can aim for an optimum use, far below a maximum. In 1982, the

council of Arctic Village, an Athapascan Indian community of 120, voted to limit residents to five caribou per person (from the Porcupine herd). Ironically, based on the track record of science and technology in the north, the ancient ways may still prove to be better—capability and flexibility rather than specialization and complexity.

Within unknown limits, all people need to establish a pattern of use that is sustainable and flexible, leaving other possibilities open. The general pattern is: Sustainability within cycles of depression and exuberance, economics fit to the resource base, without external input in energy or money, prevention of unwanted ecological or social costs, and harmonization of cultural differences. The root problem is how to live with technology in a mature manner.

Technological multipliers are efficiencies that allow a limited increase in the carrying capacity of the entire ecological system. The load on the system can be expressed as the resource demand multiplied by number of people. Trade diminishes some resource or food capital, but can be used to avoid some minimums. The Critical Minimum is a factor limiting carrying capacity. It is not known. Assigning a multiplier to the effect of technology is difficult due to the contradictory impacts of technology; here, it is estimated at 2, which is to say that technology can have an overall benefit.

6.5.3.5. Cultural Values

There have been two cultural patterns on the North Slope Region. An archaic one that offered family egalitarianism and limited impact and a technological one based on republican democracy and industrial consumption. The cosmology of the latter contains the image of Alaska as resource storehouse. The cosmology of the first has an image of the region as a place to live with other beings.

The Inupiat developed a cosmology appropriate to the place. Most of the universe was addressed in folklore and did not play a significant role in religious behavior. Religious attitudes, however, played a significant part in hunting. Animals were considered to be endowed with many of the same abilities as humans: the ability to reason, to talk, and to react. Although animals allowed themselves to be taken in a hunt, if insulted or mistreated they would withdraw their presence, to the detriment of human survival. Hunters attempted to placate and compel animals with ritual. The world of animals was considered to be superior to that of humans. Every individual had power of some sort. Shamans were more intimate with the supernatural world and had greater power. He or she performed acts necessary for the good of the group.

There were elaborately evolved restrictions and taboos relating to the animal world. For instance, weapons made for caribou could not be used on sea beings. Although there was no limit on the number of caribou to be taken, there were restrictions on how the carcasses were to be treated; the heads of dead caribou on a sled were bent upright so they would not hit the ground. By contrast, only five wolf traps could be set at one time (five being enough for a parka); more and the wolves would be offended.

The essence of tribal experience is distilled into metaphors, into myths and stories. Native knowledge exists in a spiritual framework. The country is sacred to the natives. Folklore stresses the Raven (Tulugaak) as creator of the world by bringing the land up from water and differentiating night from day. The world itself is considered flat, resting on four wooden pillars. Counter-intuitively, sacred knowledge allowed people to fix sophisticated machines, such as jet engines, without technical training, by approaching the machine as if it were alive.

The Inupiat can not compete against industrial culture, but it has not been completely eliminated either. The monoculture of coke and cars tends to overwhelm the subtle adaptations of the Inupiat. A coherent culture provides a secure platform for exploration and open-mindedness; it provides criteria to judge the 'special effects' like television. A conscious culture, perhaps with elements of native traditions, with appropriate technology and knowledge, could improve and guide the culture of the market place; television, as does telephone and radio, unites people through information, but a strong common culture is indispensable for uniting their hearts.

A good index of the quality of life, according to Athelstan Spilhaus, is the number of choices a society provides for its individuals. Western culture has valued the pioneer life of the individual—independent, self-sufficient, free to choose different life styles—but with more people, the choices are being subtracted. The more open spaces are valued, the fewer people the area can support and still have the open spaces. It may be that the Inupiat of the North Slope Region require 20 times the space as rural settlers; and, it may be that these settlers require 10 times the space as their urban counterparts. Or, it may be that people would prefer to have more discretionary time and less work time, as was possible in archaic societies.

There are numerous advantages of way of life of North Slope Region bands: Fewer working hours (about 4 per day); more leisure to talk, sleep, engage in rituals; a diet adapted to conditions; deliberate underproduction, below the maximum levels; deliberate control of population growth below maximum levels; and deliberate under use of resources, resulting in small ratio of people to resources. Subsistence economics means simply that surpluses are not accumulated. This might make bands more vulnerable to food shortages, although the ratio reduces the possibility; furthermore, industrial cultures have far higher incidences of starvation.

Indicators of the quality of life cannot all be expressed numerically; they are elusive. Quality depends more on the spirit of the society than a count of material possessions. Even orthodox ecological criteria are not adequate to evaluate the quality of a particular environment for human life. Nevertheless, a cultural multiplier can be assigned to aesthetic and support space needs; it is estimated at 0.7, which means that the hybrid industrial culture does not satisfy enough needs or requires more space per person.

6.5.3.6. Cultural Goals & Limits

Traditional goals for Alaska as a state (Eschenback and Geistauts, 1986) include: Stability of economic growth, Beluga coal commercially produced, new mines opened, increased oil production, North slope oil shipped to Japan, railroads extended, Susitna dam put on line, become a major agricultural exporter, and build a world-scale petrochemical plant.

Alaska's future seems to be dependent on oil. Because of its remote location, harsh climate, rugged terrain, and small population, the Delphi group considers that its future is tied to resource development rather than to manufacturing or service. A development plan seems implicit, but not as a coherent popular strategy with goals and priorities.

The goals of a native-culture dominated society might include: Self-determination, population limits, paths of cultural renewal, wilderness limits (more nonhuman creatures), limited resource use (renewable especially), and better communication. Many local limits can be transcended, but global limits perhaps cannot be transcended. Therefore, local cultures are related to some extent, as part of a sum.

6.5.3.6.1. Cultural Limits

Ultimately, North Slope civilization depends on wilderness—for recycling, pest control, genetic diversity, soil-making, and water purification, among other things. North Slope civilization depends on native cultures for vitality, and those cultures depend on wilderness for their context and imagery. The North Slope Region has adequate resources to feed and care for its current population—at a reasonable level. The rates of use of energy and some minerals are far too high. Demands and values are not related closely enough to the particular beauties and limits of the home ecosystem. The explicit goals of the cultures need to be fit within the limits.

6.5.3.6.2. Limits of Economics

Sustainable development requires recognition of the large number of limits. The ecological approach to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant. The North Slope Region, for instance, faces very real limits in rainfall, minerals, and fragility of the landscape. Every community is forced to accept some upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of the community itself and the natural communities on which it depends.

Complex societies depend on production of resources. Increased complexity requires more information processing and more integration of disparate parts. The costs of communication increase. Complex societies seek control. Yet, investment in complexity yields declining marginal returns because of the increasing size of bureaucracies, increasing taxation, and costs of internal control. There is no reason why a culture could not stabilize at a lower level of complexity.

6.5.3.6.3. Limits of Government

The size of communities in the region is small enough for people to meet and “exercise government” (in James Madison’s words). The North Slope is a good candidate for direct democracy. Small communities are essential to the democratic ideal. The uniqueness of place gives belonging and identity. The whole community gives meaning and richness to life. The population density of much of the North Slope Region may cause some difficulty, however. People will not be within walking or sledding distance, but may have to travel long distances to meetings or communicate remotely through telephone, computer, paper, or friends.

People will have to impose limits to keep things from growing. They will have to make and enforce limits on immigration and birth, limits on housing and public services. Nature is self-organizing, and, society is self-organizing, but people need to recognize some limits and define others, and then take responsibility for keeping to those limits.

6.5.3.7. *Summary: Design Planning & Recommendations*

Growth with minimal planning might be tenable for a short time if Alaska had renewable resources that could be traded in a sustainable way. But, oil, gas, and gold extraction damage and destabilize the ecosystems, according to David Klein (1970). Native organizations, such as the Inupiat Paitot, resist much exploitation, but are not powerful enough to stop the largest exploitation schemes, such as the trans-Alaska pipeline. Regardless of whether petroleum quantities justify development, most of the NPR should be converted to wilderness designation.

This plan recommends two large wilderness areas coinciding with the two largest caribou herd migration areas, 80,000 for the west Arctic herd and 80,000 for the Porcupine herd; these sizes should be adequate to preserve the associated populations.

A culture, like population growth or participation in a food web, is an ecological activity. Each culture is value driven; values determine how the culture adapts. The Inupiat way of life is still an ecologically viable way. The values of its way keeps the culture knowledgeable of and adapted to the environment. Instead of adopting the capitalist value system with its addiction to resources, which could degrade and destabilize the Arctic Slope region, the Inupiat must find a political way to subordinate the economy to their traditional culture and keep within the limits for ecological viability. Technology could be directed to use local resources instead of providing a means of importing food and clothing rapidly from other regions. These decisions are political rather than technical. Politicians could be directed to supply local needs instead of trading fish, oil, and copper for money. One immediate strategy would be to seek control of traditional lands. Another strategy would be to seek a steady state population until the caribou herds build up again and then calculate an optimum.

The establishment of the North Slope Region as an independent region would not be unrealistic. The design recommends 80,000 for a reserve for the operation of traditional Inupiat culture; this area would overlap about 50% of the two herd wilderness areas.

A number of concrete recommendations can be made to address the wilderness goals of the North Slope Region: (1) Gradually increase preservation of wild and restored lands, perhaps up to 90 percent by 1999, to protect ecosystems and resources, (2) Start educational campaigns for public awareness of the uniqueness of the North Slope Region and of the effects that lifestyles have on it, (3) Offer tax incentives to private and public corporations to redesign their paths in the community, (4) Promote equity in opportunities and rewards for all people, and (5) Create a geographical/environmental data base for the intelligent management of the land.

The goal of design planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in food, and self-limitation in size and desires. If human patterns were based on mature ecosystems, civilization would be far more complex; human values would allow for the welfare of humans, animals, plants, and land. The inhabitants have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for themselves.

According to an Inuit myth, the first human beings lived on an island, Mitligjuaq, in the Hudson Strait; no one ever left and eventually there were so many that the island began to sink under their weight. An old woman shouted: "Let it be so ordered that human beings can die, for there will no longer be room for us on earth." And it came to pass.

6.6. *[Empty Topic]*

6.7. *Designing Adaptive Patterns: Agriculture to Industrialization*

Previous adaptive patterns have extended beyond the range of their adaptation, in time or space. For instance, it is unlikely that modern cities will ever be able to survive a ten-year drought, much less a twenty-year or fifty-year drought, or a hundred-year series of droughts. It is unlikely that industrialization, or industrial agriculture, will survive the decline of fossil fuels. Possibly our adaptive technology will not survive its effects on humanity or the planet. So, we have to design many of our adaptive patterns, from agriculture and cities to technology and industry, to fit a changing planet.

A growing population based on agriculture offered advantages, not just survival of the species, but a competitive advantage against other species. Agriculture determines what we eat and how often we eat. But, agriculture requires the conversion of many wild ecosystems over vast landscapes. People are no longer scattered over those landscapes, but concentrated in cities, trading for foodstuffs from elsewhere. What if design tried to concentrate agriculture in the cities themselves? What if the fields on and around buildings were multi-level and complex? What if we reduced our reliance on grasses, like corn and wheat?

Cities hold well over half of humanity. How well could cities withstand three 20-year droughts in 100 years? Could they have farms on roofs? Could they make vats of food? Could they keep in storage enough food in cans or freezers to last for 20 years? Could cities limit their populations?

Technology is evolving on its own, without goals, plans, or management. We might decide what we want technologies for, then assess them critically, as part of the overall shape of civilization. With management, we might refuse many technologies as too dangerous, expensive, or silly. We might try to balance technology with the goals for cultures and ecosystems, and integrate it into the forms that we desire.

Industry has brought great benefits to many people and cultures, from simply increasing the number of clothes that people have to producing incredible machines that allow materials and food to be harvested, processed and shipped almost anywhere. But, industry has also produced destruction, pollution and waste on a massive scale, as a part of its production. The creation of a whole industrial ecology could integrate industrial processes with ecological ones.

6.7.1. *Calculating Optimum Regional Human Populations*

Most all of population studies are concerned with finding a *maximum* human population. Yet, as we know, maxima in natural systems are rarely stable. Human populations are limited by the biological constraints of ecosystems, by biogeochemical cycles, by our knowledge of these systems, and possibly by human psychological and cultural limits. Therefore, an optimum human population is calculated, using a deductive, synthetic, conceptual model based on data generated from research on net primary (NPP) and net community (NCP) productivity. A deductive approach is used because accurate measurements of trophic level productivities in most ecosystems are lacking. Its synthetic character is more appropriate to integrate quantitative and qualitative data, which are both present in human studies. The model is conceptual because of the inherent fuzziness of the systems, which can change scales and forms relatively rapidly.

6.7.1.1. Assumptions & Considerations

Ecosystems result from the interaction of all living and nonliving factors of the environment, according to Arthur Tansley. These ecosystems are profoundly affected by both random and purposive physical and biological factors. As a result, habitats change and organisms adapt. By modifying their habitats in the process of living, organisms change the characteristics of the system and force further adaptation. More important, organisms are limited by the productivity of the system in varying degrees. Human populations (*homo sapiens sapiens*) inhabit specific ecosystems and rely on them. They are adapted to and limited by the productivity of ecosystems.

The total amount of biomass or energy produced by populations through growth and reproduction is the productivity of the system. Gross Primary Production (GPP) is the rate of energy storage by photosynthesis (equal to photosynthetic efficiency) in autotrophs (plants). The maintenance and reproduction of plants is paid for by the energy expenditure of Respiration (R). The amount of energy stored as organic matter after respiration is identified as Net Primary Production (NPP), which equals plant growth efficiency. The calculation of NPP is shown by: $NPP = GPP - R$.

NPP accumulates through the history of a system as plant biomass expressed as kilocalories per square meter (Kcal/m²). The kilocalorie is used as a unit of energy flow and production; it is a useful common denominator for these calculations. The biomass minus the decomposition in a system is the standing crop biomass of that system. The problem of confusing production (amounts) with productivity (rates) is avoided by considering all values per unit area (m²) over the entire year (m²/yr). The energy stored in heterotrophs (consumers) is referred to as secondary production (SP) or assimilation. The storage of energy or organic matter not used by heterotrophs is Net Community Production (NCP). The relationship between productivities (where R_a =autotroph respiration and R_h =heterotroph respiration) is of the order shown by: $GPP = NPP + R_a = R_a + R_h + NCP$.

In a balanced ecosystem, NPP equals respiration; in an accumulating system, NPP usually exceeds respiration by 1 to 10 percent. Although stable ecosystems tend to produce a maximum GPP, species, biomass, and the production to respiration ratio (P/R) continue to change long after the maximum has been achieved. In fact, as the GPP approaches an asymptote, respiration increases. In a balanced system, tropical rainforests for instance, NCP approaches zero, as adapted heterotrophs become more efficient at using production. In accumulating systems, such as grasslands or young forests, NCP can range from 20 to 70 percent. A balanced system is integrated and self-perpetuating, where production (the photosynthetic fixture of carbon) is balanced by respiration (the oxidation of carbon). As a system becomes balanced, the pressure of selection of organisms shifts; the capacity to live in crowded circumstances with limited resources is favored. Populations that depend on rapid individual turnover (r-selection) are not as successful as populations of large, long-lived individuals (K-selection). As an ecosystem ages, pressure is put on some populations by other populations. Competition and predation become more complex.

Mammals are the best regulated of highly evolved species. Their behavior is controlled and population regulated through the use of space. Most populations, wolves for instance, regulate their density well below the limits of the food supply, often by as much as 50-70 percent. Territoriality can be correlated inversely with trophic levels and productivity. But populations can also be limited by: Specificity of prey or plants, the size of prey or plant

populations, predators, and natural events or catastrophes.

A maximum carrying capacity for humanity can be calculated. The carrying capacity is the population sustainable on a long-term basis of renewable and nonrenewable resources or energies. For humans, this capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Domestic animals can extend the carrying capacity somewhat, since many of them consume agricultural wastes or use lands marginal for agriculture, but they are not as efficient as wild populations. Technology could expand the carrying capacity to some extent, with higher yield crops and resource substitution, but also it could reduce the capacity with unforeseen side effects—through the use of pesticides, for example. War and social disorder reduce the ultimate capacity. Furthermore, the capacity decreases as the *per capita* use of energy and resources increases. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, aesthetic satisfaction, and others—must be included. Given the current political and technological situation for humanity, it is difficult to imagine how equilibrium could be reached without a significant reduction of human populations.

6.7.1.3. An Net Community Productivity (NCP) Model

It is possible, however, to calculate a stable human population in balance with healthy ecosystems, using NCP instead of NPP. The population for this model would be much lower since NCP is generally lower. For instance, in tropical and temperate grasslands, NCP may approach 60 percent of NPP, although 30 percent is much more likely. Temperate forests may approach 30 percent. For tropical forests, however, NCP approaches 0 percent. Tundra and much of the ocean environments are also very low. When NCP is used to calculate a *maximum*, the measurements are consistent with the low figures of several studies.

Gross regional populations are relatively low for tropical rainforest and raingreen areas, as well as for the Mediterranean and estuaries. By contrast, the gross potential populations of woodlands, temperate mixed systems and ocean shelf regions are relatively high. The ocean itself is only as high as it is because of its vast area.

For regional populations, adding the NCP of all ecosystems is not enough. First of all, not every system is stable enough to use; other systems should be set aside for various reasons, from services to aesthetic appreciation. Other factors, such as inedibility or waste, have to be considered. Of the NCP produced, 75% is unavailable, 5% is eaten by pests; approximately 65% of that harvested is inedible, 80% of that edible is lost in processing, and 25% is wasted during consumption. Multiplying the NCP by these qualifiers, using the island nation of Ireland as an example, results in a maximum number of **2.45 million**. This figure is almost identical to a flat 1 percent rate of the NPP, subjected to the same loss percentages. A crude *optimum* population is **1.44 million** (See Section 77222). This conservative number would insulate human populations from environmental variables and from fluctuations in productivity.

For another sample region, for instance the Woodlands ecoregion, the maximum population would be 70 million people (or an optimum of 35 million). All the cropland region, with its massive petrochemical subsidies, could support 1.37 billion (or an optimum of 685 million, using the 50% rule). At a rough guess, and assuming it had been restored to health over 20-40 years, the ocean might support an optimum of 220 million people.

Lower densities of humans will always be able to harmonize more successfully with

biological processes. For the long-term survival of the human species, adaptability to environmental changes is necessary. This requires a wide diversity of gene pools, which is achieved by a relatively large population divided into local, partly isolated groups in healthy regional ecosystems. The optimum size of a regional human population is actually the sum of optima for local habitats. Before an optimum human population can be put forward as a goal, numerous questions must be addressed, including:

1. How much land should be left in its native state? Enough to save one of each kind of ecosystem? Enough to support atmospheric cycles? Enough for exotic ecosystems? Enough for public service? Enough for extensive recreation?
2. At what level of luxury should humans live (in Kcal/yr.)? Just basic amenities (such as clean air and water)? With the potential of having every technological device available? With an excess of flexibility?
3. What are the physical limits of resources? Should all nonrenewable resources be used, and, if so, at what rate? Should only renewable resources be used?
4. What is an optimum? Laboratory studies with rats show that, with a choice of optimum rat environments, some rats reject the optimum. Should the optimum be set for a majority (by numbers or cultures?) or for some low denominator?

How these questions, and others not asked, are answered, and then quantified, determine an optimum human population. Knowing how many humans are alive to feed is easier than describing the basics of a quality of life. In calculating an optimum population within ecosystem restraints, few have considered minimum wilderness preservation, air and water quality, genetic minima, nonrenewable resources, appropriate technological innovation, the importance of cultural frameworks, adventure, research, beauty, uniqueness, and other intangible experiences. If human civilizations were based on balanced ecosystems, they would be more complex. The complexity encountered in trying to imagine them may serve as a Zen koan-work, to bring us to rational breakdown and finally to a thoughtful alternative: humanity as a self-conscious, self-limiting, poetic species.

6.7.2. Designing Agriculture

Traditional agriculture proceeds by substituting selected domesticates for wild species in equivalent niches, or by manipulation of the ecosystem, whereas modern agriculture replaces the biota, or transforms the ecosystem into an artificial system. People-powered agriculture works well. Horse-powered and oxen-power agriculture is still harmonious, because living creatures can fit better into biological and ecological relationships than machines can. The health and fertility of one is involved in that of the whole system.

Inorganic tools can be inserted into an agricultural order, but only within limits of kind, scale, and power. A tractor, for instance, can have too much power. It starts the destruction of the system. It also depends on the destruction of systems elsewhere to get its structure and energy. The tractor, farmer, and farm become resources for the industrial economy, run by capitalist ideas.

Agriculture, growing crops and raising animals, provided more food, but it was less nutritious and less palatable. By increasing the population, agriculture increased widespread hunger. The reduction in biodiversity, by monocropping, undermined biodiversity and caused some ecological crises, which resulted in periodic and devastating famines. If the trends to

more and more control, and to greater and greater profits—with the effects of fewer farmers and monocultures—continue, then agriculture may become a form of chemistry.

One goal for agriculture would be a net of no lost areas from the footprints of cities or no lost areas for crops because of cities. If people are concentrated in cities, then their reliance on corn and wheat fields could be reduced. By situating some agriculture on rooftops and lots, and making it more organic and labor-intense, cities would be less dependent on distant areas.

Designing agriculture requires the perspectives of ecological design. This kind of design first recognizes the ecological restraints of a place, the patterns of feedback, the points of disequilibrium, and the peripheral frame of the system. Agriculture has to be place specific and fitness-oriented—it has to make a goal towards a satisfactory or optimum production, rather than a maximum. It has to become part of the regeneration and repatterning of the system—it cannot keep the system stable at one level indefinitely; yields will go up or down, depending on other variables, from weather to species composition.

6.7.2.1. *Domestic Animals*

What is the solution to the treatment of domestic animals? How can we design areas for domestic animals? Based on knowledge about the needs of animals, physical and psychological, they have to be in contact with a natural predominantly environment for most of their lives. Animal places have to be area-limited and standards-limited. In fact, the area would be determined by standards. The number of animals would be determined by total area, especially with social animals like pigs or horses.

Zoning would affect that area. The standard area could be calculated per animal for feeding and privacy maternal behaviors, as well as social interactions. Different areas would be needed for different species. Essentially, the animals would be free-range in a natural environment. Standards would be established to limit crowding, which is not simply uncomfortable but can result in pain and life-threatening stress; in fact, research has been done on crowding in rats and other animals. Drug use could be limited to the presence of diseases and then limited to sick animals.

We also need standards for experimental animals, starting with a limit to meaningless experiments, such as cosmetics, which already have vast human populations being tested informally. Tests would be limited to deadly diseases that are not established in human populations. Psychological testing would be minimized. Caging would be temporary for test and zoo-like conditions would predominate for the test pools of animals. The best approach might be to integrate animals into new systems of agriculture.

6.7.2.2. *New Systems of Agriculture*

Agriculture is a form of ecocultural play. It is nature based and culture based. The design of agriculture has to be based on the development of ecosystems as well as historical traditions. It has to incorporate failure as well as bottom-up action, although it can modify these with to-down restraints. It has to be attentive to consequences of its actions, be perceptive of changes. It can assemble niches with ecological redundancy that can be exploited reasonably for human needs in a long-lasting, sustaining pattern.

Agricultural systems can be classified using two variables: Energy type and diversity of plants. Traditional systems—shifting cultivation, nomadic pastoralism—depend on human or animal labor. Modern systems—plantation, commercial—depend on combustible fuels for

energy; these systems also tend towards monocultures. Traditional systems usually incorporate greater biotic diversity, and tend to be more polycultural. Traditional systems are very labor intensive, that is, participatory.

Agriculture started out as a food management system. The first grains may have been status foods, used only at certain times of year, like salmon or other annual foods. Then, agriculture became a labor Management system that required training and encouraging people to work harder and in a special niche.

Later, it became an energy management system. It tried to control the energy sources, the converters, and the outputs. More energy put into crops and more energy extracted. To model energy, we can consider one human being is rated at 0.1 horsepower (abbreviated 'hp'). A team of oxen is 1.2 hp. A 50-hp tractor is rated at 50 hp. In tilling a one hectare field, human power is twice as effective as the oxen and 4 times as effective as the tractor (in terms of the amount of work performed by horsepower. However, in terms of gross costs, such as shelter, food and clothing, human power is 3.45 times as expensive as a tractor and 2 times as expensive as oxen, who require food and veterinary care. Eventually energy surpluses flow from country to cities.

In a time management system, time constraints are also a problem. Although one person could produce a crop in 700 days, it is more effective to use 70 people in 10 days. Human labor is low in absolute levels of work. Animals constituted energy slaves.

As more effort was put into the land, agriculture became a territory (and perhaps property) management system, finding and dedicating land to crops. One could also consider agriculture as materials management. A hydraulic civilization required tools, dams, pots and labor schedules. Of course, agriculture could be considered a beer management system, catering to the desire for intoxication. Fermentation had an additional nutrient bonus from yeast as a protein. Yeasts were also used for breads.

Agriculture is a novel information system. Because of population density, there is a drop in costs of transmitting information. The brain is more tightly packed. This is advance in information technology. Information is presented in terms of labor, a greater array of goods, and special projects. Information guides energy use. Chiefs give signals that channel energy into projects. The signals are trigger effects, small changes in energy that cause large changes in the cultural output of energy.

Agriculture, finally, is an ecological system, based on ecological limits, based on natural processes, and based on interactions with other systems, including human ones. In its early stages, agriculture is constrained to early stages of succession. That is, it uses nutrients and energy for quick growth and reproduction, rather than invest in efficiency or durability or maturity. Fossil fuels have allowed this artificial condition to continue.

With knowledge of ecosystem processes, traditional agriculture can be modified to allow the collection of significant quantities of food from mixed systems, without landscape conversion and without interference from energy subsidies or biocides. Eventually, agriculture will have to become more mature. Wes Jackson and others are working on this transition.

6.7.2.2.1. Promise of Regenerative Agriculture

Regenerative agriculture pays attention to the total input flows for agroecosystems: Solar, human, animal, tools, fuel, fertilizer, pesticides, drying, processing, and transporting. Under some circumstances, pesticides and fertilizers might be needed to stop pest populations or give

advantage to crops.

Intensification has been a trend in agriculture, but different processes need to be intensified. Exploitation needs to be more intense. Perhaps specialization does this, from secondary products from domestic animals. Agriculture tries to intensify production, to increase yield from land use, as a result of intercropping or adjusting, and to increase yield from human labor. Water control may allow multiple harvests, to increase productivity. It might be possible to breed more rapidly maturing strains.

There are many kinds of specific measures that can reduce erosion, starting with contour plowing. Plowing can be eliminated altogether with seed-drilling. In 1943, Edward Faulkner, showed there was no scientific reason for plowing. Plowing gives a short-term increase in soil quality, by mining the subsoil. Fukuoka's ideas of multi-planting protects soil.

6.7.2.2.2. Natural Farming

Masanobu Fukuoka is another of the major pioneers of sustainable agriculture. Professing no knowledge, he presents a farming method that involves no tillage, no fertilizer, no pesticides, no weeding, no pruning, and less labor. He calls this practice the “no-plowing, no-fertilizing, no-weeding, no-pesticides, do-nothing method of natural farming.” The idea that people can grow crops is egocentric to him. Ultimately, it is nature that grows crops. He sees modern agriculture as ‘doing-this and doing-that’ to grow crops, but it is meaningless work. With his ‘do-nothing’ method he is able to get yields in his rice fields that are equal to the highest yields attained with chemical, do-something agriculture. He accomplishes these high yields by careful timing of his seeding and by careful combinations of plants, in a polyculture.

6.7.2.2.3. Regenerative Agriculture & Permaculture

Permaculture is a design system that aims to create sustainable habitats by following natural patterns. The word ‘permaculture,’ coined by Australians Bill Mollison and David Holmgren during the 1970s, is derived as a contraction of permanent agriculture, or permanent culture. The idea of permaculture is considered among the most significant innovations developed. However like nature, the permaculture concept evolves with time making its static definition difficult. Nevertheless, permaculture can be described as an ethical design system applicable to food production and land use, as well as to community building. Permaculture seeks the creation of productive and sustainable ways of living by integrating ecology, landscape, organic gardening, architecture, and agroforestry. The focus is not on these elements themselves, but rather on the relationships created among them by the way they are placed together in place, the whole becoming greater than the sum of its parts. Permaculture also addresses the careful and contemplative observation of nature and natural systems, and the recognition of universal patterns and principles, as applied to specific circumstances in unique places.

Permaculture uses zones to focus efforts. The zone nearest to the house (1) is the location for those elements in the system that require frequent attention, or that need to be visited the most often. The vegetable garden (2) may also have larger scale compost bins or bee hives. The area where crops are grown (3), for domestic and trading purposes, could include orchards. After establishment, care and maintenance requirements, such as mulching, are relatively minimal. Watering or weed control is performed every week. Animals in these zones, such as chickens, can be used as a method of weed control and also as a producer of eggs, meat and fertilizer.

The next zone (4) is considered semi-wild; it is used for timber production from coppice managed woodland and the placement of aquaculture ponds. The fifth zone (5) is actually wilderness. There is no human intervention other than observation of natural ecosystems and cycles. Mollison considers this zone the source of the most important lessons of the first permaculture principle of working with nature, not against it.

6.7.2.2.4. Natural Systems Agriculture

What is the difference between ecosystems and agroecosystems? People? Domestic plant and animals? Not just people or domestics but their kind of actions, that is, their relations with their system. In an ecosystem, people are just one more group exploiting the system. But, in the agroecosystems, people are manipulating the system, that is, they are modifying it.

The goal of Natural Systems Agriculture is not only to fit agriculture within limits of the ecosystems, but to increase its presence in cities and artificial areas. The Land Institute has worked also for over twenty years on the problem of agriculture, to develop an agricultural system with the ecological stability of the prairie and a grain yield comparable to that from annual crops in a modern, fuel-subsidized field. The Institute collaborates with public institutions in order to direct more research on Natural Systems Agriculture.

Because this work deals with basic biological questions and principles, the implications are applicable worldwide. If Natural Systems Agriculture were fully adopted, it might be possible to witness the end to agronomic methods and technologies from fossil fuel-intensive infrastructures in developing nations.

Natural Systems Agriculture is a new paradigm for food production, where nature is mimicked rather than subdued and ignored. Located in a native U.S. prairie, the Institute looks to the prairie as a model for grain crops. They are investigating the feasibility of perennial polycultures or mixtures of perennial grains.

The functions of a natural system can be achieved by mimicking its structure. With additional research, the Institute is working to show that an agriculture that is resilient, and therefore productive over the long term, economical, such that the need for costly inputs would be significantly diminished, and ecologically responsible is well within reach. The impetus to search for a new agriculture is soil loss and soil pollution. Agricultural chemicals poison soils and waters, which harms insects, birds, and mammals, including human beings. In the United States, after two 200 years of industrial agriculture, about quarter to a third of topsoil is gone. Natural Systems Agriculture would leave the ground unplowed for years and use few or no chemicals, solving many environmental problems at their root.

6.7.2.2.5. Tree Farms

Cultivation of trees seems to have begun in Africa. Where grasslands seem limited in exploitation, further food could be derived from tree fruits and leaves, or from consumers of microscopic plants. A broad-leaved tree layer appears to be biologically desirable on most lands. Much of agriculture on small farms is multilayer; two other crops can be grown under fruit trees. Lawrence D. Hills claims that growing trees for food is a rational land use. Carob, mesquite and honey locust could be mass cultivated. Productive forests could be planted on otherwise marginal lands. He states that 4-20 tons of protein per acre is a possible yield, with pasture, crops or other trees planted between rows. The most efficient systems are extensive, where nature does the work. For instance, only 1000 hours per year are needed to manage

food in a hunting-gathering society.

Forests are natural buffers; they influence local and regional climates making them milder; they provide continuous flows of clean water and protect soils. Trees create microclimates, reduce wind speed, lift the water table, and increase worm population. Redwoods have a life span of 1500-2000 years. Their vital role is to filter coast mists; redwood transpiration precipitates rain from mists. Managing such forests requires a long-term plan. Planting oaks with beech, the oak rotation is 320 years, with 100 years for the beech. This requires generations of foresters.

Forests can be managed as wild forests, from which nothing or little is taken. Or, forests can be managed as tree farms. A tree farm can be defined as a tract of privately-owned forest, large or small, managed by a certain forestry program. A tree farm can be a Christmas tree plantation (usually the most intensely managed form), a multiple-use forest, managed wild forest, or other. A tree farm can be a forest, or part of a forest, or simply land on which someone has planted trees. The kinds of tree farms can be related to the models on which they are based and to the base environment. Base environment refers to clearcut, old field, or wild forest. Up until now, there have been two basic models for treating the forest: The agricultural model that removes a whole crop annually, and the stewardship model that tends the forest, but removes as much as possible under human control. A third, wild form is possible and desirable.

A tree farm has to have certain characteristics to be good. Since tree farms are called farms and not mines, let us assume that they are expected to be sustainable. Protection of the forest is a requirement. Without a forest, there is not a farm. If the forest is degraded, the farm cannot last long. The forest has to be allowed to be healthy; the habitat has to meet the needs of the community of species; and the genetic pool of the species has to be large enough for long continuity.

Tree farm management involves occasional planting, using careful techniques, such as root spreading, but also the follow-up care, such as mulching, hand weeding, and possibly protection from browsers and direct sun. One major problem with some tree farms is that indigenous flora and fauna are thinned or removed in favor of “useful” species that can provide maximum production. This “redesign” of the forest almost always requires external human controls and inputs in the form of biocides, fertilizers, soil scarification, and artificial selection. Simplification of the forest for short-term maximization of goods usually leads to dedifferentiation and destabilization. Although such tree farms may contribute to soil conservation, wild life diversity, and biogeochemical cycles more than a plantation, they do not contribute nearly as much as old-growth forests.

Industrial forestry depends on formal knowledge of the forest, but tree farms combine knowledge with intimacy. Tree farms can be sustainable and productive—although not necessarily all of them are or will be—relieving demand pressure on wild forests, national and provincial forests, and old growth areas, which may have a better chance of being preserved from interference. Tree farms could act as buffer forests for wild forests. The tree farm is one level of application of ecoforestry; in one sense it may be the most useful area to begin with, since it is necessary to convince only one person, the owner.

Tree farms have to take care to plant appropriate species. Planting generations of pines can lead to soil deterioration in some ecosystems. The pine roots are sheathed with acid for the root to get a hold in rock. The acid also helps with root competition, and an acid pan is

formed deep in soil. For the second crop, roots do not go as far down, due to the acid pan. A third crop has such shallow roots that it is liable to blow over. Pine litter is acid, and it may discourage wildlife habitat.

Attention must also be given to equipment on tree farms. Heavy machinery forms a hard pan in soil. Engines cause the ground to vibrate, and a pan forms 25 centimeters (10 in) deep. The roots of some young trees may have difficulty penetrating it. The life span of the trees may be shortened. Felling should be by stems or group selection. There should be no clearcutting. Planting should be a last resort. Good forestry allows for natural regeneration.

The small size of most tree farms ensures that the production exists for local needs according to local demands. The small size also ensures that mistakes will not destroy an entire ecosystem. Small size is conducive to flexibility and sustainability. The blend of activities in tree farms, from intensive multi-cropping to the utility of complex, symbiotic associations, make them similar to agroforestry or permaculture applications.

Although tree farms are often tracts of privately owned forests, the tree farm tag can also be applied to certain kinds of permaculture, as envisioned by Bill Mollison, to a traditional farm with stands of trees, as thought by Wendell Berry and others, to natural farming where pines, cedars, and fruit trees are planted with grain and root crops, as described by Masanobu Fukuoka, and to permanent tree crops, such as chestnut, honey locust, walnut, carob, grown on hills and mountains to complement flat-land agriculture, as presented by J. Russell Smith. The common theme in these kinds of tree farms is the careful maintenance of the productivity of the land; industrial tree farms, plantations, and orchards do not, in general, share this theme. Maintenance of productivity, or sustainability, has always been the goal of healthy cultures or agricultures.

Finally, tree farms cannot exist independently of their ecological, economic, and cultural contexts. Without changes in taxation and the industrial financial system, tree farms may succumb to pressures to cut heavily. Without changes to Canadian and U.S. styles and levels of consumption, the demands on tree farms to provide materials may be too heavy. Without changes in values, miracle cures, quick profits, speed, paper use, and superficial efficiency, tree farms may not be able to adjust to forest time and labor-intensive harvesting.

6.7.2.3. Industrial Agriculture

There are many possible ways of getting food: Hunting/gathering from the environment, traditional farming and animal rearing, industrialized farming, meat factories, culturing plants hydroponically, vat grown meats, artificial meats based on yeast, algae or bacteria, as well as food built directly by matter compilers from chemical elements.

Genetic engineering is progressing quickly and so are biological studies. After all, human tissue can be grown in labs relatively easily. So, food could be produced in vats. The food, for instance tomato paste, could be made cancerous, so that it would keep replicating cells. The cells could be kept immortal by keeping the telomeres. At the desired size, it could be prepared, sliced into cubes and canned, or freeze-dried, or irradiated and packed. Growing meats in vats would be more difficult, since a significant part of the flavor results from the muscular movement of the animal as it finds food; other tastes could be introduced through duplication of food source chemicals. Perhaps electrical stimulation of meat cells would make it more flavorful.

Modified algae could be produced in tanks, then textured and flavored by various

technological processes. There is a range of possible artificial foods. Any of these solutions, of course, creates new problems, not just in relationships with other forms of life and the environment, but in scale especially. Table 6723-1 compares the total acreages necessary to feed four billion people using different methods.

Table 6723-1. Methods and Acreage

<i>Method</i>	<i>Area in Ha</i>	<i>Percentage of current</i>
Current production	1,507	100%
Current production, waste eliminated	1,250	82.8%
Feeding all cereals to humans	740	49%
Using the Asian Method	650	43%
Growing all food in greenhouses	60	4.0%
Using industrial agriculture, assuming vegetarianism	170	11%
Growing food hydroponically	6	0.4%
Growing algae in vats	5.4	?
Using leaf protein	0.03	?

Single-celled protein could feed four billion humans using only one-seventh of the oil products waste, worldwide.

A *hydroponics* method offers 500 times the yield with only one tenth the water required; there is no runoff and better pest control is possible.

Although *leaf protein* is not palatable straight and must be machine processed, the machinery is available and the cost is still only one-seventeenth the cost of meat in India. It is more efficient than grasses. It offers new stores of plants for food (300,000). And it is the most suitable kind of harvest in the tropics, with their vulnerable soils.

The *single-cell protein* yeasts or fungi are very efficient and fast; harvests can be measured in hours, not seasons or years. Although it is a fairly expensive process—it must be grown in tanks—it can be grown on petrochemical wastes. And, it produces no wastes and has virtually no pests. SCP is of poor nutritional quality.

A comparable weight of *algae* contains three times the protein of beef. It is also efficient. Algae is also expensive. It concentrates pollutants. And it is amino acid deficient.

Industrial production may be the logical step under the current system. As long as it is constructed as a form of industrial ecology, wastes and resources may be recycled in natural systems, which have reduced impacts and disruptions.

6.7.2.4. *Vertical Urban Agriculture*

In most of his arcologies, Paolo Soleri incorporated balcony gardens, while expressly having fields within walking distance of the structure. As traditional cities struggled with tax and abandonment problems, many people started using vacant lots for gardens; some used rooftops and balconies. Participating in these gardens not only provides edible produce but meaningful work. As distant, industrial-scale farms began to have problems with the effects of biocides and rising transportation costs, other people considered integrating agriculture in arcologies or as part of green skyscrapers; this approach promises to reduce fossil fuel dependency for transportation and chemical additives. Although some schemes would require high-tech elevators or water-delivery systems, there would be some need for more intense labor to harvest

and distribute the food.

Urban agriculture in high-rise buildings could use the exposure of the buildings to grow crops in windows or exposed balconies. This would have the potential to reduce trash, waste and pests. This also has the potential of interlinking agricultural ecosystems with close wild systems, especially with mobile pollinators and birds. It would allow nearby arable land to be used for crops requiring a flat surface of soil.

A building-system of agriculture would allow more control of temperature and moisture. It would offer more control of safety and security, as well as faster response time to plant problems, such as molds. Water use would be reduced and recycled. Some of the farms could use soil, others a hydroponic or aeroponic system. Plowing with tractors would be eliminated. Footprint would be restricted to the building footprint, although special care would be needed to site buildings away from the shadows and wind and water flows of other buildings, perhaps with a variable height pattern. Solar or wind energy systems could provide much of the energy needed for electrical requirements. The human shift to cities means that more should be accomplished in cities to make them as self-supporting as possible.

Some arcologies, especially terrace-based, could use a variant vertical system. Food waste could be recycled with small animal production on lower floors. Grey water recycling would replace irrigation of large areas. Carbon emissions could be better controlled in a vertical system. In a future promising expensive changes due to climate and breakdowns, a vertical agriculture that avoids many costs and could switch to labor-intensive sources of energy could provide food to people isolated in a building in a city.

6.7.2.5. Refitting Agriculture

Agriculture exists within an economic order. Through ecological design, agriculture can be reformed into an integrative, natural-capital-using, adaptive process. To be less destructive of ecosystems, and to reduce its waste, agriculture has to begin to use appropriate energy and technology, at appropriate scales. Its costs constraints have to be based on physical constraints, such as size and energy, as well as on quality.

Food output per acre has been rather stable throughout history, but it is increasing rapidly now, with the use of industrial measures, like fertilizer, large capital outlay for new equipment, and new technology. It may be feasible to irrigate large parts of the desert, if certain problems, such as salinization, could be solved. The per-acre yield, however, may be reaching an asymptote. Humanity is fiercely competitive and exterminates any species that robs fields. There is no real balance of nature on farms—too much is artificial in the cultivation and irrigation, which requires constant attention and control.

The agricultural revolution that began in England in the 1700s grew up with science. The other half of the revolution was capitalism. The two have not quite been compatible. They have different logics and different goals. Many times capitalism forces environmental destruction, due to the limits of the system. The gamble is to win big or lose big.

Conscious learning has reformed natural ecological organization into the conscious and elaborate design of agriculture, according to Jantsch. Humanity entered a lower order of nutrition with invention of agriculture.

It may be possible to manipulate the entire biocenotic environment to prevent pest problems. But it cannot be manipulated meaningfully unless agriculture is decentralized. But, decentralized agriculture is no solution unless efficiency is greatly increased. In the U.S. alone,

there is 21 million tons of leaf waste from carrot and bean tops, bean and potato plants; that protein could be extracted for food. Although it may not be very palatable, it costs less than one-fifth as much as soybeans in India. Breeding is unlikely to eliminate all waste. In a few leafy vegetables, such as spinach, everything above ground can be eaten. Some plants, like potatoes, in which leaf and root growth are simultaneous, out yield others, like sweet potatoes, where tuber growth is only starting when leaves are failing.

Balanced land use means management based on sustained yield over a long term, inclusive of forests and marshes, also. The future depends on ecologically scaled projects, not on giant industrial land or water projects, and on the separation of large-scale industrial management from optimum-sized applications.

Since humanity is still part of the ecology, its actions can be examined in that context. New human niches have depended on this savings of capital of the earth being withdrawn for a temporary gain. Humans should not take the Net Primary Productivity (NPP) of a system, but the Net Community Productivity (NCP) or a smaller yield—that fraction which it is feasible to remove and use without destroying the basis of productivity. For grain or forest products, this portion is about 30% of the NPP (as dry mass per unit area and time). Higher efficiencies might be possible under very favorable circumstances, but the best calculations will have some uncertainty and lower yields should apply to most species. For wild animals, the kill must be lower than the trophic-level efficiency—usually less than 10% or 1% with some birds and fish. There are things that can be done to make agriculture sustainable and successful:

1. Diversify crops, especially adding drought resistant varieties. Grow wild lupine to combine with soybeans for food. Convert from intensive cattle raising to antelope farming. Grow more varieties of apples (reduce imports of apples from outside the area). Increase self-reliance on most foods (except those that cannot be grown there).
2. Develop new products from existing crops, e.g., oils, drugs, and fuels. Rapeseed, for instance, is used in hydraulic fluids, plastic film, nylon, Lorenzo's Oil, as well as vegetable oil; certainly, there are unforeseen applications.
3. Use appropriate technology (solar power, field drilling, organic growing); import less energy, possibly export some. Stress low-input agriculture; low-fertilizer and low-pesticide may result in lower gross sales per area but in higher net revenue per area.
4. Process the crop (for example, sell noodles and noodle products as well as wheat).
5. Market the crops and products locally; package them, advertise them, and distribute them.
6. Form cooperatives, especially for specialized market or low volume products (beets, for instance).
7. Create a land trust to protect farm land from pressures of development, even as its market value as a nonfarm increases. A land trust could funded by property transfer tax. The land trust could lease the development rights on farmland.

For a regional approach to agriculture, we must calculate all set-asides first—that includes wild and restored areas, and common areas used for foraging and herding cultures. What remains is the area we can use for cities (often located on fertile soils and near rivers) and agriculture. That area should be divided into appropriate use areas, for regenerative agriculture or for large monocrops of corn or wheat. Monocrop areas, whether for corn, coffee or bananas, must be reduced. Some of those species can be intercropped in natural systems. Others can be limited

by the area permitted for them. The diversity of agricultural plants needs to be enlarged by planting different strains, especially older, more traditional ones. If agriculture in converted or subsidized (by water or energy) systems should prove to be less than needed to feed the current (likely over the optimal) human population, then agriculture needs to expand into city areas, especially into vacant lots and onto the rooftops and balconies of buildings. This kind of approach assumes that the distribution systems and the will to use them already exist or can be employed.

We depend on vegetation for more than food: it makes up the content of much of our newsprint, construction, furniture, clothing, and packaging. Of course, much of the straw and slash should be left so that the system can regenerate. Furthermore, with shortages of minerals, many substitutes are expected to be organic. The ecological design of agricultural systems has to be responsible to the living communities and ecosystems. It can do that with strategies for a flexible living order that address fitness and inclusion with caution and knowledge with its power. Working in natural systems can be inspiring. Exploiting systems in ways that increase health and biodiversity can be equally inspiring.

6.7.3. *Redesigning Cities*

Cities are the chosen domiciles of most human beings. Yet, we rarely think of planning them. We need to think about cities as a form of ecosystem that can be made more self-sustaining and complex.

6.7.3.1. *Problems with Cities*

With cities come unanticipated or unwanted effects, sometimes erroneously called ‘side-effects,’ although they are equivalent to the intended main-effects. The new city ecosystem, that replaced a native ecosystem, is greatly simplified; there are fewer plant and animal species, and lower diversity leading to homogenization, especially when cosmopolitan or favorite species are present. Plant productivity declines, due to fewer plants and lower rates of photosynthesis. Connectivity to the surrounding matrix is lowered—the matrix itself is minimized by increased patches and corridors, such as roads, which perforate the landscape and also act as barriers to plant and animal movement. The number of patches increases, which decreases interior species and increases edge species, such as squirrels, raccoons and coyotes. Native patches and corridors, such as woodlots or streams, are reduced or eliminated. The agriculture around cities is more homogenous, with decreased fallow areas. Stream corridors are degraded or destroyed, making a city more vulnerable to floods. Sewer systems route more water faster to an ultimate sink, lakes or the ocean. Household wastes affect the landscape directly, if they are buried or burned. Nutrient and mineral cycles can be disrupted. Local weather can be disturbed. And, the environment can become degraded.

Cities change their own microclimate, with heat islands and dust domes. The masses of materials used to build the city are used inefficiently. The energy to run the city is greatly concentrated—thousands of times more than in a native ecosystem—and the energy is used inefficiently. Unless the infrastructure, from buildings and power lines to sewers and roads, is kept up, it can decay and cause greater inefficiencies and problems. A budget crisis, from loss of tax revenue or improper use of funds, can affect the infrastructure and most amenities of a city. The disruption of supplies, due to social and political actions, such strikes or attacks, can

lead to other problems, from displacement to disease. Even in small, well-managed cities, there is an increase in violence, sickness, drug use, crime, and impoverishment, all of which require some response from the political structure of a city. Ian McHarg noted that with crowding, there was an increase in mental and physical illness from stress.

The human system in the city, with imported food and water, has a smaller system of carnivore predators, such as fleas, lice and bedbugs, and decomposers, such as bacteria, fungi and gulls. The surrounding native system of primary productivity is based on depauperate system with few trees and layers and a simple food chain of rats, birds and squirrels.

6.7.3.2. *Redesigning & Designing the City*

Much design has to do with solving one problem or a set of problems. Very rarely is a city redesigned to solve problems. And, very few cities are designed to avoid recognized problems.

One challenge for a city is to balance its inputs and outputs to minimize the effects on the residents and the environment. For example, G.T. Miller notes that for a city of a million people, there are daily inputs: Sunlight (higher or lower depending on size and shape), atmospheric deposits (), water (625,000 tons), food (2,000 tons), fuel (9,500 tons), manufactured goods, and buildings (high or low depending on area, height and the success of the city attracting new people or businesses). The outputs do not always balance inputs: Heat leaving is often greater because of the use of fossil fuels; water may be less due to evaporation or use in processes; sewage may be high (500,000 tons) and include water; solid waste/refuse may be high (9,500 tons); and, pollutants may be significant (air only, 950 tons).

Because cities are so concentrated, and occupy a relatively circumscribed area, they require distant support systems for food, materials, and energy, as well as a smaller system for pets (monkeys, cats, canaries, or fish) and support machines, such as automobiles. This requires constantly increasing inputs and outputs.

6.7.3.3. *Refitting Old Cities*

Many cities were expansions of old trading villages or fortified garrisons. The Romans, for instance built many small military towns in France, Germany and Britain. When Spain colonized much of the Americas, the Spanish built new towns based on the Sante Fe model (in the general shape of a cross) from 1492. In old cities, corporations and individuals have built new buildings that use new strategies, such as source reduction, waste treatment, recycling of materials and water, and a shift from inorganic to organic. A building may be designed as an artificial ecosystem that can be incorporated into the surrounding ecosystems.

Many scientists and economists regard cities as wastelands, but surprising amounts of food can be grown in cities on rooftops, terraces, and empty lots (idle land in cities is commonly over twenty percent of the area). Biologists are just beginning to study wild animals and plants in cities.

6.7.3.4. *Building New Cities*

Building a new capital city is often the first thing a new nation does. The Aztec capital of Tenochtitlan was built on a island in Lake Texcoco, possibly due to concerns with territory and defense. Beijing is an example of a new city built for the purpose of starting over. In Renaissance Italy, new towns were planned and built on utopian or geometric designs. Saint Petersburg, Washington, Canberra, Tehran, and Islamabad were built as planned cities. Many

of these planned cities, Adelaide for instance, were planned with a foursquare grid layout that was imposed on the site. Several cities in the Netherlands were built when an inland sea, the Zuiderzee, was reclaimed to increase territory (and reduce flooding). Many of them were placed in fertile valleys or wetlands. Brasilia was placed in the 'empty' center of Brazil. Dimitrovgrad Bulgaria was planned as an industrial center. In Canada, many new cities, such as Medicine Hat, were built where the railway company decided to put tracks. New towns were started around Hong Kong to house the booming population; many of these were planned with public housing and rail transport considered. Ireland planned several new towns in the 1960s to accommodate a growing population and new industrialization. In the same period, Japan started a series of new towns, such as Senri New Town and Tama New Town, based on the English Garden City tradition.

Many visionary architects have designed ideal cities. Le Corbusier (born C.E. Jeanneret) built cubical models of Paris. Frank Lloyd Wright designed a suburban paradise in Broadacre City. Garden cities have been proposed by Ebenezer Howard and Patrick Geddes around 1900. Some were built, often as rings around an older established city, such as Washington or London. Most of these new cities are based on the prevailing assumptions of old cities, such as having as much energy as possible and using as much land as is wanted, for buildings, roads and parks. Many of the new towns, particularly in England and the United States, were created with automobile-oriented layouts. Roads, for instance, were designed and built with no knowledge of road ecology or the native ecology. Many of these cities were planned for an optimum population within their area, but today are proudly said to be 'still growing!'

Growth is a problem for most cities, especially those that seem idyllic with many amenities and opportunities for work or pleasure. Unfortunately, by not limiting growth, those cities attract so many new residents that the infrastructure starts to fail.

6.7.3.4.1. A Standard New City

Peachtree City, Georgia, in the United States, was chartered in 1959. It was designed to have four separate villages, each with facilities for education, recreation and shopping. It was located at the intersection of two state routes. As part of the layout, a system of golf cart paths was integrated with roads to connect homes and schools (giving the city more golf carts than any other in the world).

The city area is about 60 square kilometers (24 sq mi), with over 30,000 residents (and a density of over 1300 inhabitants per square mile). Many of the public or corporate buildings are low or one-story, as are many houses; the feel is horizontal. It could be a suburban paradise like Broadacre City.

In order to attract business, the city established an industrial park. And, companies like Panasonic automotive systems and Cooper Lighting have based headquarters or large plants there. One of the constant problems with new cities is the volume of traffic. Although golf carts were suggested to avoid some of the problems with traffic, this city has some cases of golf-cart gridlock.

Like many cities, water use has to be scheduled or rationed, and waste channeled and moved; garbage has to be collected and transported somewhere else. Areas are zoned for activities. Transportation has to be planned and replanned due to growth and changes in patterns. Police have to monitor order; crimes have to be solved. Murders, rapes, and robberies do not seem unusually high or low for a city of its size.

6.7.3.4.2. An Ecological City

The ecological city proposed by Paolo Soleri, Arcosanti, is a prototype arcology. Arcosanti is being built around a central concept: Arcology, the fusion of architecture with ecology. Arcology is one way to deal with the problems of urban life—pollution, waste, energy use, scarcity, crowding—using known physical and biological effects. Soleri is using: The greenhouse effect, which is the collection of heat behind glass; the horticultural effect, the control of select plants for shading, eating, and amenities; the apse effect, the use of shape to influence micro-climate to provide cool air in the desert in the summer without using energy; and, most important, the urban effect, the concentration of human potential through complexity and miniaturization, something that has drawn humans to cities for thousands of years.

Ecological cities, arcologies, are different from traditional cities, which depend on chance for amenities and build on suffering and waste for their wealth. Traditional cities have sprawled around trading or religious centers, occupying river valleys and fertile soils. Arcologies would disturb fewer ecosystems to support human populations. Being built vertically and not horizontally, and being built on less productive lands, such as deserts, scrublands, mountainsides, they would occupy less land than a similar population in an accidental city—less than one-tenth as much land. This would save established farmlands as well as native marshlands, watersheds, and grasslands. Paradoxically, because of their density and intensity, such cities leave more and better land for farming and wilderness; recycling is made easier; and transportation is shifted from motor to foot. Heavy industry and automated production is restricted to the central bowels of the city. They can be built to contain their own agriculture and waste recycling.

The construction of Arcosanti began in 1970. It is planned to be twenty-five stories high on thirteen acres, holding five thousand people. So far, but thousands people, students and professionals of diverse ages, races, and backgrounds have participated in the building the base, which includes, residences, foundries, meeting halls, green houses, studios, schools, shops, a fine arts amphitheater, visitor center, and dining areas.

Architecture is more than just a frame for keeping the weather from furniture and appliances. Soleri employs it to sensitize people to their humanness and their part in the food chain, indeed, the whole ecological network. Arcosanti is the apex of architecture and environmental design, but it is also a center for innovative thinking—through meetings, conferences, and celebrations that address political, scientific, technological, theological, and artistic issues. Arcosanti attempts to mirror the complex workings of individuals and societies in an ecological framework. It is not a single-vision solution to all things. In Soleri's words, it is an "urban laboratory" where people can learn how cities work. Soleri is the first to consider the supporting matrix, the ecology, of cities, and the first to address more psychological needs. His plans are not perfect, nor are they designed to replace all cities. But they are a first step to bring humanity into harmony with the limits of nature.

6.7.3.5. Infrastructure of Cities

To function, cities depend on a large number of structures to move people, energy and materials, such as food, water, and clothing, in and out of its boundaries in a timely manner. Roads, rails, ports, and airports have to be built and maintained.

6.7.3.5.1. Energy

We are addicted to cheap fossil energy. Victor Papanek notes that the easiest way to save energy, and cut waste, is to use less. Conserve. But, we can also produce designs for survival. We ought to reestablish energy patterns for regions, and use combined systems of wind, water, solar, organic and fossil fuels for energy. Singly, these may be inadequate, but as a mosaic they could meet decentralized needs for houses, businesses and some industries. The energy pattern should be pieced together organically from the potentialities of a region. Technology already exists to tap the flow and it should be easy to expand. Both the location of the flow and the technology could encourage decentralization. Decentralized, less consumptive energy patterns would reduce the risks and the constant crisis of costs. The scale of some sources, such as solar, could be increased.

6.7.3.5.2. Communications

Telecommunications, transportation, and tourism will accelerate, blithely unaware of their impacts on family structures, biogeochemical cycles, including the ozone layer, and wilderness. Computers are now allowing us to live in an amazing hyperworld of the Web, where communications propagate like electronic wildfire through the system, where people are brought together by the computer. This wild place could make our lives come alive with beautiful graphics and vital exchanges. The modern world has become a very interactive system for most classes, especially with computer and communication technologies, which can lead to totally integrated mass communication and extreme compression. Although modern communications technology could work the same, it also may allow cultural differences and complexity to remain. It would provide paths for communication that might stimulate cultures. Cultures could learn from one another.

6.7.3.5.3. Sewage & Wastes

Throughout our history we humans have always left behind things that we could not use. Some of these kitchen middens are very valuable to archaeologists; they tell us a lot about the lives of our ancestors. Other of our leavings have been of great value to animals, such as rats or birds, who have learned to live with us and benefit from our messes and excesses. As we became more numerous and more technologically advanced, we made things that rats and birds could not use, and that we could not reuse easily. These things formed concentrated pockets of trash on the landscape (trashscapes?). When these places became too ugly or dangerous (causing pollution and illness), we started to clean them up. We noticed that places that were ugly and dangerous were not popular vacation destinations or desirable places to live (although it seems that the poor cannot escape them as easily as the rich).

Using ecological design, we can plan to incorporate waste into our product streams. Trash is merely a resource that is out of place. There are several possible solutions. We could just accept it (and help future archaeologists). We could develop ways to keep the resources in circulation, by recycling or forming industrial partnerships among companies that could use the waste of other companies. Failing that, we could collect and recycle many kinds of trash. And, failing that, we could store it in landfills until a way is found to deal with it. Certain parts of the infrastructure will depend on the economies of scale, such as sewage treatment plants, although in that case artificial wetlands could replace the artificial treatment systems.

6.7.3.5.4. Roads

Roads are built in cities and between cities. Sometimes, parallel roads are added to handle one-way traffic loads. Roads are put into forests for harvesting and into roadless areas for fire control. Population increases. And, more people need more land for buildings, factories, farms, and roads. That means fewer places for wilderness, recreation, autos, or buses. Politicians, as well as business people and drivers, are asking for more, wider, smoother, and direct roads. Cities want better roads leading to their centers. Forestry managers want more roads into forests. Resort areas want more roads leading to the sea or mountains. Economically roads can stimulate income, at first. But, there are other ways of looking at roads.

We can look at roads with an ecological perspective. People, like most mammals, use roads (or paths) to get from one place to another, to get supplies; to visit others, or just to look around. This is a fine use of our technology. It allows us to increase our horizons and better our lives. Better roads make traveling more efficient. There is less waste of oil and gas, and less wear on vehicles and their occupants. But, every technological innovation in vehicles either requires or makes roads. And, Roads have effects that go far beyond the movement of people.

New roads lead more people to new places, thus changing the characteristics that often make those places attractive (e.g., being off the road). Roads increase the flow of things between points. But, too much flow (of matter, energy or form) can destroy biological relationships and diversity. Roads are a major force in fragmenting the habitats of plants and animals. Many animals cannot live near roads or noise or human activity. Many animals and plants need large areas to roam and roads cut into their areas (although, highway routes and underpasses can be modified; for instance Britain builds underpasses for frogs). Roads directly affect natural and human communities in many ways, causing: Changes in populations of animals or plants that cannot cross them (isolation); the spread of organisms that use roads to colonize new areas with plant or insect or animal pests (that is, things that are out of place); problems with erosion; problems with spreading trash (other things out of place); changes in hydrology and wetlands; changes in social circumstances—for instance, private cars changed public morality in America. Many kinds of crime are increased, for instance, bank robberies, if there are fast roads nearby with easy access. There are changes in economies, as new roads bypass old routes. Many countries answered the demands of their citizens, business people, and politicians (and ignored the environment) by building bigger, faster roads. Then as people crowded on the roads, they get more crowded and slower, and the demand for bigger roads rose again. Many countries have found that building more and larger roads does not solve the problems of congestion, accidents, and danger. These problems have a lot to do with the kind of transportation on the roads, that is, cars, trucks or buses.

Global ecological design has to pay attention to global human effects, such as ship, plane and auto transportation lanes, as well as communications technology, from wires and spectra to transmission lines and satellites. Roads can be planned and deconstructed as necessary.

6.7.3.6. *Thoughts on Where & How*

A city could promote appropriate technology to manage resources for its region. Dangerous technologies could be reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. In many old and some new cities, traditional housing should

be preferred, since its form and design are integrated into the culture, it is adapted to the local climate and is usually less expensive, due to use of local materials. Much of traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place.

With arcologies, and their urban ecologies, the city could change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation. The placement of a new city is important. It should be sited away from flood plains and other geological threat areas. It should be located away from fertile fields, as well as from wetlands or wilderness areas. Surprisingly, the use of a single ecosystem for living, working, growing food, moving around, and creating things, disposes of many of the problems from the artificial separation of human and nonhuman systems. The city becomes an integrated ecosystem that may be more self-reliant and stimulating.

The properties of good places could be used to help guide designs for cities. Action, for instance has to be appropriate for the scale of the city as well as the environment. Because of the complexity of interrelationships, the program of actions has to be coordinated. Ecological designs become actions to create good places, such as urban places, within a good environment modified by good cultural practices. Good places have individuality, which makes them unique. Design needs to reflect that uniqueness in all its productions, to insure diversity at the urban level. Diversity can lead to richness, which is also an important quality of good places. Good urban places offer the circumstances necessary for conviviality, that is, for all residents and beings to live together. The consistency of a place permits residents and beings to anticipate changes and disturbances. When this happens, health becomes more of an attribute of living in that place. Design needs to address health above all else at the level of good places and good cities. Healthy systems can be enhanced by ecological design.

6.7.4. Redesigning Regional Technology: Wild Lives & Living Technology

Since we cannot foresee the problems, we do not know what kinds of questions to ask to devise solutions. Therefore, we must always wait until some system fails before trying to correct it. Therefore, we will always be reacting to natural and artificial situations. Therefore, there will always be unavoidable costs in lives and resources before some new working situation is found. There are many examples of this series: We did not clean air until the pollution reduced visibility to a few meters; we did not clean up lakes until the fish were dead, we could not swim in them, or they caught fire—we could not force ourselves to pay for the ounce of prevention, no matter how unhappy we were with the tons of cure. Although the word ‘solution’ is used for several headings, it is not used in the sense of a one-time, all-time permanent fix. It is meant in the sense of simply an answer, or positive, adaptive, temporary response to challenges or problems.

6.7.4.1. Engineering Proposals for Solutions

Many critics are armed with lists of problems. What about solutions? This work accepts so many of the criticisms and tries to suggest kinds of solution, or at least good responses to many challenges. It is a guide, for suggestions to people who try to resist the global mechanical solutions by default.

Many people offer technological fixes and substitutions. They suggest that technological substitution will be effective in dealing with the increasing impacts of human beings on the system. They argue that technological options are crucial, starting with noncarbon-based energy systems and large-scale geoengineering approaches. In the past, nations responded to environmental change, such as drought or resource depletion, by changing lifestyles (usually reverting to simpler ones) or relocating. These responses are not possible in a 'filled planet.'

How should we design machines or machine interfaces? Will technology, and our knowledge and wisdom, allow us to design artificial beings that will fit into the current evolutionary processes? We need to design better machine infrastructures, to reduce the area they require that replaces natural support systems. We need to control accidental and designed releases from the machines, so those substances will not interfere with natural processes or cycles. We need to design to reduce the mass of machinery, as well as the mass of its energy and material requirements.

Machines have evolved culturally so that they have greater capabilities and are more efficient, but we need to redesign the entire machinomass so that it fits together and within the ecological network. Nanotechnology offers some relief from size and mass, but it also threatens a different kind of unanticipated runaway processes. Should we design machines that interface with living systems, without knowing more about living systems? Should we design robots to replace humans when we cannot even employ all the humans who want or need to work? Certainly machines can function in abiotic reaches of space or perhaps even as they do in very inhospitable earth environments. Should the machines be structured with rules that are anthropocentric, machinocentric or biocentric? Maybe the function of design should also be to limit the uses and kinds of machines, or at least address the needs and uses, benefits and costs, of machines in an ecological context rather than the narrower western economic context.

Machines are part of human ecology, like other tools. They too contribute to flows of elements, such as sulfur and nitrogen, although the machine contribution may exceed the total of all natural living and nonliving sources. Machines also increase flows of rare elements, such as lead or mercury to tens of times the natural flows. Machines also create new compounds that are suddenly introduced into a system that has no pathways to deal with them. They displace wild ecosystems, modify food webs, and create new energy flows within the system. Cars replace horses, and mowers replace deer and other grazing animals in simplified ecosystems. Video games may be the cockroaches, leaf-blowers may be the rats of the new world, taking more energy than they yield benefits. Television may be a form of cancer that encourages the replacement of every living thing with new machines, from guns to televisions.

Of course, machines are not living yet, as we know, although they follow rules, change and evolve. We apply control to them, but they seem autonomous in many ways. They have many known and unknown effects, that we foolishly call 'side-effects' and these may diminish ecosystems, as well as people (other people, not as dominant or machine-like), or simply proliferate more machines.

6.7.4.2. Management Solutions for Technology

As technologies developed, human relationships with animals and plants changed. Hunting, grazing, and agriculture provoked large ecological disturbances. Early domestic animals were revered, but nondomestic animals were considered competitors or nuisances. Now, domestic animals are treated as processed commodities and wildlife is regarded as useless.

Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Technology has greatly increased the kind and quality of materials used for buildings and machines, especially aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems. Unbridled, unconscious technology has given us benefits, but only at the cost of irreplaceable stocks of energy and environmental degradation. Instead of expecting technology to triple or quadruple our wealth, it is more likely that it has barely had a positive effect. Making technology appropriate, responsive, and conscious may go a ways to increasing its positive impact.

There is no reason not to develop complex instruments to monitor and analyze the environment. Machines do not need to be dismantled. Technological developments are more easily assessed in a small, self-supportive community, where they are not necessary. Necessity was not the mother of invention; curiosity was. And curiosity needs time, not pressure. Small communities could use sophisticated but unobtrusive technology. Evolution occurs in small populations, demes, in which a mutation has taken place. W.I. Thompson claims the metaindustrial village is such a deme. With desk-top computers and libraries, satellite and cable television, advanced science would be possible in the most rural setting. Leopold Kohr states that small firms have been shown to be more productive as separate entities.

Technological processes must be brought into balance with the cycles of the earth. They must not damage or degrade natural cycles. Avoid unnecessary harm. It may be appropriate to use trees or to compete with black bears for tree use, but it is never wise to destroy the ecosystem of trees and bears. Laws on pollution and noxious wastes have been notoriously lax and sometimes wrong-headed. Minimal acceptable tolerances are legal, yet people often prefer zero amounts of many substances. Minimal compliance with them is virtuous in comparison with many companies, but it would be better to lead to higher standards.

Technology makes things easier. The cost of technology makes things harder. Every technology has a benefit and a cost. How are the two balanced? Someone has to list all the effects and then appraise the risks with them. Who does that? When should technologies be denied existence or admission? Who should decide? We need a comprehensive program for evaluating technologies on every level of every dimension for as long a time as possible—perhaps only over one lifetime, but perhaps over the time of seven or more human generations. There have to be high standards for evaluation.

Managerial strategies are needed. Technological solutions are sometimes used to avoid alternative solutions or management solutions that may require changes in lifestyles or luxury demands, but management cannot be avoided. Now that system changes are becoming global, while most technological solutions are still local, management is required. For instance, starvation is a regional problem, often relating crop and distribution failures. Carbon emissions are also regional and large-scale. The green revolution benefited those rich enough to buy and grow hybrid crops using the necessary chemical fertilizers and pesticides, but not those with less buying power.

Technological fixes by themselves are not adequate. Drought and crop diseases could lead to collapses of agricultural and social systems. The uncertainty of climate and stability of ecosystems requires adaptive management. Management can use other tools, such as the precautionary principle. Management has to address distribution and consumption.

To manage the planet, we should probably avoid planetary scale civil works that is

macro engineering as a large-scale management approach. In terms of telecommunications and manufacturing are not sure what to say. In terms of managing human health, we have to identify linkages not only from areas but also from parts of the human genome. And of course we have to management the environment and all the resources in the environment. We have to be able to anticipate natural disasters, as well as the mitigate or control them. We have to manage automation. We have to test or fit virtual reality technologies, especially for training in design. We have to consider population trends in population goals. We have to consider worldwide tensions the end violence. We have to assess the possibility of some kind of electronic global village. Then there is the question of some kind of global, language, such as English, used specifically in business science or aviation for example. We have to manage public issues, such as healthcare, genetic screening, the use of energy, and socially significant crime. Then of course we can guess about many of the possible at or probable developments such as increasingly cheaper telecommunications.

Is there a managerial solution for climate change? Could it be as simple as restoring forests and grasslands, and using alternative sources of energy? Could international management create large-scale migration corridors for warm species to ward off extinctions?

Design is not engineering. It incorporates some engineering. But not the perspective of engineering, which is to fix something broken or exceed some limit. Engineers use and sometimes create new technologies. Our situation is not a problem to be solved. It is a context to fit, to learn to live with and in.

6.7.4.2.1. Responsibility

Management solutions require greater responsibility for the effects of pollution on species and habitats. Sometimes that is just a matter of allowing 'enough time' and 'enough space.' If we cannot recapture plastic pollution, we may have to minimize the release of plastics. If we have cut too many forests, we may have to restore forests to some greater extent. Some countries have reforestation programs: Costa Rica, Vietnam, and China. If people are trying to buy dangerous things or exotic species, we have to deny, regulate, monitor, or tax those things. If there is too much demand or too many people, then we have to lower those numbers. Many things would not be problems if we changed our consumption patterns or lowered our populations.

6.7.4.2.2. Goals for Use

A nation has to define the goals of technology, from simple technique to the simplification of chores, as well as to consider the concept of nonharm. Then, it has to analyze the results of technology, not just the mass production of things, but also the effects on human health and behavior. A nation has to discern what is missing from an application of technology, whether it is human scale or appropriateness. A nation has to decide how to manage technology.

Goals should be relatively simple to define, given the needs of a population and the limits of a home system. We can set goals for the conversion of mature ecosystems into agricultural ones; perhaps the maximum global limit is 15 percent of land, with local goals ranging from 10 to 90 percent. We can set goals for fresh water use, to reduce to 15 to 50 percent of any one system.

Biodiversity cannot be saved in the few, small isolated reserves on the planet, as it is. There are some good local and regional reserves, but no global ones. Ethical reasons for saving

biodiversity have to come first, before economic tools of valuation or resource use and policy. Goals for biodiversity can range from reducing the extinction rate from land conversion to trying to save individual species from climate change, either in zoos or gene banks.

6.7.4.2.3. Budgets for Elements & Molecules

Several authors have calculated a carbon budget for the planet. Prior to 8000 YBP, the CO₂ content of the atmosphere was 160 parts per million (PPM, before large-scale cutting and burning of forests). Prior to the industrial revolution by 1800, it was 280 parts per million of CO₂ in the atmosphere. This was equal to 645 gigatons of carbon in CO₂ in the atmosphere (the actual weight of the CO₂ would be 3.7 times more with the oxygen). For 2004, there are 380 ppm, or 869 gigatons of carbon. Tim Flannery suggests a budget of 660 gigatons, but as he states, half would stay in the atmosphere, raising CO₂ levels to 550 PPM or 1210 gigatons by 2100. It might be better to drop to 3 gigatons of new carbon per year. Carbon in living things comes to over 1 trillion tons. CO₂ is 387 ppm now. If we think 350 is safe and we want to bring down CO₂ to that number, we should be reducing our output to below 280 until the new goal is reached. Some have formed a active group to reduce to 350, and this is a good start, but we need to be lower as quickly as possible.

The benefits of Contraction & Convergence, a suggestion by UK politician Aubrey Meyer, are promising. Everybody has an equal right to release CO₂ or 'pollute with greenhouse gases.' This right could be traded similar to the Kyoto agreement. Under a global C&C agreement, citizens of the US would have to buy or trade carbon credits from poorer countries where people use a hundred times less. Meyer suggests three steps: (1) Reach an international agreement on a cap on atmospheric CO₂ concentrations. Then, (2) estimate how to cut back to that goal, and (3) divide the budget among the worlds population on per capita basis. This approach would reward fast-increasing populations and would not be fair. To be fair, in terms of ecological and cultural carrying capacities, would take a different calculation.

A fair budget could be figured in this way. Figure a world carbon budget, as an emergency budget using total from 8000 YBP divided by the current population for 10-50 years in the future. Then, for a permanent budget, use the numbers from the period 1400 or 1800 for 10-50 years in the future. Then calculate planetary cultural carrying capacity. Sum all the capacities and assign it 100%. So, for instance, if China has 13% of cultural carrying capacity, regardless of the actual population, then it gets 13% of the carbon use at the 1800 level. This kind of budget would be tied to the actual productivity of regions, combined with any technological advantages. Of course, the budget should be reassessed regularly, every five or so years.

Budgets should be made for all critical elements and molecules, such as nitrogen and phosphorus. We think that the boundary for nitrogen in systems is 39 million tons per year (removal from the atmosphere). It is 133 now. Nitrogen losses can be reduced by planting winter crops. The CAFOS animal feed operations should recycle their own nitrogen. Biofuels need to be discontinued, especially from corn, but also from grasses and trees. A global budget for phosphorus would limit the rate of flow into the ocean, which has been a sink for millions of years, to under 10 million tons or less per year; we may exceeding some critical maximum limit already. The rate increased exponentially when humans started contributing to natural erosion and movement with agriculture, deforestation and conversion to cities and roads. Better agricultural techniques can reduce it significantly.

Ozone budgets are relatively well-known. The gases from industrial processes, HFCs and CFCs, are 10,000 times better at capturing heat energy and last for many centuries. The Montreal Protocol reduced CFC gases in the air. It was the first victory over a global pollution problem. Many companies benefited from the change and from redesign of processes. There was some reduction in ozone loss from substitutes, like hydrochloroflourocarbons (HCFCs), which still cause some depletion, and Hydroflourocarbons (HFCs) cause almost no depletion. The Kyoto Protocol could be as effective, if all nations would agree. Kyoto does not get ratified by the US or Australia due to prohibitive costs. The cost of compliance might be high, but we need to measure the costs of doing nothing. Well, hurricanes can cost 10 billion.

Emissions trading in sulfur dioxide was invented in the US in 1995 to deal with pollution from burning coal. It is very successful.

6.7.4.2.4. Industrial Ecology Revisited

Despite a few paths of plastics recycling, aluminum or steel, most industry is a one-way path from energy and materials to waste energy and materials. Major changes are occurring, though. The scale of civilization now makes externalization unfeasible. The costs of pollution and waste are being internalized; other inputs, such as labor and capital, are becoming more expensive. Economies will have to internalize or be forced to internalize. With the internalization of costs (losses as well as benefits will accrue privately), the system will benefit from its responsibility.

Like agriculture, industry draws energy and resources from the earth and dumps its waste back. But, it draws too many resources too fast, and there is nothing that has coevolved to live on the waste. Unlike a pioneer stage of succession, industry is, in Evan Eisenberg's words, at a "fetal" stage. It relies on the maternal biosphere, or the biospheric matrix, to feed it and lick its wastes. Alas, this fetus is very large and could kill the mother soon, unless the fetus matures or the mother reacts faster.

Isolated attempts at industrial ecology have been less successful. Biosphere 2, for example had difficulties balancing gases. The underground part of Biosphere 2, in the desert in Arizona, is a larger technosphere that supports the operation of the biosphere, with 200 motors, 100 pumps, 60 fans, valves, computers, miles of wiring and ductwork. These machines circulate air faster and scrub algae better than the minimal natural processes in a closed environment. Kevin Kelly refers to it as a marriage of ecology and technology, a symbiosis. Dorian Sagan considers that man-made systems are ultimately natural, a phenomenon of metamorphosis. Perhaps the biosphere project is a crude form of planetary biosphere reproduction.

6.7.4.2.5. Evaluating Technology

We need some global organization, perhaps similar to the State of California's Department of Toxic Substances Control (DTSC), to focus on evaluating new technologies, especially alternatives to treat, recycle, clean up, and eliminate or reduce hazardous waste at its source. DTSC uses demonstration projects, data analysis, and life cycle assessments to provide support to other DTSC programs and help developers bring their ideas to market.

Such an organization would deal with remediating chlorinated solvent groundwater plumes, with life cycle assessment of the impacts of a product, and with evaluating nanotechnology. It would have to decide when to accept or reject a technology that promises some advantage, perhaps starting with potential impacts on the planet, then on ecosystems, then on human cultures and human individuals.

6.7.4.2.6. Containing Technology

The intent of many corporations and governments is to transfer technologies rapidly to the marketplace. Many technologies, however should require longer testing periods and required modifications. A suitable global organization would also decide under what conditions the effects of technology could probably not be contained. Does technology always escape and produce its effects on the nonhuman environment as well as on other cultures? If so, then technology is always ecological, that is, it is always part of the environment. It always generates some change in the environment it is part of. It is not the same environment after the introduction of the extension of technology. Any addition (or subtraction) is a change, and any change has many effects on everything. The loss of wolves in Britain did not simply subtract one species; it affected all other species in varying degrees. The conditions of survival all changed.

Attempts at containment raise questions. When should we reject a technology that promises some advantage? How do we balance technology against human or nonhuman lives? Perhaps we should start with potential impacts on the planet, then on ecosystems, then on human cultures and human individuals.

6.7.4.2.6.1. Applying Precautionary Principles

Technology has to be held to standards according to the precautionary principle. For instance, we have to require a minimum testing sequence for new technologies, with a minimum waiting period. Perhaps a moratorium? A moratorium is a legally authorized period of delay in the release or performance of a technology.

Some groups implement the precautionary principle as the basis for environmental policy, others for human health policy. The principle and the main components of its implementation (the 1998 Wingspread Statement on the Precautionary Principle, in Raffensperger et al.) are stated: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."

Several groups and government bodies in the United States, including the Board of Supervisors of the City and County of San Francisco, have made the precautionary principle the basis for environmental policy. The Precautionary Principle should be applied if there is the possibility of environmental or health damage, and if there is uncertainty as to whether an effect will occur (and its potential magnitude). Precaution is about anticipating and avoiding negative effects or damage. It requires more science, from different fields, to make the best possible decisions for preventing harm. The precautionary principle requires more, not less science than traditional decision-making methods. The managing body has to acknowledge the uncertainty and ambiguity involved in any decision.

The principle is especially important with gene technology. A substantial proportion of soybeans, corn, and cotton grown worldwide is genetically modified. To date, most genetically modified plants are grown in the US, followed by Argentina and Brazil. Many consumers are

concerned about the use of gene technology in food production, although less concerned about its use to produce medications and vaccines. However, the principle means taking precautions, rather than the thoughtless denial of the experimentation necessary to establish risks and dangers. The experimentation is crucial, but it should not be rushed for political or economic reasons.

6.7.4.2.6.2. Integrating Technologies & Lives with Design: Amish & Swiss Approaches

Technology needs to be integrated into society. It needs to be made appropriate to the goals and desires of a culture. The notion of appropriate technology, however, was developed in the twentieth century to describe situations where it was not desirable to use every new technology or those that required access to some centralized infrastructure or parts or skills imported from elsewhere. The ecovillage movement emerged in part due to this concern.

Technology needs to be integrated into the entire environment. Some technologies have negative environmental effects, such as pollution and lack of sustainability. Some technologies are designed specifically with the environment in mind, but most are designed first for economic or ergonomic effects. The effects of technology on the environment are both obvious and subtle. The more obvious effects include the depletion of nonrenewable natural resources, such as petroleum, coal, ores, and the added pollution of air, water, and land. The more subtle effects include debates over long-term changes, such as atmospheric heating, deforestation, natural habitat destruction, and coastal wetland loss.

The underground part of Biosphere 2, in the desert in Arizona, is a larger technosphere that supports the operation of the biosphere, with 200 motors, 100 pumps, 60 fans, valves, computers, miles of wiring and ductwork. These machines circulate air faster and scrub algae better than the minimal natural processes in a closed environment. Kevin Kelly refers to it as a marriage of ecology and technology, a symbiosis. Dorian Sagan considers that man-made systems are ultimately natural, a phenomenon of metamorphosis. Perhaps biosphere is a form of the planetary biosphere reproduction.

Technology changes institutions and the relationships between them. As an institution adapts a technology, its view changes. A new technology threatens other institutions, which have competing technologies, so the whole mass has considerable momentum and investment. As the nature of institutions changes, the nature of communities, cities and cultures changes.

Technologies change the structure of things with new metaphors. As metaphors (like totems) are good things to think with, technologies become things to think with. The whole idea of technology, according to Evan Eisenberg, is not to eliminate work or to replace nature with synthetic artifacts, it is to restore the balance of work and leisure that hunters understood—it is to find the best way between the dirt and the mouth. Sometimes this can be done with simple tools. When complex tools, such as computers, are used, they have to be designed to be appropriate to the use and environment.

A nation could promote appropriate technology to manage resources for its region. Dangerous technologies would be reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. Traditional housing, for instance would be preferred; its form and design are integrated into the culture, it is adapted to the local climate and is usually less expensive, due to use of local materials. Much traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place. With arcologies, the urban ecologies designed by Paolo Soleri, the city can change its relationship

with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation.

One way to balance technologies is to create a program for recovering old technologies that are useful under many circumstances and may be more appropriate than more complex solutions. Digging sticks, for instance have been useful for collecting or harvesting vegetables. And, they can be used just as effectively in rooftop gardens as in Amazonian rainforests or Australian deserts. Another way might be to base an approach on the Amish or Swiss.

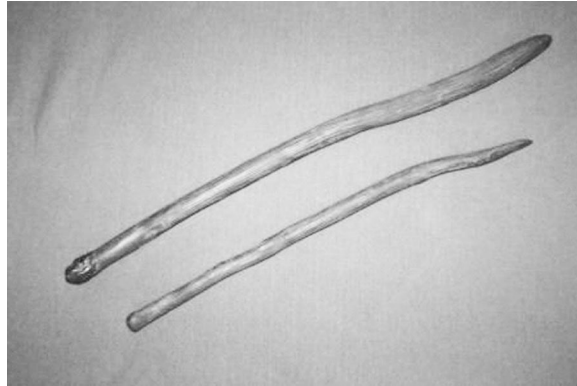


Figure 674262-1. Aboriginal Digging Sticks

6.7.4.2.6.2.1. *The Amish.* The Amish have developed an attitude toward technology based on their biblical cosmology and philosophy of life. The Amish are a contemporary, ‘low-technology’ farming culture living in the eastern and central United States, having fled several nations in Europe to find religious freedom. The Amish, although decentralized groups that vary in conservatism, in general, accept only technology that permits them to maintain their isolation from a secular, consumer society. So, for example, some use limited access to telephones, electricity and electrical appliances, and automobiles.

While the old order Amish are permitted to use batteries, generators, and many devices powered by those sources, they reject electricity from power grids, and the use of 110-volt electric appliances and computers. The prohibition of power-line electricity serves as a way to separate them from the outside world, so that their Bible-based standards will not be diluted or forgotten. The act of rejection of electricity also contributes to bonding in the community and is an acknowledgment of the need to submit to authority. There is no need to debate the possibility of every new worldly appliance to come along; it is removed from individual decision-making. The decision also effectively isolates the Amish from pervasive media like the internet that surely would have compromised Amish community. The rejection of electricity general serves to delay social change that may erode fundamental value beliefs.

Many Amish decisions about technology seem to be very flexible. For instance, people who are sick and need refrigerators are allowed to have them. Sometimes an Amish home will have a telephone to serve many families, usually for emergencies or communication with other Christian neighbors. When an Amish family purchases a secular home, some Amish churches allow a ‘grace period’ of 6-12 months during which the Amish family may continue to use electric power, until the home can be adapted to Amish standards.

Many Amish use candles for light. Some still use windmills for power or pumping water. Amish typically make use of various batteries for devices such as flashlights, and recharge them

using a diesel generator. Some Amish accept the use of solar panels to generate energy to charge batteries, heat water or power an electric fence. Solar energy is recognized to be part of 'God's grid.' All of these forms of power serve a practical purpose, but are limited in scope, thus restricting the type of technology that can be used.

The Amish stress simplicity and humility. They avoid any behavior or expression associated with self-exaltation, pride of position or enjoyment of power. They believe that God is pleased when people work in harmony with nature, to care for animals and plants. Amish always live in rural communities. Most Amish travel in horse-drawn buggies, although some modern conveyances and conveniences are used restrictively. Technology is not considered inherently evil—those technologies that are banned are those that might distract or damage the community.

However, the Amish are embedded in a technological society. They depend on the use of their neighbor's high technology, such as telephones and automobiles. They also depend on an industrial system for their 'low-tech' tools and materials. The Amish do not reject all modern technology, but choose pieces of it to use it in a controlled manner to live consistently with their values. They subordinate technology to the good of God, family, and community, and that subordination becomes a symbol of their separation the secular, which can hold evil. The Amish life might seem extreme in its simplicity and austerity, but Amish leaders are responding to extreme situations with extreme measures.

The Amish model may be impractical as a model for larger society. Some of the technologies the Amish reject are instrumental in the realization of human potential and improvement. It may be unwise to give them up entirely. Even if there was a general will in our society to adopt the Amish model, it is unlikely that the material needs of the current population could be met satisfactorily without some of the technologies the Amish reject. At least the transition to the Amish model would be extremely difficult. Third, human nature being what it is, even if we generally acknowledged the wisdom of the Amish model, few of us would be willing to give up the material comforts that the Amish reject. On the other hand, if civilization faces collapse soon, extreme measures may make the Amish model practical for many people.

6.7.4.2.6.2.2. *Swiss Technology.* Accelerated technological change has become a fact and involves the evaluation, development, implementation and substitution of technologies within innovation-driven enterprises. The Swiss embrace new technologies for improvements and trade advantages. But, they are reasonably cautious about adopting technologies. Strategic technology management needs to address these issues. Management control has experienced a fundamental change and in parallel, the question arises whether current management control systems can adequately cope with complex technology issues in technology-based enterprises. Previous technology management control approaches may be inadequate. Management needs to develop a Technology Management Control Systems in technology-based enterprises.

The Swiss Jura Arc is an illustration of the construction of a local system of production using new technologies (Maillat et al., 2000). Conventional production systems can be transformed into systems based on microtechnologies that result from a combination of conventional micro-engineering technologies and newer technologies, such as optics, new materials and microelectronics. A technology district formed as individuals made decisions to reconfigure the production process and management. The environment is the focus in

innovating the production process. Dynamic complementarities and interdependencies, between production and local institutions, are emphasized. Theoretical linkages are identified between the industrial, technological and territorial dynamics.

The Swiss pay attention to the implications of technological change on their society and on the dependencies of environmental, public and private interests. They use a holistic approach to technology management, a systems approach, which analyzes and contrasts technology management on corporate and national levels. With different levels of observation of technology, multiple perspectives can be used to manage new forms of technology.

6.7.4.2.6.3. Certifying Technology

Like electronic appliances and forest management, technology could be certified in terms of its performance qualities and impacts. With certification, the entire history of a technology would be made visible and known. Certification traditionally has been driven by consumers facing negative impacts. Although existing rules and laws protect people from faulty products, there is currently no way to protect them from an inherently harmful technology. Certification inherently requires more attention to and knowledge of system impacts and limits.

Most criteria are numbers on costs, impacts, and wastes, but they could reflect pollutants produced and the synergistic effects with other pollutants or technologies. An international certifying body, an independent, third-party group, could use a systems and practices approach to proscribe the use and reach of a technology. Although certification will be blamed for management failures and higher costs, it could reflect real, long-term costs and could keep high standards to improve the overall balance and health of the ecological and technological system. Certainly, certification will cause shifts in patterns of use and appreciation. It addresses issues of equity and justice as well, not only for human generations but ultrahuman beings, who also participate in the planetary system.

Certification will allow consumers to choose technologies that enhance common values, within the large-scale economic and political trends that shape human culture. Technology problems are part of a matrix of industrial social practices and policies, but there are now pressing economic and ecological reasons to revamp them. To be successful, certification has to address industry shortcuts and economic shortcomings. The goals of certification should include making technology benign and sustainable, as well as protecting ecological systems from harmful technologies.

6.7.4.2.6.4. Using Appropriate Technology

Appropriate technology is that technology designed with special considerations for the environmental, ethical, cultural, social, political, and economical aspects of the community it is intended for. Proponents of appropriateness claim those methods require fewer resources, are easier to maintain, and have less of an impact on the environment compared to techniques from mainstream technology, which is wasteful and environmentally polluting. This form of technology offers labor-intensive over capital-intensive approaches. Laborsaving devices are used when there are low capital or maintenance costs. In practice, appropriate technology is often something described as using the simplest level of technology that can effectively achieve the intended purpose in a particular location.

E.F. Schumacher, in his book, *Small is Beautiful*, popularized the movement used by Gandhi. Schumacher was very strongly influenced by Gandhi's philosophy. He took the village

development idea further with ‘intermediate technology’ in early 1970s. Many others, such as R.B. Fuller, Victor Papanek, and Arne Naess, contributed to the appropriate technology movement.

6.7.4.2.6.5. Embracing a Technology Diet?

In the case of industrial nations, we have been embracing excess for many generations, so that we are crippled by stress and sickness. Perhaps all we need is a diet, an emergency diet. The essence of a diet is to restore oneself to health, by restricting unhealthy consumption. As societies and cultures may also be guilty of this kind of behavior, so they need to put themselves on a diet. We know that people are unable to perform well on unbalanced diets or sometimes even behave in a human way, so the diet would have to be whole and healthy, just without excess or overindulgence. A diet for a small industrial planet could be presented as a series of actions based on technical, managerial and design ideas.

For example, we could start a carbon budget for planet, and cut carbon use drastically by decarbonizing the power grid with solar, wind, and other sources, then ban new coal-fired plants and regulate existing ones. We could extract CO₂ from the atmosphere, by planting trees and designing a permanent agriculture. We could regulate our population, by basing it on biological/cultural carrying capacities and by starting a Year of Consideration with no births.

We might freeze our energy use at 1950 or 1910 per capita levels. We could cut waste by using less and sharing, by designing more ecological technologies, and by creating entire industrial ecologies. We could cut transportation, by not traveling as much or as wastefully, and by using old-fashioned practices like walking or by using virtual technology like the internet. If we did travel, we could optimize transportation with hybrid or solar cars that get 40-200 mpg or better. Trains could be solar electric or maglev. Ships could return to sailing technologies. Airplanes could be grounded 3-4 days a week.

We could seriously cut the automatic or planned expansion of human/ urban/ agricultural areas, cut conversion of wild ecosystems, and preserve wild areas as wisely as possible using north-south ranges and north-south corridors, even through cities and fields.

6.7.4.3.2. Technology Design Related to Properties of Culture and Life

We can use the properties of ecosystems to consider design concerns with technology, although those concerns might be better linked with the properties of a culture: Conduct, wholeness, flexibility, adaptation, endurance, and vitality. Each of these properties should help us understand the limits and alternatives to design technology.

6.7.4.3.2.1. Conduct Related to Design Technology

Conduct is the course of cultural behaviors through a behavioral landscape. The concept of the epigenetic landscape can be used to explain why people become trapped in the use of a technology. The use-need path or chreod is deeper than the cognitive path that relates technology to history and need. So, we have to use the technology even though we may be aware of simpler solutions, such as bicycles or evaporative cooling. If the need chreod is too deep with investment or profit, we cannot explore the cognitive chreod. This may explain why necessity cannot be the mother of invention; the necessity path, eating to avoid starvation for instance, is too deep to allow exploration of a shallower path of daydreaming or design. The broader behavioral landscape of leisure is needed. Conduct can be described as the stable

path of culture through a landscape of possibilities. Once the course has been set, it is most likely to channel most subsequent behaviors, unless some event or catastrophe triggers a deeper course.

6.7.4.3.2.2. Wholeness Related to Design Technology

Culture provides an identity for its members. It tells them who they are, where they came from, and why they are special. Identity is basic to human existence. People are identified by their roles. A person is an incarnation of his and her group—even in industrial culture, one is identified as an astronomer or farmer. Specific technologies are often part of an identity. Identity is that persistent quality that can be described apart from its performance in interactions, but not isolated. The relationship between identity and wholeness is a rhythm, with unique patterns. In fact, culture is concerned with all things and beings in a whole. If the rhythm is whole enough, it could incorporate appropriate technologies into it.

6.7.4.3.2.3. Flexibility Related to Design Technology

The rules of a culture lend order and stability to the whole, as well as flexibility. Flexibility means not being over connected, or not being too rigid or too efficient. That means that culture is able to slough off older technologies for newer ones—or new ones for appropriate technologies that fit better into a sustainable pattern. That way culture is able to keep some options and unused connections open. Some of the flexibility comes from different ways of establishing connections in specific places. Culture is bounded by ideas and habits, but is open to flows of energy and materials. It is a loose-fitting patchwork of ideas, relationships and things. It requires order, but not too much order. It is tolerant of discontinuities and contradictions, and this gives it flexibility. If the contradictions between technology and moral behavior become too great and maladaptive, however, the culture can collapse. Flexibility can allow the choice of technologies regardless of novelty or fad-value.

6.7.4.3.2.4. Adaptation Related to Design Technology

The patchiness of culture is parallel to the co-constrained construction of a species and its environment. Co-constrained construction enforces coevolution, the emergence of a highly ordered complexity to full structuration. Culture has to balance between embracing change and resisting change. People show a desire for new technologies, tools and products, but often fear and resist change. Resistance to change is a normal part of a cultural process. Groups like the pygmies have specialized to fit the requirements of the environment, successfully. This makes it difficult to adopt other cultural arrangements. A culture modifies and is modified by the environment, and both can adjust and survive. Technology is part of a culture and it aids survival in the wider environment. Each technology is a way of exceeding the limits of the environment. This changes the environment, which pushes new changes in human thought and technology. Technology itself, however, has not been used for improving ecological balance. It could and it needs to be used that way to aid survival.

6.7.4.3.2.5. Endurance Related to Design Technology

A cultural system is stable and persistent in time. It is a general property of some systems that acquired information is used to close the door to further inflow. A mature culture needs less information, since it works toward preservation, and closes itself off to information that

does not fit the shape of the culture. The effect of maturity is to allow a maximum variability between systems with slight external differences, such as place or initial conditions. Cultural shapes need to be loose enough and diverse enough to change when new information is required. Cultural stability is the ability to maintain cultural identity under the flow of external forces and disturbances. A culture has to be able to resist disturbances that are too disruptive. Sometimes those disturbances result from an inappropriate technology that then needs to be modified or rescaled. If the technology cannot be modified, it has to be resisted. Resistance is a positive act for a self-reliant culture. Culture also has to be resilient enough to recover from intermediate and small disturbances from the environment or technology.

6.7.4.3.2.6. Vitality Related to Design Technology

To be constant and stable, a culture has to be vital, that is, it has to be productive, to be able to convert energy and materials into foods and structures for survival. With order and integration come stability and security, without which no one can survive. Primordial security comes from a physical, knowledgeable relationship with nature. Stability can also be related to compartmentalization, communications, and the richness of interactions and connections. The system, with all of its technologies, is self-creating. It renews itself as its contents change, as disturbances change the parameters of the system. But, technology that does not fit the culture or its environment is a barrier to cultural renewal. If a culture is vital enough to be productive with less complex technologies, then it can judge and choose technologies according to its best longer-term interests and not be trapped in the depth of habit or investment. When human societies were small, the amount of control and security required was small. Although societies have grown to immense sizes, human security has not, despite incredible increases in the sophistication of technologies. Perhaps that is because vitality does not always require sophisticated technologies beyond a certain point to achieve goals of a good and stimulating existence.

6.7.4.3.3. Technology Design Related to the Properties of Life

We can use the properties of life to consider design concerns with technology. These properties are: Movement, cellular structure, irritability, growth and development, adaptation, and reproduction. Each of these properties should help us understand the limits and alternatives to design technology. Because of the emergence of technology from human creativity, many properties of technology seem similar to living.

6.7.4.4. *What Technology is Necessary?*

Everyone agrees, to some extent, that we need science and technology to meet human needs. And, these systems have to be integrated systems of production, consumption, and distribution. They have to be postindustrial and ecological.

The most meaningful actions have to be at the largest scale possible—hence, global ecological design. But to be good at global, we have to think in the solar system. Cosmic address of our place is: Earth, Solar System, Orion Arm, Milky Way Galaxy, Local Group of Galaxies (Milky Way Group?), and Local Supercluster of galaxies, universe, and perhaps local clusters of universes.

We tend to think of civilizations or nations as metaphors for behavior. Primasck and Abrams suggest that identity with ‘generations’ might be more meaningful than civilizations.

But, generations are shaped by cultures and now by global influences and trends.

Advanced communities have to adapt biologically sound processes. Pollution is only a symptom of imbalance and improper resource utilization. The wars on pollution and on poverty are as ineffective as the wars on people. A serious problem is our lack of understanding of the extensive, long-term effects of pollution on the atmosphere. Once it is determined that materials and wastes, especially nuclear or chemical are dangerous and long-lived, they should be minimized. There are ways to reduce generation of wastes by acting on the flow: Reduce number of products; reduce the quantity of waste in each product; increase the durability of each product; and make sure that the cycle is a spiral. The best results might come from a mix of these strategies.

The greatest threats facing ecosystems and biomes, and the organisms and species adapted with them, are not just disease organisms or pollution, but the synergistic effects of fragmentation, pollution, and climate change. And these are best addressed all at once.

We need to relax, paradoxically, to have more time. A problem with the degradation theory is that time and leisure are needed for technological innovations. People starving rarely invent their salvations. We need to have faith in our strength and resolve so that we can act wisely with technology and design. The computer offers computing speed and storage of information, but despite our faith in it, it is not enough to solve any problems. Paradoxically, we need to be less adaptive. As Rene Dubos pointed out, we may be able to adapt to pollution and habitat destruction, simply because, like rats and bacteria, we can adapt to radical changes, even if other plants and animals that we value cannot adapt and perish. Therefore, we need to implement thoughtful plans and designs.

6.7.5. *Redesigning Industry*

Industries were developed to produce material needs on a large-scale, so that more things could be supplied to more people. The scale had the effect of lowering the costs of items, so that almost anyone could afford things, such as clothing or toys that had been out of their economic reach.

Industry has special requirements that have to be met for it to be profitable. It requires capital investment, special designs, regulated labor, free materials, a directional flow, and free environmental services for renewal. Industry has effects other than low-cost or profit, which can seem like costs: People have to act as identical, replaceable machines, and they have to be regulated, due to disrespect and violence; pollution and its sometimes required, sometimes expensive cleanup responses; negative changes in the health of workers or consumers; and, the samenesses of the products.

Industry developed within the context of a western civilization that held dear a few cosmological ideas: It's us against the environment, other men, and animals; it's the individual (or corporation) that matters most (although each is replaceable); we can control everything with machines and should; resources are infinite; and, the ability of technology to fix problems is also infinite. Industrial culture is a package deal, complete with Christian conservative virtues and Newtonian physics. The package inflates many luxuries into needs, so that the cost of a simple car becomes a need, even in a city with advanced mass transport.

Industrial design is not just about designing products, but about designing the factories and processes within an ecosystem context, that is, the land, cycles, and connections.

This requires consideration of anything that has some connection to the industry.

6.7.5.1. An Artistic Approach

The architect and designer William Morris reacted to the plain aesthetic of industry and the replacement of art labor by machinery by starting the English Arts and Crafts Movement in partnership with Edward Burne-Jones and D.G. Rossetti. The movement was a reaction to the 'soulless' machine production that resulted from the industrial revolution and a search for authentic and meaningful styles for a new approach to production. He applied his theories of hand-craftsmanship to the designs of churches and houses, as well as to designs for textiles and wallpapers. As a pattern designer, he was concerned not only with patterns based on a close observation of nature, but also patterns of work and accomplishment. Morris was concerned with preserving what was valuable in the natural and 'built' worlds, the very things that were threatened by the faceless movements, such as industrialism and modernization, with the attempt to control everything from production to prayer.

While the Arts and Crafts Movement was a reaction to industrialization, it was not specifically anti-industry or anti-modern. Quality production could be accomplished with a design, labor, tools, and machines. Workers could use machines to produce furniture and other things. The difference was in the control of the designer in all stages of production and the use of machines to supplement labor rather than replace it. Designers and workers would work together to develop higher standards of handicrafts.

Morris actually designed artifacts for machine production, as long as the process did not involve the complete division of labor and indifference to craft talent. In building a desk, for example, one person or team would handle all the legs of the piece and another all the panels; a third person or group assembled the parts, and a fourth handled the finishing work, such as paint and varnish—all according to a plan of a furniture designer, who would or would not participate in making the item. Machines would be used appropriately. The Arts and Crafts movement sought to reunite what had been ripped asunder in the nature of human work, having the designer work with his hands at every step of creation.

Although dismissed as a romantic, Morris stimulated a movement towards artistic sensibility based on ideals and principles that many people find true. His work had effects on western architecture, cottage garden design, and on the Garden City town movement.

6.7.5.2. Industrial Ecosystems

Paul Hawkin and others have suggested the possibility of an industrial ecology that could mimic a mature ecology in its use of recycling and wildness. Industrial designers and managers need only reduce the capital use of energy and streamline recycling. The Danish have created an example in Kalundborg. Statoil sends most of its byproducts to industrial neighbors: Sulfur to a sulfuric-acid plant, heat to local greenhouses, gypsum to a wallboard plant, gas and wastewater to a coal-fired electric utility, which sends its waste steam to Statoil and fly ash to a cement company. A flowchart with boxes and arrows might make it resemble the charts of mature ecosystems.

One problem with an industrial ecosystem might be how it fits with natural ecosystems. A related problem might be the total energy and material in the industrial system—that is, the scale might overwhelm natural ecosystems accustomed to solar energy budgets. Although we can expect many species to invade or exploit an industrial ecosystem, we need to choose them

carefully so that they do not overwhelm the system.

We can use the properties of ecosystems to consider design concerns with industry, starting with 'Course.' Living systems do not display homeostasis—constant value—so much as a particular course of change in time—homeorhesis (from the Greek meaning 'same flow'), according to Conrad Waddington. The course is stabilized, not the constancy. Changes to a system are symbolized by trajectories in a multidimensional phase space or landscape. Homeorhesis is a significant phenomenon in evolution. Waddington applies it to the tendency of a process to continue in its original pattern, even if disturbed. Homeorhetic mechanisms protect the system from many disruptions. Negative feedback counteracts the effects of change to maintain the system in a steady state or homeorhetic state. A mature community is self-perpetuating and homeorhetic, with a dynamic balanced energy-matter budget.

The course exists in a natural topology with valleys and hills. The valleys occur in various shapes. Some could be very narrow canyons, others large meadows, similar to old mature earth forms, with meandering rivers. The name for a characteristic of an attractor surface in multidimensional space is a chreod, not a valley. The cross-sectional shape of the chreod describes the reaction of the system to fluctuations. With a steep slope, for example, it is difficult to divert the developing system from the bottom of valley; even with a strong force the system will return immediately as soon as the influence stops. With a shallow slope, like a flood plain chreod, it is easy to divert the system; it meanders before returning. But actually the perturbations alter the landscape itself, making a steep valley again, not just shifting the river. As the environment changes, the system changes with it.

Ecosystems have many properties and are affected by many environmental conditions. Their changes are symbolized by trajectories in multidimensional phase space; orderliness can be described in terms of constraints on trajectory courses, and these constraints are visualized as attractor surfaces. If the system starts from any condition, represented by a point in multidimensional phase space, the trajectory will move to nearest attractor surface and then move along it. If industrial design can be fit, with proper scale and energy impacts, into the order of ecosystems, then the whole system could function with minimal disruption.

Another property is identity. An ecosystem has an identity as a whole. The ontology of any living system is the history of the maintenance of its identity as a whole through continuous self-making, or autopoiesis. If there were no identity, there would be no differences and so no relationships. Ecosystems are part of an unending, imperfect process, without any final state. Furthermore, the human attempt at perfectibility through self-improvement causes disharmony, which is part of the same imperfect process. Each system is a practical application to place. Unknown factors determine a large part of the operation of any system. Furthermore, there is chaos in every system; there are plagues and random frenzies. Industrial ecological design has to accommodate the uncertainty and imperfection. In grassland, industry has to be part of that grassland.

Diversity is an emergent system property. The environment has been constant enough for organic evolution, but variable enough for natural selection to be challenged. Variability challenges organisms to adjust and thrive. Variability, even in small ways, leads to diversity. Diversity, as a measure of genetic variability in ecosystem, enlarges information. A mature system needs less information, since it works toward preservation. The limit of maturity allows maximum variability between systems with slight external differences, like temperature.

The industry has to enlarge the system, and increase diversity, but help the system stay

within the limits of variability to preserve its basic structures and functions. The variation of climate, for instance, an external disturbance, can change the physical and chemical parameters of the forest. Acid rain causes biochemical and soil chemical reactions, which in turn provide *in-form*-ation to other organisms, which use it to regulate their physiological processes which can effect the forest, e.g., insect damage changes the level of seasonal growth of trees. Damage to trees from pathogens, or disease agents, is an internal disturbance. Industry can produce some disturbance, like any natural phenomenon, but it has to be limited to the stability and resilience of the system. The use of energy has to keep pace with the process of maturation of the system.

The property of Coconstruction suggests that the organism and environment are co-implicative, co-defining, and co-constructing. They engage in a process of self-assembly, where the complete self is the organism-environment system. Construction requires participation, complexity, and development. The process of construction involves a self-presentation offering new symbiotic relations and novelty. Novelty always enters with environmental change, which serves to maintain the openness of the system. Novelty enters with fluctuations. The “strategy” of ecosystem development is increased control of, or homeorhesis with, the physical environment and novelty—probably to protect itself from perturbations. There is a fundamental shift in energy flows, as increasing amounts of energy are used for maintenance. As more and more energy is used for maintenance, the net community production (NCP) approaches zero. The mature system becomes more efficient, as it supports a larger biomass with the same amount of energy. The food chains become more weblike, dominated by detritus chains as opposed to linear grazing. Construction depends on diversity for the reciprocal constraint. Local context allows for more rapid construction. The constraint forces species to change. Industry, when young, resembled pioneer ecosystems—as it matures, and is shaped by ecological design, it may more resemble a more mature system, with less gross productivity and a more scaled and directed productivity that fits within the limits of the ecological framework.

The property of stability is the ability to maintain the identity of a system under the flow of external forces and disturbances. Stability can be refined through the specifics of constancy, resistance, resilience, and accommodation. Stability can be related to ideas of compartmentalization, communications, richness of interactions, and connections. Ulanowicz suggests that stability might be explained by diversity flow topologies, where flow topology is a descriptor of how ecosystems develop. The stability of ecosystems, as originally proposed by Eugene Odum, becomes the result of regular flows of energy and materials. Growth and development are characterized by a qualitative formalism of increasing ascendancy, which explains the drive towards coherence, efficiency, specialization, and self-containment. Industry cannot kick any of these properties out their courses or limits. Or topology.

Productivity, the final property, is the ability to convert energy into living forms and the ability to incorporate materials into living forms. Productivity, in general, depends on the vigor, or strength or vitality or health, of the system. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions (which may include hurricanes, volcanic eruptions, or fire). Health is a dynamic measure of ecosystem organization, vigor, and resilience. Organization is described by diversity and connectivity; vigor is related to the amount and speed of productivity; and resilience is a measure of reaction to stress. Too much stress, for example, leads to unsustainable patterns of behavior; continuous

stress leads to a breakdown of processes that becomes irreversible—the system dies. To relate health to growth and productivity, we could say that the capital of an ecosystem would be its physical environment and its gross primary productivity; interest would be the net ecosystem productivity. Our measurements of productivity, however, are not adequate. We are measuring over a year or two only to establish a growth rate or productivity. We should be measuring over centuries.

The production percentage would be the amount necessary to keep the ecosystem healthy. Obviously, a pioneer community may change the conditions to favor a new level of the system with new components. With a goal of maturity, an industrial ecosystem could furnish some of those new components, as long as they fit into the processes that lead to productivity. This may limit the scale of industry, so that economic scales may become less important than the ecosystems scale, with its limits and long-term changes.

An ecological industrial system would be concerned with the interrelated design of the movement of things and energy, and with the creation of power and waste. If resources stayed in place then the culture in each place could specialize in value-added economics, instead of moving the raw resources around. The system could optimize the scale and style of mass production, so that some needs, such as clothing and transport, could be made efficiently and inexpensively, but to be high-quality and long-lasting (within the constraints of the need for change and fashion). The system would emphasize repair, reuse, and reassembly; in fact, this part of the system could be extended to local shops and crafts people or engineers, which would involve local populations.

6.7.6. What About the Design of Civilization?

The real question is whether any civilization that human groups have formed is enduring. We know that foraging groups (hunter gatherers), and some herding, horticultural and agrarian societies are sustainable, mostly because of their size and limitations. But, we do know if this is or will be true for modern civilization, especially an urban, industrial civilization. Amory Lovins suggests that modern civilization is imperiled by three main problems: The dissolution of civil society, weak support systems, and dwindling public wealth to address problems and suffering. Ignoring these problems could lead to worse violence and terrorism that would further undermine communities and nations. Perhaps the problems are unavoidable and emerge from our commitments to science, growth, and flirtation (commitment) with chaos.

The direction of modern science seems imperative. Francis Bacon thought that we had the power to remake nature for human needs, and that history was moving to a complete human mastery of nature. Many other thinkers state that nature is moving towards a goal, of consciousness or completion. This might be the controlling idea of modern civilization: Progress leads to a perfect heaven on earth. Progress cannot be stopped, and the suffering and bad ideas in its name are tolerable side effects. The atomistic aspect of science concludes that nature is composed of indifferent atoms and selfish genes, and not a holistic structure with integrity. Nature is simple, orderly and predictable; she can be dominated and controlled. Therefore, we can do anything, or try anything and see what happens.

In a similar way, growth has become an imperative, also. Civilization, with population and energy use, has to grow to be efficient and successful. But, growth can affect the extent and kind of problems. Growth can lead to an unsustainable pattern of civilization where over

energization and overuse can lead to inappropriate sinks and explosions in ecosystems, starting with human ones.

We can think of the complex of civilization as rational response to climate change; we can think of cities and centralized religions and governments, as responses to drought, in a different way than nomadism. This alternate direction became more complex. Government became important to coordinate larger numbers of people engaged in irrigation of plants and storage of surplus food, to distribute rewards, settle disputes, and defend against aggressive neighbors, whose crops may have failed. Religion became more important as the climate became less predictable, as people looked for ultimate rewards.

The direction of modern civilization is based on myths and fallacies that are not rational or sustainable. For instance, one American myth holds the contradictory views that civilized processes cannot rip the fabric of nature, but if it could, it could repair nature. Another myth is that the US is doing everything it can to help the disadvantaged and poor in its nation as well as around the world—ridiculously not so. The poverty of other nations affects any one nation. Ignoring international diplomacy, military decisions to protect the nation are based on the fallacy that military actions will provide security for one nation even if the rest of the nations are unstable. Extremism and violence threats affect every nation eventually. This is more so, when nations are linked in global travel and trade.

After traveling in Italy, as American Ambassador there, G.P. Marsh pointed out that civilizations have collapsed due to ignorance of natural laws. He recognized that climate change could contribute to collapse, as well as that human actions could result in large-scale harm to the environment. At first humans responded to and adapted to environmental changes; then they started changing the environment in all its diversity and dynamics to suit our immediate needs. Sometimes, civilizations collapsed, if there was imbalance or excess. When earlier civilizations collapsed, however, they were isolated from groups by natural barriers as well as by looser links of trade. The drivers of the collapse were local and maybe regional. In general, groups were self-sufficient. When Maya civilization collapsed, the urban political structures, the people were able to return to simpler forms of foraging or agriculture.

In an interconnected global civilization, massive ecological or social failure in one region might threaten the stability of the entire global system, if people cannot go back to a state of relative isolation and self-reliance. Furthermore, the role of chance or contingent events becomes larger, as droughts, shortages or diseases affect different groups or areas. Geoffrey Chew suggests that the collapse of civilizations is not really a problem for learning, but it is a problem of not learning, as when cultures choose not to learn from past mistakes. Of course, like death, collapse is hard to learn for the dying or collapsing entity—in fact the lesson cannot be learned if the collapse is complete. In order to avoid collapse, a culture has to learn from the past. But, nothing in our past has prepared us for the number and strength of global connections. During any collapse, many cultures have been able to adapt and evolve by expanding into other areas, but this is no longer possible in a completely occupied, territorialized, owned planet.

Every civilization faces a spectrum of risks, which may push the civilization to find new sources of land, food or energy. The need to solve such risks pushes the system further from its original state and can accelerate the operation of the system. Acceleration makes decision-making, especially weighing alternatives, much more difficult. The conjunction of long-term risks can lead to a management or governmental crisis. We have never planned or designed

our civilization to respond to impacts and the dynamic changes of the entire planet. We never designed civilization to respond to complex challenges or to slow or invisible catastrophes. Thus, we are not responding to many kinds of catastrophes, and when we do, we only shore up a quick fix, regardless of the regularity of the catastrophe. Sometimes we may not recognize that the catastrophe is an effect of our designs and activities. Sometimes when we do recognize that, we think that we can use the same mindset and approach to correct the problems later, when it might be more economically or politically feasible, although it rarely is.

Furthermore, we are engaging in several large-scale experiments, which can conceivably impact large areas of, or possibly the entire, planet. These experiments are not just our civilization, but also our way of growing food, traveling, and converting landscapes. They are experiments on the change in the makeup of the planet, because we select so many different kinds of organisms that we need and we transformed so many ecosystems. Civilization and cities are large parts of that transformation, now. Albert Einstein noted that problems cannot be solved at the same level of awareness that created them. Because the global system creates problems, such as war, poverty and environmental destruction, it cannot solve them by continuing that behavior.

But problems can be solved at a different level, by new type of planetary civilization with different values and social institutions. I think that the problems are not global or regional or ubiquitous. I need to expand that. Change can result from either random mutation or accidental behavior. But, conscious invention can produce new structures with new capabilities. If a global civilization is to form and to survive, it must develop into a completely new type of social system. A blind, consumer society cannot be transformed into a consumer society without structural change.

Because modern civilization is dynamic and developing, it has the potential to change itself to be more stable and less intrusive, and make changes. Individuals, groups, and nations have the ability to design social and living systems. We do not require more data or knowledge before we start redesigning systems. Buckminster Fuller said that to change something you have to build a new model that makes the existing model obsolete—it is not necessary to fight the existing reality.

In this approach, eutopias need to deconstruct the destructive impacts of civilization. Maybe we can design a general self-regulating feature to lessen environmental stresses when they become apparent. But, we need to be able to see and understand them first. Another thing that the eutopian framework can do is to de-westernize civilization. We also need to deglobalize those things that should not be globalized, such as traditional cultures. Perhaps what we need is a form of cultural anarchy that could be coordinated through the United Nations or new framework. Culture is the process that gives meaning to the lives of people who live in the culture—it is not decoration or artifice, it is a body of knowledge that allows people to make sense of the world. We need the eutopian framework also to dehomogenize the world. We tend to be drifting toward a more homogenous world since our weak global culture tends to be bland and generic. Yet, if it wipes out all other cultures, there will be no rivals or successors. Traditional cultures are not failed attempts to be industrial; they are manifestations of the human experience of specific places. They allow us to be aware of our place in this area of the planet.

One serious question is what to do with those nonurban or nonindustrial cultures that choose to continue to be nonurban or nonindustrial. Should we make a park for them?

Should we isolate them in some way or have some kind of boundaries that sort the technology that they can use? Maybe the word Park is not the best way the best word, since they are not zoological specimens. Maybe we cannot save them that way, but what we could do is allow them to create the boundaries they want.

Vaclav Havel has suggested that a fundamental shift is needed to change the direction of the current civilization. His deep conviction is that the only option is to enlarge the sphere of the spirit. It may not be enough to invent new machines and new institutions. We must develop a new understanding of existence on earth. Only by making a fundamental shift will we be able to create new models of behavior and new sets of values.

Morris Berman suggests that as our civilization matures, we can recognize that visual communicators sometimes manufacture misleading memories, which can be as dangerous as 'hot steel.' One solution is that everyone has to participate in design, to become a designer, perhaps as everyone was in a foraging society, where we made everything and built everything ourselves. The future of civilization is our common design project, Berman says. He suggests that designers have more power than they realize, especially in critical situations, and ours is critical. One great threat to human future is consumption or overconsumption. Now, design itself fuels mass overconsumption. We can leave a better legacy by using our best ideas immediately, and not rely on copying our chromosomes. We have made many major errors in human civilization, from our agricultural conversion of ecosystems to the production of plastics and synthetics and to our unplanned growth. Human civilization cannot afford major global mistakes. We have to try balancing civilization as a global phenomenon.

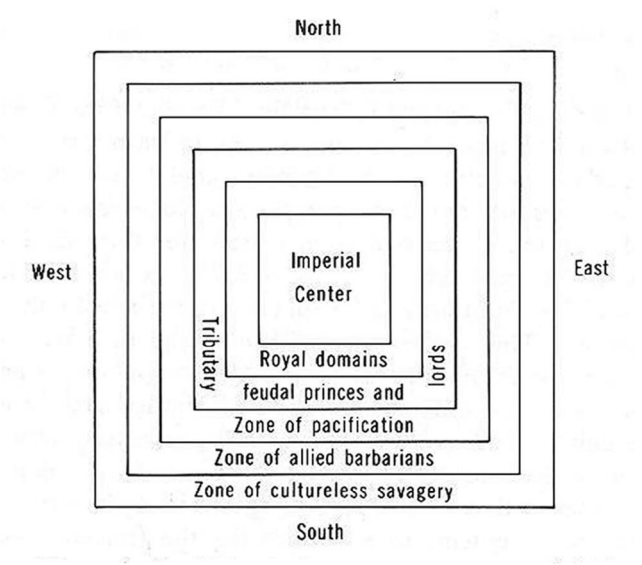


Figure 592-1. Ancient Worldview of Chinese Civilization

6.7.7. *Necessities for an Ecological Civilization (in China)*

By John B. Cobb, Jr.

It is my great joy and privilege to welcome you to Claremont. We are truly honored that you have come to exchange ideas with us. You certainly should not come to the United States in hopes of finding here an ecological civilization. What you may find are people who have been hoping and working for breakthroughs in this direction, but have grown increasingly frustrated by developments in this country. The chance that China may take the steps that could lead to such a civilization is for us a source of great hope. But the chances of any nation actually doing all that needs to be done for such a civilization to emerge remain uncertain.

One requirement for a nation to move far in the direction of ecological civilization is cultural or spiritual. People are not likely to treat nature with the necessary respect if they do not deeply feel that they are part of it. In this regard the remnants of indigenous cultures point the way, but none of them are in position to lead a contemporary nation. As hunting and gathering cultures gave way to agricultural ones and then to urban-oriented ones, deep diversities emerged with respect to the relation of human beings to the encompassing world. The separation went furthest in Western Europe, climaxing in what we call the Enlightenment and modernity. Chinese civilization, on the other hand, retained something of the ancient feel for participation and belonging in the natural world.

Not everything about modernity is bad, and not everything about traditional Chinese culture is good. Nevertheless, the persistence of the influence of that culture almost certainly supports an ecological consciousness better than do those cultures that have been alienated from nature for many centuries. The awareness of a tension between tradition and modernization in China may offer the most hope for the emergence of a new consciousness fully supportive of the move toward an ecological civilization.

Another prerequisite for a nation to move toward ecological civilization is that those with greatest power care about the well being of the nation's people as a whole and especially for the poor. A nation that is largely controlled by corporations and especially financial institutions, such as the United States, can do very little. I believe that the Chinese government still remains dominant over those who have private economic power, and I hope this continues. In every society wealth threatens to corrupt, and China is not free from this danger. But as of now I believe that the government can act, and that it has the will to act, for the common good of the people of China, and to a lesser extent, of the world.

A third prerequisite for moving toward an ecological civilization is control of population. There is no way that an ecological civilization can be established with an exploding population. The population must be stabilized. Such stabilization has been achieved in some countries without effort or even intention. But the problem has been a difficult one for China as for many other countries. Among those nations in which economic and cultural factors did not support the move toward this goal, none has worked as hard as China to achieve this stabilization. In the process China has encountered many problems and many criticisms, some of which are valid, and despite the seriousness of its efforts, they may have been insufficient. But if any country is to be given high marks for its efforts to deal with the problem of overpopulation, it is China.

Beyond these basic prerequisites, China has taken the great step of announcing its intention of becoming an ecological civilization. Of course, even genuine intention does not

mean that this one goal replaces all others. China also has the goal of being a great power, and it has not abandoned the goal of growth in conventional GDP terms. The question is now whether it will envision the nature of an ecological civilization wisely and quickly begin the experimentation and implementation that is so urgently needed.

Most of the current discussion focuses on what can be done to reduce the rate of exhaustion of limited resources, the polluting of air, water, and soil, and the rate of global warming. This is important and deserves all the attention it is getting. But if the world is on a collision course with disaster, it is also important to consider how the disaster could be avoided and not only delayed. In 1972 we held here in Claremont a conference on "Alternatives to Disaster." This question still preoccupies me. And I will summarize my present judgment.

We can divide most of contemporary global society into two parts: Rural and urban. The countryside provides what is most essential for any society: Food and fiber, as well as raw materials for construction and for industry. On the other hand, most of the construction and industry along with commerce, government, and advanced education, communication, and entertainment, take place in the urban sector. In the world in which we now live, neither the countryside nor the city is sustainable. I will make two proposals for change, one about agriculture in the countryside and the other about the physical construction of cities. In conclusion I will comment on how these changes would contribute to the solution of other problems.

In a survey of issues especially affecting the countryside, one would need at least to consider mining, forestry, and livestock in addition to farming. I select the latter for my example. To be an ecological civilization a nation must be self-sufficient in food and fiber, and this must be produced in sustainable ways. I will separate the two points: Self-sufficiency and sustainability.

Until recently China was basically self-sustaining in agricultural production. In 1995 Lester Brown published a booklet entitled, "Who Will Feed China?" Since China was self-sufficient, many did not appreciate the book. But Brown saw that as Chinese became more prosperous and ate more meat the situation would change even if the population of China did not increase. Now the Chinese government is seeking to gain control of large tracts of land especially in Africa from which it can supply the additional food Chinese will need.

This is from many points of view a wise and farsighted move, but it is not compatible with an ecological civilization. Africa does not have genuinely surplus land. On the contrary there is much hunger, even starvation in Africa. A truly ecological civilization will do as little damage as possible to weaker and poorer people in the process of supplying its own needs. Furthermore, nations that are not self-sufficient will increasingly enter into conflict with one another over control of such assets. An ecological civilization cannot be one that is frequently at war.

But is there any alternative? Obviously the first responsibility of the Chinese government is to its own people. Even if China is still nearly self-sufficient, its needs will increase, and problems with Chinese agriculture will worsen. Deserts will continue to spread; aquifers will be exhausted; and the glaciers in Tibet will melt.

I cannot speak to this question of an alternative possibility with any personal authority. I will only say that I believe that the most important research for China to engage in now is how to produce more food and fiber with less water and less arable land. This involves both the more efficient use of water and the development of crops that need less. Further, since

China's need for agricultural products is increasing, the quest must be for ways of farming that are even more productive than those now used. This is asking for a great deal.

The need to produce more agricultural products with less water and arable land will tempt a modernizing China to engage in crash programs of high tech farming that will prove radically unsustainable. This will make the achievement of an ecological civilization impossible. China must not go the way of industrial agriculture. China should build on its great resource of skillful hard working peasants who can learn to be even more productive. This will be a labor-intensive form of agriculture, and, if China becomes an ecological civilization, it will owe this achievement most of all to skilled farmers who learn how to produce more with less. A major element in envisioning such an agriculture will be the shift from annual to perennial grains now led by Wes Jackson of the Land Institute.

People who know assure me that there are methods of sustainable farming that can increase total production. They are very labor intensive. They have been developed here and there at the fringes of organic farming. Learning from them and developing a highly productive agriculture appropriate to each ecosystem will require a great deal of study and training.

Mainstream economists have taught farmers how to economize on labor, that is, how to produce more crops with less human involvement. The modern industrial farm has resulted. The agriculture of the future will need to economize on land, water, and chemicals. If it requires a great deal of human and animal labor, so be it. An ecological civilization is one in which the needs of all are met in sustainable ways. This may require hard work. It will require a love of the land and a sense of solidarity with all life that is very different from the feelings of those who drive huge combines over vast fields. I believe China has the possibility of developing this form of agriculture and achieving self-sufficiency of a sustainable sort. That will be a huge step toward an ecological civilization.

For this to work, farmers who are skilled in making more out of less in a sustainable way should be honored by all of society. This is both a matter of paying well for their products and public recognition of the importance of their skills. If we want farmers to engage in sustainable and even regenerative agriculture, we must make sure that they see what they are doing as contributing to the well being of their children and their children's children. Developing an ecological civilization involves cultural, social, and economic changes as well as technical skills.

Critics will point out that food will cost more when its production is so labor-intensive and when the labor of farmers is well compensated. My reply is, so be it. The cost of food is going up under the present system as well, because the cost of oil is rising and even with more chemical additives the supply is not keeping up with demand. But in the present system the profit from the rising price goes primarily to the great agricultural corporations. Sometimes the income of those who labor on the farms grows less than what the price they must pay to eat the food they produce.

There must also be a reversal of the trend, dictated by urban growth and economic policies, to turn much of the best farmland into industrial and residential sites. An ecological civilization will prize its farmland too much to continue this process. This trend results in part from policies that make moving to cities attractive to members of farm families. Hence celebrating and rewarding farm labor will reduce the process of shifting population from the countryside to the cities. But we also need to reconceive cities so that the trend will be to

return land to its most important use.

This leads into the second major element in an ecological civilization – ecologically frugal urban habitat. For habitat to be ecologically frugal it would need not only to use little of scarce resources and to end pollution; it would also need to use less land, especially land needed for agriculture. In this regard many years ago I was captured by the vision of Paolo Soleri. He proposed that many structures, such as bridges and dams could have multiple uses, such as providing housing without taking up additional space. But, most important, he showed that what at first glance seems to be unpleasant crowding could in fact improve livability.

A great deal of the space in our cities is devoted to transportation. In addition to the streets and highways, there are also parking lots and filling stations. All this contributes to noise, crowded streets and sidewalks, and pollution. Much can be done to improve this by building subways and using bicycles. But Soleri proposes a more radical solution. Remove the streets altogether and fill that space with buildings, or rather incorporate it, along with the existing buildings into a single architectural ecology or arcology. Build this single structure high into the air. It will then be able to house not only a large population but also businesses and schools and sports stadiums and theaters. At the base of these arcologies will be the industries that support them. Within the arcologies, there will be elevators and escalators and moving walks as well as walking and biking paths. Much of the land now covered by streets and buildings can be returned to agriculture or woodlands.

One particularly nonecological feature of our current world is its rapid consumption of fossil fuels. These are a finite resource, but more serious than that is the consequence of their consumption. Pollution and global warming are the results. Industrial agriculture adds greatly to the use of fossil fuels. Transportation is another great user. And cities consume enormous quantities to heat and cool their buildings.

An ecological civilization will greatly reduce its use of fossil fuels. Of course, this can be done by shifting to other forms of energy, but most of these also have problems. This is especially true of nuclear energy, which does not belong in an ecological civilization. Only passive solar energy seems to be completely free of such problems. The goal of an arcology, like that of ecological agriculture, would be to meet all its needs with passive solar energy. Soleri believes that if sufficient energy can be gathered for the industries at the base of the arcologies, the waste heat from these industries can meet the other needs for energy. The solar energy might be collected in vast greenhouses that would also be part of the labor-intensive agriculture of the ecological civilization.

There would remain transportation between cities and between them and the countryside. The first goal here, too, would be to reduce the need. Consider first, human movements from one city to another. In our social and economic arrangements a great deal of this is required. However, the goal in an ecological civilization would be to make arcologies together with the nearby countryside as self-sufficient as is practical. Most businesses would operate in only one arcology. Business travel would be greatly reduced. There would be less tendency for family members to disperse to distant arcologies, so that the need to travel for family reasons would also be reduced.

Nevertheless, communications with people all over the country and the world would continue to be important. Advances in technology are already making it possible for widely

scattered people to interact extensively and satisfactorily without being physically together. This should be encouraged. Of course, some travel would continue, mostly by rail, but also by air.

More important than human movements is the transportation of goods. Here physical movement cannot be avoided. The products of the countryside must be brought into the city and the produce of factories must be taken to the countryside. Some increase in the use of animals for this purpose is possible, but for the most part the task will be to find the most efficient means of such transportation and use solar energy as far as possible to power it.

However reduced, there should and would be continuing exchange of goods between arcologies. This should be done mostly by rail with trains powered as much as possible by solar energy. These trains could, of course, also carry passengers.

Even in what I am sketching as an ecological civilization there would, thus, be some use of fossil fuels. But it would be a small fraction of present use. Hopefully, it would be within the limits of nature's capacity to absorb wastes. Technological progress should further reduce it.

Obviously the economic system that would fit in with arcologies and the primacy of farming would be quite different from the one that has dominated most of the world in recent times. The major issue would not be capitalism versus socialism. It would be meeting the needs of an ecological society. China rightly decided some years ago that prices should be set by the market rather than the government. Arcologies together with their surrounding countryside would provide markets of sufficient size for there to be sufficient competition in many fields. Considerable freedom of action in the business community would be possible.

However, the economy would be market socialism, that is, a civilization in which the society as a whole insisted that its comprehensive well-being be the goal of all of its functions. Economics would change its bottom line from growth measured by money to success in meeting the needs of all people in a sustainable way.

Needless to say, my effort has been simply to sketch an outline of what would constitute an ecological civilization. The real work is in the development of details. But I hope that an overview can encourage us to recognize that the task, though difficult, is not impossible. I believe that China is uniquely positioned to lead the world.



Figure 677-1. John B. Cobb Jr. speaking with Tu Weiming about building an ecological civilization

6.8. Making a Regional Design for the Palouse Grasslands

Comprehensive ecological design is based on the biohistory of an ecosystem, the cultural values of the people, and knowledge of the limits for sustainable development. This approach makes the limits explicit and sets equitable goals within the limits. A synthetic framework provides for the health of the ecological system, as well as for the health of its human inhabitants.

This regional ecological design considers the whole system and design communities for an optimal fit within the limits of the system. Communities should be designed for an optimal fit within the limits of the system. Ecological design considers an optimum population within one ecosystem, although it is connected to others by trade for some necessities or luxuries. This kind of planning is a conscious adaptation of the benefits of technology to the traditional idea of physical and cultural limits. Direct observation and traditional knowledge yield far more “information” about the societies of animals than autopsies and mathematical models. Using the Palouse ecoregion (or bioregion) in the Northwest United States as an example, we can outline a comprehensive plan to deal with some of the limits and goals, using five general design steps (discussed elsewhere in Section 3.9).

1. Identify our place within its natural boundaries. The Palouse is a uniquely identifiable ecosystem, with recognizable boundaries and a unique history and character.
2. Calculate the optimum amount of wilderness to preserve the natural cycles indefinitely. If the current area is less than our calculations, as in the Palouse, restore the difference and set it aside as a reserve.
3. In the remaining area, zone areas for appropriate use, including conservation, preservation, and artificial areas (with historical, cultural, and functional importance).
4. Identify the resources available for human use, including raw materials and the productivity of the areas. This productivity can be used to calculate a base line population.
5. Apply cultural modes—in style, values, and technology—to set limits on technology and population. Preserve the cultural values. Renewable resources will sustain a population longer than energy capital like oil or gas.

As part of the formulation of a plan, we have to examine the natural and cultural histories of the Palouse. We need to understand interactions in the ecosystem, as it existed before humanity, as it was lightly settled, and as it is now, dominated by humanity.



Figure 680-1. Location of the Palouse centered in southeastern Washington

6.8.1. *Biocultural History of the Palouse*

The Palouse grassland is a dry, intermountain grassland of approximately 6 million hectares (roughly 15 million acres) centered in southeastern Washington, characterized by grasses of boreal affinity, located within the Columbia Basin Physiographic Province in the Pacific Northwest. Its origin, topography, and soil composition are unique. Wind-deposited loesses form steep, rolling, dune-like hills that overlie the Columbia River basalts. The geological foundation of the area is basalt, from lava flows that occurred 15 million years ago. Lighter deposits of volcanic ash fell from Glacier Peak (12,000 years ago) and Mt. Mazama (6000 years ago). The eruption of Mt. St. Helens (in 1980) added a 2-8 centimeter deposit of ash to much of the Palouse. Heavy deposits of loess, coming from arid lands to the west continuously since the Pleistocene (300,000-500,000 years ago), resulted in fertile soils of loam and silt loam texture, which developed in a semiarid Mediterranean climate. The landscape has moderate to high relief; elevations range from 180 to 1200 meters (roughly 600-4000 feet). Annual precipitation varies from 200 to 800 millimeters (roughly 8 to 32 inches); the average is about 440 millimeters (this is significant because it is near the minimum for dry-land agriculture). A high proportion (45-65%) of this precipitation falls during winter. Maximum temperatures coincide with minimum precipitation during late summer, producing intense drought.

The primeval vegetation was composed of dense stands of perennial bunch-grasses (caespitose grasses, such as Idaho Fescue, Bluebunch Wheatgrass and June Grass) and shrubs (including Snowberry and Wild Rose). The Palouse has 40 habitat types in 9 zones. The ecotones separating habitat types are relatively sharp. Palouse vegetation is determined primarily by climate, sometimes by soil and topography; unlike most other grasslands, it developed without significant grazing or regular fires. Fire plays a minor role in these habitats, since the perennial species sprout from underground parts—in fact, fire kills native *Artemesia* species. In its natural state, grazing by deer did not significantly affect the composition of the grassland. Archeological history indicates small populations of Bison and Pronghorn Antelope as recently as 2000 years ago, but no permanent populations have established themselves since, possibly due to increased snow depths west of the Rocky Mountains. The native grassland is relatively rich in species; there are 93 mammalian species representing 58 genera. Birds and insects are also well represented. There are at least 25 mosses and 9 lichens. And, there are at least 10 sensitive or threatened species in the province.



Figure 681-1. Topography of the Palouse
(Photo by the author from M. Lynch's Cessna 1975)

6.8.1.1. Archaic Human Cultures

The Palouse has supported several groups of people with unique cultures for over 12,000 years, according to archaeological evidence. A number of prehistoric living sites have been found in caves, shelters, and camps. These archaic peoples caught salmon, steelhead trout, and other fish in the Columbia and its tributaries. They hunted rodents, jackrabbits, deer, antelope, and elk, and possibly mountain sheep and bison. They trapped migratory birds nesting along streams, and sharp-tailed grouse and sage grouse.

About 5,000 years ago, as the area became more densely settled, people depended more on wild plants, such as roots and berries. Settlements became more permanent, especially in winter. Groups tended to disperse to temporary camps in the summer, when food was easier.

Tribes of people developed unique identities, as Spokane and Columbia-Sinkuise in the north, Coeur d'Alene and Nez Perce in the east, Palus, Walla Walla, Umatilla, Yakima, and Wanapam in the central and south, and Klickitat, Wishham, Kittitas, and Wenatchi in the west. Although their languages are different, many of their beliefs and customs are similar. Neighboring tribes would maintain ties through trade, marriage, and sharing resources (hunting and gathering grounds). Tribal political boundaries were not as sharply defined as in modern times. Nez Perce often shared Palouse villages and intermarried. Coeur d'Alene may have hunted or fished in the area at other times.

Palouse people had very few large settlements. A village rarely exceeded 200 people. The earliest lodges, for instance, were pit houses, covered by up to 3 feet of earth over grass mats on a frame of wooden poles, with a central opening for smoke. After the people acquired horses, and became more mobile, the shape of their buildings changed. Mats on wooden-pole frames were easier to dismantle and move. In the summer, mat or deer-hide lean-tos were used on hunting trips. Later, they favored deerskin tipis.

In the early fall, men traveled South to the Blue Mountains to hunt deer, elk, antelope, sheep, goats, bear, and wolves. Women picked berries and dug potato-like camas roots for winter. If the field was good, a woman could gather enough in four days to feed a large family for a year. Large camas were gathered in abundance between Pullman and Moscow. The camas could be eaten raw or cooked to a mush. Cooking was done in a large pit lined with rocks; most would then be dried in the sun on scaffolds. Food was stored in different kinds of woven baskets, made from bear grass, wild hemp, and cedar roots.

Although inhabitants of a village (or a band) recognized a certain amount of the land surrounding as their territory, they shared most of the hunting and gathering grounds with people from neighboring villages or tribes, including the Nez Perce. Clubs and societies promoted bonds between nonfamily members of a tribe. Many social ceremonies reinforced the cohesion of a group. Gatherings were regular, to celebrate the first fish or last crop of berries, as well as social ties. They visited, traded, played sports, and gambled. Some of the exchange items included furs, skins, dried roots, berries, fish, baskets, feathers, horses, and slaves.

The peoples were able to convert animal and vegetable resources into all their needs for food, shelter, and clothing. When other items were available, such as horses and metal knives, they were able to trade, fish, berries, baskets, and roots for them. In the 1700s, probably no more than 40-60,000 Indians lived in the Palouse; this number could probably be supported indefinitely by the Net Community Productivity—that is, using only that amount

of ecosystem productivity that is not used by the plants and animals. Indian contributions to agriculture, architecture, government, and planning have rarely been acknowledged.

Palouse peoples were able to use the area without changing its character fundamentally. They were able to work out appropriate solutions in harmony with their environment. Traditional forms of restraint, such as prescriptions for marriages and births or restrictions on hunts, ensured that tribes would not interfere with local animal and plant populations, much less with ecosystem cycles. Population density was controlled by the traditional approaches to resources. Cooperation and consensus, as opposed to competition and individual exaltation, permitted planning to remain informal. Cultural beliefs made planning for the indefinite future more inclusive; life was continuity in form (from bear to human, for instance) as well as in state (from unborn to person to ancestor).

6.8.1.2. European Expansion

The Lewis and Clark expedition traveled along the Snake in 1804, noting that the bunchgrass prairie supported herds of horses very well and predicting that if it were cultivated it would provide in great abundance. Meeting with Lewis and Clark gave the Palouse a skewed impression of white people. Lewis and Clark seemed generous, giving away articles or trading fairly for goods. Expecting a future of trade and friendship, the Palouse invited Lewis and Clark to return with more goods to trade, including guns, knives, axes, kettles, blankets, and tobacco. European objects were later acquired through trade with other Indians; these included metal knives and hatchets, copper kettles, glass beads, and copper bracelets. Trade with the British added tobacco, alcohol, and blankets.

Explorers were followed by trappers. Trappers were followed by people who wanted first to trade and then to run cattle, which thrived on the bunchgrass. The first wave of travelers was aiming for Oregon and did not consider the plateau to be prime farming country. The Indians were surprised, not only by the number of whites settling, but also by the white concepts of land use and land ownership. Trying to adapt, the Indians had started herding cattle and cultivating gardens, while continuing to fish and gather. About the time of the first homesteaders (after 1860), they expanded ranching and farming.

The ranchers and farmers altered the natural habitat of the Palouse and destroyed the economic life of the Palouse Indians. War resulted after gold miners overran the land, disregarding Indian rights, and several were killed. The Palouse were eventually moved into the Nez Perce reservation to the east, completely removed from their traditional lands. Even boundaries of that reservation were adjusted annually to accommodate the migrations of European settlers.

Settlers started farming along the Snake but quickly moved north. The area around Paradise Creek was originally named Hog Heaven, because the pigs fed well on camas bulbs. Later the whole valley was renamed Paradise valley. The bunchgrass hills were at first considered unfarmable. The cattlemen kept to the bottomlands, until people realized that the grasses were a natural and nutritious feed. When farmers discovered the fertility of the hills they moved in and pushed the cattlemen toward the scablands.

Agricultural development was the first intensive use of the region. In the last 100 years, dry-land farming has almost completely replaced the original vegetation, although fragments can be found in fence corners, right-of-ways, cemeteries, and inaccessible (mostly northeast-facing) slopes. As agricultural technology became more advanced and the demand for crops

increased, less desirable segments of the prairie were tilled. Smaller islands of native vegetation, regarded as waste places, were left for livestock grazing, since the native vegetation was palatable and nutritious. However, native vegetation was easily injured by close cropping and unable to compete with introduced exotics on disturbed sites. Even the few remaining natural stands, on the steepest slopes and boundaries, have been influenced by fertilizer and herbicide drift. Since the 1880s, alien grasses, chiefly cheatgrass and Kentucky bluegrass, have pioneered most disturbed sites. Often, Cheatgrass and bluegrass out-colonize native species. However, in the Kramer Natural Area, two areas disturbed by cultivation and a road have healed over with native vegetation similar to the undisturbed area. Apparently, dominance depends on the order of establishment— whoever gets there first wins the soil; the exotic species do not displace established and undisturbed natives, but natives cannot displace established exotics.

The Palouse has become more populated, with hundreds of thousands in urban locations. Population increase in the area for the past two years has been estimated at 4 percent. This increase surely will outstrip the human infrastructure and put more stress on the system. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of fertilizers and pesticides. Dams have been built all along the Columbia, altering the river and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population. We have simply dominated the entire ecosystem.

One of the ecological consequences of human activity is the degradation of wild habitats for human developments (food, housing, and recreation) and the introduction of novel elements into the biosphere—elements that have not been harmoniously worked in over time. The biomass, or demomass, of the human species probably far exceeds the biomass of any nondomestic species, and that biomass is supplemented by the tremendous biomass of domestic animals, which is four times greater (Borgstrom, 1975). This biomass forms an equivalent population that consumes much of the same food, such as milk, fish, and grain. The ecological domination of humanity is related to other characteristics as well: A large biomass, a large annual increase (almost 2 percent), high structural organization (information, matter), and high energy use.

This dominance has major effects on the Palouse: Transient perturbations in energy relations (from oil spills, burning); chronic shifts of systems (from dams, irrigation, chemical wastes); species manipulation (from the import and export of exotics); and, interference competition with wild species. None of these effects are exclusive to humans as a species, but they are excessive, rapid, compounded, and large-scale. With a comprehensive, ecological, long-term plan, we can direct or anticipate changes and impacts.

6.8.2. *A Plan for the Palouse*

In place of a comprehensive design, this thought experiment is offered to describe an optimum human presence within ecosystem restraints; it is a deductive, synthetic, conceptual model based on data generated from research on biological productivity, the rates of resource use, and cultural valuation. It also considers minimum wilderness preservation, air and water quality, genetic minima, nonrenewable resources, appropriate technological innovation, the importance of cultural frameworks, adventure, research, beauty, uniqueness, and other intangible experiences.

A deductive approach is necessary because accurate measurements of productivities in

most ecosystems are lacking and exactness in values is misleading. A synthetic approach is necessary to integrate quantitative and qualitative data. In combining measures of qualitative and quantitative, it is simpler to set aside the first and then to calculate the second. The model must be conceptual because of the inherent fuzziness of the systems.

This model is in harmony with strategies for sustainable ecosystems, the conservation of biological diversity, and aspects of global change. This model attempts to work out plans and policies for long-term environmental stability by paying attention to the architecture of physical and social institutions, that is, to buildings as well as politics. The goal of planning is to enhance life—all life, not just human life—so the model is not restricted to one species at one time.

The human population of the Palouse can be related to land area, productivity, technology, and culture in one algebraic expression. An optimum population (P) is calculated by adding the total annual agricultural productivity (in Kcal) to the total annual resources (in Kcal) of the available land area, multiplying that sum by technological and cultural modifier fractions, and dividing that by the annual per capita requirements for food and resources. The available land area (A) is obtained by subtracting wilderness areas, conservation areas, and other areas to be reserved from the total area. The net usable productivity (N) is calculated by subtracting the total unavailable productivity (M) from the net primary productivity (NPP); M includes percentages for below-ground productivity, various wastes, and inedibility. The sum of annual food requirements (R_f) and annual resource requirements (R_r) per capita are combined in one expression (U). Energy values for resources, water power or zinc for instance, are considered. The exponent (T) is a technological modifier, based on the use of technology in extending or contracting the mineral base or food productivity. The exponent (C) is a cultural modifier, based on the application of cultural values in determining area, productivity, use, and style of life. The total area, gross productivity, and energy are known quantities, while the remaining factors must be evaluated in a mathematically fuzzy way.

Table 682-1. Population Equations

$P = \{([A \cdot N] + E) \cdot T \cdot C\} / U$	
where $A = A_0 - A_1 - A_2 - A_3 - A_4$	$E = E_1 + E_2 + \dots E_n$
$N = NPP - M$	$U = R_f + R_r$

For the total figures for all essentials—food, shelter, clothing, transportation—energy is converted to Kilocalories and placed on an annual budget (and averaged over 1, 10, or 100 years). These calculations are used for the purpose of illustration; they are not conclusive or binding. The entire equation is expanded in the following discussion, beginning with a determination of how much wilderness to set aside.

6.8.2.1. *Palouse Common Lands*

Relatively unspoiled common places, like grasslands, are being altered rapidly by industrial agriculture and human population pressures. Grasslands are among the least protected biogeographical provinces on earth. They are being replaced by surplus crops subsidized by energy-intensive industrial agricultural methods.

Wilderness designations in the United States have been inspired by recreational interests, protecting mountain areas good for hiking, camping, and hunting. Most Wilderness Areas

are higher elevation areas in the western states. Even in the western states of Idaho and Washington, other regions—such as basin and range, Snake river lowlands, Owyhee broken lands, and Palouse grasslands—are scarcely represented. Wetlands and forests in the eastern part of the country are poorly represented. Wilderness designation has recently begun to consider potential economic interests and ecological self-preservation—the recognition that the Earth provides free life-support services, as through its biogeochemical cycles. Now, we should plan a global strategy, not only to save wilderness, but to preserve diverse working ecosystems, including semi-natural and artificial landscapes that are not considered wild or special, but are common lands. These lands should be kept at an optimal level, although some percentage should be restored to an ultrahuman condition. The Palouse grassland, extending from eastern Washington to northwestern Idaho and northeastern Oregon, is an example of a common area needing restoration and protection.

6.8.2.1.1. Ecohistory of the Palouse Grassland

The Idaho Fescue/Snowberry association has a rich collection of perennial forbs, which flower during much of the growing season. The native grassland is far richer in species than farmland. Ninety-three mammalian species representing 58 genera have been recorded in the present Palouse. Birds (Sage Sparrow, Brewer's Sparrow, Western Meadow lark, sharp-tailed grouse) and insects (mostly arthropods) are also well represented. The Palouse has at least 25 mosses and nine lichens. At least 10 sensitive or threatened species inhabit the province. Of the eight habitat types recognized, the Idaho Fescue/Snowberry is the best represented and studied on small plots. Yet, even ecological studies of this habitat type are rare and localized to individual areas. Some areas are still unstudied and there has been no treatment of the habitat type as a whole. A previously unknown plant association dominated by Elk Sedge has been described on the three university sites, as well as two previously unidentified phases of the Idaho fescue/Snowberry association.

Many of the plant associations in the Columbia Basin Province are not represented in any of the small RNAs in Washington or Idaho, although some of them would be included in proposed areas. In the Zonal Meadow Steppe Association, the Idaho Fescue/Nootka Rose community has no representation (it occurs in Hells Canyon) and the Idaho Fescue/Snowberry community is only partially represented (in the Kramer Biological Study Area). Most of the communities, such as Bluebunch wheatgrass/Idaho Fescue, in the Zonal Meadow Steppe Association are represented poorly, if at all. Poor representation at present is one reason why large reserves are needed. Existing RNAs are not nearly large enough to save viable mammalian populations.

Large reserves are important for many other reasons, too. They help perpetuate global element cycles; they help maintain the integrity of wild gene pools. But, reserves can be justified by anthropocentric arguments, also; in addition to recreation, resource-banking, and research opportunities, reserves have importance for watershed management and as gene pools. Knowledge of biological history and cultural change over time contributes to the understanding of a place and keeps ecology in touch with geology as well as with human economics and politics. The most important biocentric argument for wilderness is autological—ultrahuman species need ultrahuman places. Wild reserves would permit natural processes to occur without human interference.

6.8.2.1.2. Common Land Reserve Proposal

Ecosystem preservation protects entire biotic communities: genes, populations, species, habitats, associated traditional human cultures, and all the processes and interactions. To keep the essential services of nature, from atmospheric cleaning to soil-formation, we need large reserves. Reserves are critical elements in global element cycles, also. They provide a natural base line for management reference and a unique opportunity for scientific research. Large reserves would increase representation of species and save viable mammalian populations, that is, maintain the integrity of wild gene pools. Such reserves would permit natural processes to occur without human interference. We also need large reserves to derive further benefits from understanding natural processes and direct economic benefits from species. And, for aesthetic purposes: to see and to participate in nature (these being the basis of watching and tourism).

The desired size of the reserve is a complex function of the area's key species, quantity of suitable habitat, and minimum viable numbers of species. Large-bodied vertebrate species tend to have lower population densities, thus a reserve with self-sustaining large-bodied vertebrate populations will likely be adequate for herbivores, insectivores, and primary producers. The key mammal species in the Palouse are Coyote, Badger, and mice, with White-tailed Deer as regular visitors.

Estimating the minimum number of individuals in a population to guarantee a high probability of survival results in widely varying minimum areas, depending on the key species selected. An effective population of at least 500 individuals may be needed to maintain genetic viability of each animal species (Frankel and Soule, 1981). Each animal requires a minimum area; for example, each coyote requires 700 ha (7-10 km²) for a home range. Since not all coyotes in a group breed—some become aunts or uncles and help care for pups—it is necessary to assume 3 coyotes per breeding unit. Using coyotes as the key species, the minimum area for the reserve becomes at least 1.05 million hectares. With a home range of 250 ha (2.5 km²), the minimum area for deer would be at least 200,000 hectares. With a home range of 1-5 ha, the minimum area for mice would be at least 2500 hectares. Using Idaho Fescue (with 5000 individuals as a minimum), the minimum area would be about 10 hectares. Usually, large carnivores are a sensitive indicator of carrying capacity. In the Palouse, however, coyotes can adapt to humanized landscapes, so preserving their entire range is not critical for the survival of that species, though generalist species should be preserved in at least one large range. The minimum area should be large enough for the protection of all endangered or threatened invertebrates, which play key roles in such basic ecological processes as predation, recycling, and pollination.

Although there have been debates over whether a single large reserve is better than several small ones, the shape and size of a Palouse Reserve should be determined by habitat studies of the unique natural history and conditions. The key plant species to be protected are Idaho fescue and Snowberry, with all their ecological relationships to micro-organisms and arthropods. The large carnivores and herbivores (coyotes and deer) can adapt to more artificial conditions, so their needs may not be limiting factors. The size should be large enough so that species will not be vulnerable to "extinction vortices" (Gilpin and Soule, 1986), caused by genetic or environmental stochasticity. In a Palouse reserve, disturbance from farming, grazing, or recreation would probably be the greatest threats.

6.8.2.1.3. Reserve Specifics

Based on a suggestion that at least five units of each habitat be preserved, the reserve is divided into over 25 unequal areas. The largest portion of the proposed reserve is located on the eastern edge of the bluebunch wheatgrass province and includes at least five habitat types. The recommendation for a Palouse reserve is to establish one large area immediately, about 1.1 million hectares, buffered doubly by rehabilitated fields and then by fallow agricultural land (1.3 million hectares), 3 areas of 3,000-10,000 hectares, and 22 satellite areas of 8-25 hectares, which would probably not be buffered (described more fully in Section 5.5). Saving a million hectares might be economically or politically difficult under the current industrial monolith; 1 million hectares is about 17 percent of a region that profits immensely from growing grains and legumes. A 200,000 hectare figure is over 3 percent. As a starting size for a reserve, this might be more likely; it could cost residents less than a typical sales tax increase.

The large areas of the proposed reserve would be laid out on the SW/NE axis with large fingers extending to the NW and SE, to maximize the number of protected NE slopes. Since the winds are predominately from the SW, herbicide drift would be minimized. A range of elevations across areas would minimize the effects of climatic change—and the possibility of extreme change is rarely considered in wilderness design. Soils, drainage, and land-use history and ownership would also receive similar considerations. This would allow management for diversity on different scales. The reserve would extend into the ecotones separating grassland and forest provinces; the edge effect would benefit many species.

Fence rows could limit access and might even encourage dispersal. For example, small mammals and birds use fence rows for travel and nesting; fences also create microsites for different communities. Daubenmire noted that slight differences in soil depth and moisture permitted different types of associations in the Palouse; this was especially true around fences, which caused greater dust and snow accumulations. Because soil conditions result in a variety of habitat types in small areas, even small preserves would have relatively rich flora and fauna.

The north-south finger-like shapes for the reserves would minimize the dangers from physical and climatic changes. The greenhouse effect could drastically alter the species distributions in reserves, with the loss of many species. Placing the reserves on heterogeneous soil types and topographies increases the chances that the temperature and moisture requirements of species would be met. Choosing irregular shapes would increase the complexity of the landscape (reversing the pattern of development as fields have become larger and more regular in shape and increasing the fractal dimensions of the reserves). Simply maximizing the size and number of reserves enhances the long-term survival of many species.

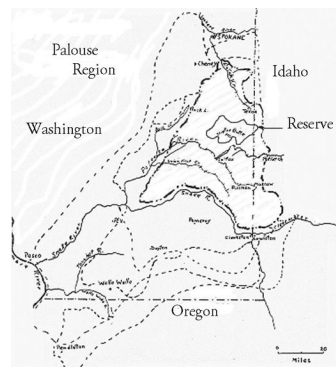


Figure 68213-1. Palouse Reserve Proposal

6.8.2.1.4. Management Concerns

There is little information on the restoration or preservation of “near natural” ecosystems—primarily native, not subject to major change. The Palouse probably has no natural landscapes and very few near natural; most are semi-natural (pastures as a consequence of human activity) or artificial (totally humanized). The Palouse could not be restored to its original state, since many species are extinct, but it could be rehabilitated. There are a number of methods (such as direct planting into de-sodded ground) that can be used to restore species-rich grasslands. The inner buffer zone, being rehabilitated, would be the most expensive to create. The outermost buffer would be managed by benign neglect—despite the fact that most ecologists do not list this as a management option. Natural processes, such as wind or species explosions, would be allowed to operate freely, even if they altered the functioning of the communities. In fact, a reserve, in contrast to a preserve, is simply an area placed off-limits to exploitative human activity, where natural processes would be allowed to proceed naturally.

The shapes shown in the map for the reserves would minimize the dangers from physical and climatic changes. The greenhouse effect could drastically alter the species distributions in reserves, with the loss of many species. Placing the reserves on heterogeneous soil types and topographies increases the chances that a species’ temperature and moisture requirements would be met. Simply maximizing the size and number of reserves would enhance long-term survival.

The cost of reserves would be high. Palouse land sells for \$2000 per hectare. The cost for restoration of a reserve has been estimated at \$20-140,000 per hectare (Lamoureux et al.), depending on the density of planting and the area. The costs of buying, rehabilitating, and managing 200,000 ha could cost \$2-4 billion. By comparison, this is equivalent to the \$3 billion that the Forest Service wants to spend to add 35,000 miles of roads in roadless areas. Larger areas would reduce management costs; smaller reserves in general require more intensive management and habitat manipulation.

Although very few people consider the Palouse a “priority habitat,” it does need protection, and it should be a part of the Biosphere Reserve Program. A large area of undisturbed grassland would be a valuable ecological baseline, for comparison with the domesticated landscapes of farming and grazing. Variables such as productivity or the effects of climate could be compared between the natural and artificial systems. Native species would be preserved, both for our sake and their own.

The Palouse is common, in the sense of being taken for granted and treated badly. Being common does not mean being without value, however. The Palouse is attractive and useful because it is so productive and forgiving. The Palouse seems like a simple grassland. Having fewer organisms or simpler patterns does not mean being less unique. The Palouse has a special beauty, more subtle than a rainforest or a desert that has become rare. If that specialness is not to disappear completely, it must be protected, now, in a reserve.

Saving common lands requires a wide vision that entails making decisions without complete knowledge, ecological or economic, within the human communities that must bear the cost. Because many of the mysteries even of common habitats have not been unraveled, saving large numbers of habitats from human intervention is a hedge against the ultimate price of ignorance—extinction of animals and plants and, eventually, humanity. The Palouse is a unique ecoregion, and there is very little of it left in a natural state. Let us save it and then save samples of common places everywhere.

6.8.2.2. *Considerations & Recommendations for Resources*

The Palouse is relatively rich in organic resources. Perhaps the most important resource is the living land itself, the ecosystem. The single most important system factor is climate, especially in the Palouse, which is in the area of marginal rainfall (less than 50 centimeters) for modern agriculture. The fluctuation of the climate over 10,000 years should also be considered. The Columbia and Snake rivers, which drain the mountains to the East, bring water through the region. We depend on that water (and on at least one large interconnected aquifer) for drinking and irrigation.

The Palouse has large percentage of arable land—about 40 percent, while the global average is only 24 percent. We put our buildings (about 6 percent of the area) and roads (circa 380 square miles, mostly rural) over that land. We dig up tons of gravel for roads. We fence off portions for range land (0.75 million ha) and plow other areas up for crops (1.24 million ha). We depend on the plants, animals, resources, and energy we take from the land.

To ensure wise use of land, we could create a more comprehensive plan for land use. Such a plan could have very specific categories (and subcategories), including (1) foundation areas, reserves, and preserves for grassland wilderness, (2) conservation areas, (3) riparian woods, rivers, streams, lakes, (4) cropland, pastures, abandoned fields, and (5) urban, gardens, historical sites, industrial sites, and waste disposal sites.

6.8.2.2.1. Plants

The Palouse is a grassland, also called a shrub steppe. There are no stands of forest, although there are willows and hardwoods around rivers and streams and the decorative, fruit, and plantation trees that people have planted and maintained. There are relatively few lakes and wetlands; there are few high elevations.

The inhabitants have converted all the arable lands to agricultural use—in general, converting wild lands to agricultural use *reduces* the average above-ground annual NPP by 75 percent. Agricultural intensification also causes fallow cycles to be shortened; a shift from mixed crops to monocropping; and a shift from natural fertility to artificial fertilizers. The bunchgrasses and shrubs have been replaced with large expanses of single crops, such as wheat or barley. Much of the productivity of plants is not usable by humans. In lightly grazed short-grass prairies, over 75 percent of the production is underground (83 percent in ungrazed). Of a dry weight sample of wheat, only 40–45 percent is actually grain. Possibly a representative average of unusable material is 50 percent. Taking most of the material is not desirable anyway because mineral nutrients are locked up in plants and are needed for new growth. Complete extraction of plants would result in removal of 30 to 70 percent of the potassium in the ecosystem. Although there is plenty of potassium locked in rock particles, it is released slowly.

Sometimes in the Palouse, farmers venture into the ecotones and even into forest areas to grow crops, which ends up costing more. There are things that can be done to make agriculture sustainable and successful:

1. Diversify crops, especially adding drought resistant varieties (the Palouse has drought conditions every summer, which can worsen periodically). Grow wild lupine to combine with soybeans for food. Convert from intensive cattle raising to antelope farming. Grow more varieties of apples (reduce imports of apples from outside). Increase self-reliance on foods (except those not grown here—e.g., kiwi, oranges).

2. Develop new products from existing crops, e.g., oils, drugs, and fuels. Rape seed, for instance, is used in hydraulic fluids, plastic film, nylon, Lorenzo's Oil, as well as vegetable oil; certainly, there are unforeseen applications.
3. Use appropriate technology (solar power, field drilling, organic growing); import less energy, possibly export some. Stress low-input agriculture; low-fertilizer and low-pesticide may result in lower gross sales per area but in higher net revenue per area.
4. Process the crop (sell noodles and noodle products as well as wheat).
5. Market the crops and products ourselves; package them, advertise them, and distribute them.
6. Form cooperatives, especially for specialized market or low volume products (beets for instance).
7. Create a land trust to protect farm land from pressures of development, even as its market value as a nonfarm increases. A land trust could be funded by property transfer tax. The land trust could lease the development rights on farmland.

We depend on vegetation for more than food: It makes up the content of much of our newsprint, construction, furniture, clothing, and packaging. Of course, much of the straw and slash should be left so that the system can regenerate. Furthermore, with shortages of minerals, many substitutes are expected to be organic. But, monocrops are directed only to one market.

6.8.2.2.2. Animals

The original grassland supported good numbers of mammals, from mice and coyotes to deer, antelope, and elk. To some extent they have been replaced by domestic species: Dairy and beef cattle, swine, sheep, and poultry. Livestock in the Palouse numbers over a 1.3 million individuals, over twice the human population, although that declined from earlier numbers. Over 60 percent of the cropland production is devoted to feeding them, and over 30 percent of raw materials to housing and transporting them (for example, it takes 5 to 20 calories of fuel to produce 1 calorie of meat).

Although many animals, such as cattle and sheep are raised on ranges, they often spend months in feedlots being fattened with grain for human consumption. About 95 percent of this food goes for respiration or ends up as manure. The 95 percent loss is acceptable when an animal is raised on rough ground or when native populations, antelope for example, are used for food. Harvesting some wild animals may be a better alternative than agriculture; this would be cheaper than improving the pasture degraded from overuse. Wild species might be more appropriate on marginal soils. Raising food animals could be acceptable using wastes and scraps that contain recoverable food, but it is not acceptable using whole grain crops or on free range. Many animal foods could come from sources unappetizing to humans, such as insects or algae. Harvesting algae directly for food is possible, but has high processing costs and poor flavor and low acceptance.

6.8.2.2.3. Energy

The Palouse has sunlight, water, and wind; it also has small amounts of gas and oil, but not nearly enough to provide energy to residences and industries. There is some coal, and it is being mined (24 trillion Kcal). Hydroelectric power is well-developed. Wind and solar energy are very abundant but not very well-developed (about 2 trillion Kcal). Power is available from

several nuclear power stations (15 trillion Kcal). The research and production of nuclear energy has resulted in over 20 hazardous waste sites being located in the Palouse. So far, over half of the energy production in the Palouse—that from water power—is intermediately renewable (184 trillion Kcal). The big difference between energy resources and energy use is the quantity of imported oil (172 trillion kilocalories).

The public service function of nature provides free services to humanity that are essential to civilization. But when the free services are overloaded and breakdown, we have to pay for the repair. Further increase in flows of energy through technology will significantly reduce the capacity of the system to support its human population, even large-scale fusion techniques. The overuse of nonrenewable resources can destroy renewable ones. For example, if acid rain from burning fossil fuels continues in the west, the primary productivity of Idaho forests may be reduced by a net 10 percent due to rising soil pH. This is the equivalent loss of energy from power of 15 1,000 megawatt reactors.

Technology could be developed to tap the flow. The stock should be kept for transitional changes, rather than being burned up mall-hopping (a favorite sport in the Palouse). In all processes in which energy is changed, some of it becomes unusable (diffused and very difficult to harness, according to the second law of thermodynamics). We could reestablish earlier energy patterns for the region, combine it with high technology collection, and use combined systems of wind, water, solar, organic, and fossil fuels for energy. Depending on water power for a time is acceptable, but even dams silt up. Singly, these sources may be inadequate, but as a mosaic they could meet decentralized needs. The energy pattern should be pieced together organically from the potentialities of a region. Consumption and production of energy must balance safely.

Energy demand has resulted in the use of high risk sources. With nuclear power, the burden of proof for safety is on the agencies themselves; its use in the absence of complete assurances of safety places unnecessary risk on future generations. With efficient homes and electric transport, all of the area's energy needs could be met by established water power, which is estimated to be half of the potential.

Passive solar heating would be adequate for individual buildings (based on a study for Latah County, 1977, J.I. Hagen and A.E. Wittbecker). Photo-voltaic cells could provide electricity and power cars. Local energy projects using geothermal sources, winds, or the sun are preferable, since their operation does not introduce new material to local cycles. All of these sources would be characterized by a small scale.

6.8.2.2.4. Minerals

Because the Palouse rests on large deposits of basalt, its mineral wealth is limited. The basalt itself is valuable and useful, however. It can be crushed as a component of asphalt, used as building stone, especially in a tree-poor area, used for landscaping, and extracted into fibers—which are strong and flexible and could be used for reinforcing concrete or substitutes in pipes, insulation, and even vehicles. Research onto other uses should be well-supported.

Other rocks are present: sandstone, siltstone, granite, limestone, and diatomaceous earth. A number of metals can be found and extracted: gold, magnesium, and copper. A few others are accessible: lead, zinc, tungsten, manganese, iron, magnesium, and nickel. The most common are zinc (24 million metric tons) and iron (10 million metric tons). There is some oil and natural gas, but not enough to currently keep the region going for even a year.

Virtually 100 percent of the aluminum and manganese used has to be imported from overseas. Cobalt, copper, platinum, tungsten, and zinc—minerals used in advanced or strategic technologies (in alloys, catalysts, magnets, and electronic devices), are absent in large quantities, and must be imported from other regions in the United States or from outside. If no substitutes are possible in electronic equipment, then these minerals have to be acquired through trade.

6.8.2.2.5. Complex Patterns

(Being edited)

Would removing a significant load of minerals change the landforms? Would it result in changes to molecular loads in water? Of course, it has in other parts of the country. Placing minerals back into cycles, after they have been isolated by geological or biological processes, means that plants and animals, including human animals, will be able or forced to react to them.

6.8.2.3. *Considerations & Recommendations for the Human Population*

The population of the Palouse is currently over 682,000 people. Most of these people live in cities, from Richland to Spokane. That does not seem like a large number of people when compared to the urban areas in London or Hong Kong, but it is far larger than the archaic population. Several trends are evident: A long-term trend to larger cities, and a more recent movement from cities to smaller towns and rural farming communities.

6.8.2.3.1. Calculated Goals

Is 682,000 people too many? How many more people could live in the Palouse sustainably? Is this number above or below some maximum carrying capacity? There is a maximum carrying capacity for this region, as well as an optimum. The carrying capacity is the population sustainable on a long-term basis of renewable and nonrenewable resources. For humans, this capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Domestic animals can extend the carrying capacity somewhat, since many of them consume agricultural wastes or use lands marginal for agriculture, but they are not as efficient as wild populations. Technology can expand the carrying capacity to some extent, with higher yield crops and resource substitution, but also it reduces the capacity with unforeseen effects, from the use of pesticides, for example. War and social disorder would also reduce the ultimate capacity. Furthermore, the capacity decreases as the per capita use of energy and resources increases. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, aesthetic satisfaction—must be included.

A number of assumptions are necessary to calculate an optimum. Calculating a population based on plant productivity is relatively simple. The Palouse could support probably a maximum of 2 million people. However, considering the need for resources and the ubiquitous Law of the Minimum, the maximum goes down rapidly. J. von Liebig's 1863 law of the minimum describes a critical minimum, under steady state conditions, of a chemical material needed for growth and reproduction. Economists have claimed that the minimum does not apply in a growing system; alas, our system has been growing through transformation and conversion and not real growth.

H. R. Hulet pointed out that a population as a function of wood production would only be 80 percent of that calculated from food production—and the Palouse has far less wood than the continental average. Furthermore, the population would be even smaller as a function of energy and fertilizer use rates. The rate of aluminum use would support only 40 percent as many (800,000). More importantly, these rates are not sustainable, being based on high American standards of consumption. A lack of some resources is not necessarily limiting, since we can trade with other areas that need wheat or peas.

The current high levels of population, at a high range of standards, can only be maintained through the constant takeover of natural habitats for arable land, or through the drawdown of fossil fuels, or by economically cheating the poor and powerless. Since the wild lands and fossil fuels are quite limited, either human populations must adjust to renewable resources or technology must provide substitutes, to avoid an eventual population crash.

Eugene Odum suggested using land area as a measure of human carrying capacity. The minimum per capita acreage requirements, with a temperate area like Georgia as a model for a quality environment, is just over two hectares (5 acres). The natural areas are based on minimum space needs for watersheds, as estimated by land use surveys. Food-producing land includes acreage for domestic livestock. Using Odum's technique for the Palouse, assuming that wilderness area has been considered in the calculation of natural areas, and converting for the differences in productivity of ecosystems (the Palouse is only about 40 percent as productive, so each person would require 4.44 ha (over 10 acres), the population calculation comes to 1.5 million people. This figure, however, does not include trade land, that productivity needed to trade for necessities, such as metals.

Furthermore, the population of the Palouse depends on the limiting factors of the earth, those scarcities that could be traded between the regional populations, and each regional population having a percentage of that ultimate limiting factor (maybe phosphorus or manganese)—the percentage distribution to be determined by the regional productivity available for human consumption. Restated, the Palouse may have enough food for over a million people, but it does not have enough wood to build them houses or enough steel to build trains; therefore, we would have to trade food resources for mineral or timber resources, assuming that other regions are able to trade.

Samuel Eyre also devised a common denominator to consider organic and inorganic assets together. He assigned a nutrition equivalent unit to weights of metal, but this calculation depended on a dollar value for food and minerals. For example, assuming the daily standard adult human nutrition requirement of 3,000 kilocalories, money income from minerals can be expressed in terms of annual nutrition units. Assuming that wheat releases 4 kilocalories per gram and is 10 percent cellulose and 15 percent moisture, then 1 kilogram of wheat yields 3,000 kilocalories, conveniently equal to the daily food requirement of one human being. One metric ton of unmilled wheat is equivalent to the annual food requirement of 3 people.

Assuming that aluminum sells for \$1122.00 per metric ton and wheat sells for \$109.00 per metric ton, 1 ton of aluminum costs the same as 10 tons of wheat (All prices: *Wall Street Journal*, 6 December 1991). If it takes 13,000 tons of aluminum to meet the needs of the current Palouse population of 682,000 (about 0.02 metric ton per person for cars, wiring, and cans), then we need to trade the monetary value of 130,000 tons of wheat to get it—enough to feed 390,000 people! And that is 390,000 fewer people than the area can support if we need to have aluminum things.

Population carrying capacity can be formulated using the gross primary productivity (GPP) of the system. Following Odum, that only 30 percent of the area should be used for producing food, the maximum agricultural area is set at 1.8 million hectares (the current use in the Palouse is actually somewhat less). Following Lieth, but averaging over the entire ecosystem, we estimate the grassland productivity at 1,200 Kilocalories per square meter per year (or 12.5 million Kcal per hectare per year); for energy-subsidized cultivated land, we take a mean of 4,000 Kcal per square meter per year (or 40 million Kcal per hectare per year). And, of that productivity, 75 percent is unavailable for harvest (60 percent is underground, 5 percent taken by pests, 10 percent used for respiration and reproduction), 65 percent of the harvest is inedible, 80 percent of that edible is lost in process, and 25 percent of the processed food is not consumed—leaving only 10 percent of the original productivity to nourish people. Thus, the gross productivity for the Palouse is 36 trillion Kilocalories per year, but only 3.6 trillion are available as food energy. Since every adult human being requires 3,000 Kcal per day (or 1.1 million Kcal per year), *the maximum number of human beings, assuming that all other needs are met, is 1.27 million.* Of course, food is not enough. We need a large quantity of calories for trade and luxuries. Assuming that other surpluses and deficits cancel out, for instance excess energy from water power for cotton for clothes or basalt for lumber, and balancing only agricultural productivity and aluminum needs, we get *an optimum population of 880,000 people* using GPP.

A maximum population could be calculated from Net Primary Productivity (NPP), but that would mean no wild or domestic animals could live in the system. The advantage of primary production as wealth is that the wealth is sustainable—plants are renewable and minerals can be recycled. One disadvantage is that the net community production (NCP) is not considered; NCP takes all of the food chain into account—the millions of other species. Furthermore, dollars are used instead of human work units—using human work units, the number of hours of labor to produce a standard measure, would make wheat and aluminum much closer in price. Also, the technological production (in integrated greenhouses or algae farms) of food is not considered.

It is possible to calculate a sustainable population using NCP instead of NPP. For temperate grasslands, NCP may approach 60 percent of NPP, although 30 percent is much more likely and 25 percent is used for the Palouse. *The maximum population calculation for NCP results in 380,000.* These population figures have been maximum for the productivities. Because the climate is variable, the ecosystem is ever-changing, and humans have unforeseen effects, we should strive for an optimum number, which we could arrive at through an arbitrary multiplier like .5 (Wittbecker, 1981). Assuming the multiplier is 50 percent, *the optimum population becomes 190,000*, obviously less than the current population. This multiplier is considered as part of the cultural factor.

Each way of calculating a population has become more comprehensive and cautious, and has resulted in a smaller population. The target population for planning depends on how cautious we are. Should we gamble and go for more people? If we calculate the maximum wrong, we break the system, and we do not know how to repair it. On the other hand, we might approach some minimum. The likelihood of this possibility is low. The Indians did not approach it at 50,000. The minimum number for genetic health, for the entire species, could be 5,000 individuals. For a guarantee of fertility, 50,000, and for a minimum for social contact, again 50,000.

Ultimately, our cities depend on agriculture, and agriculture depends on wilderness—for recycling, pest control, genetic diversity, soil-making, and water purification, among other things. Our cities depend on cultures for their vitality, and cultures depend on wilderness for their context and imagery. Therefore, we must preserve wilderness areas and cultural knowledge first.

The Palouse has adequate resources to feed and care for its current population—at a reasonable level. The rates of use of energy and some minerals are far too high. Our demands and values are not related closely enough to the particular beauties and limits of our home ecosystem. We have to fit our goals within the limits.

6.8.2.4. *Resource Use by Population*

Just as important as any calculation of the population in an area is the rate of resource use by that population. Grasslands were the basis of early civilizations, and few regions have been altered as thoroughly or as devastated by human occupation, by overcultivation and overgrazing. Using too many resources, such as water and timber, too fast can make deserts.

We are digging up metric tons of minerals per hectare. We are draining the aquifer for our irrigation; and the Palouse is in the top ten areas in the United States for amounts of irrigation. We are mining the soil for everything it has and letting the rest erode. The Palouse is subject to moderate and severe erosion, with from 25 to 75 percent of topsoil lost and over 75 percent in many areas. This percentage represents hundreds of million tons of topsoil lost annually and thousands of hectares of agricultural land degraded through erosion annually.

We are using 10 to 30 times as many resources, e.g., 94 million Kcal and 2.63 million liters of water per person per year, as the Indians did 200 years earlier. Are we 10 to 30 times as happy? Indigenous peoples did not use resources at an accelerating rate. They were limited by their technology, but more importantly by their wants, as taught in myths and stories. Our high rates are clearly unsustainable. The difference is in our technology and values.

6.8.2.4.1. *The Impact of Technology*

Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, the result is disappointing and does not compare well with traditional methods, using draft animals and human labor (Wittbecker, 1976).

In another instance, technology has greatly increased the kind and quality of materials used for buildings and machines, especially aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems. Unbridled, unconscious technology has given us benefits, but only at the cost of irreplaceable stocks of energy and environmental degradation. Instead of expecting technology to triple or quadruple our wealth, it is more likely that it has barely had a temporary positive effect. Making technology appropriate, responsive, and conscious may go a ways to increasing its positive impact. Two technological processes are especially important, substitution and recycling.

Substitution is one way to avoid shortages of resources. For instance, petroleum products

have substituted for rubber from trees for many uses, including tires; aluminum, relatively abundant, is substituted for copper, even though its electrical properties are less desirable. Plastics, also from petroleum, are used to substitute for wood, leather, and metal in many industries. Some substitutions may temporarily ease pressures on biological systems, but they depend on the supplies of petroleum, a practically nonrenewable resource. Therefore, in considering substitution, we should concentrate on materials that are plentiful and local rather than scarce or remote. Basalt is a good example. Perhaps wheat chaff is also. There are not substitutes for everything, so there must be a minimum of irreplaceable stocks.

Recycling is well-established in larger towns, although without a constant market it has to stockpile materials. Waste is still dumped in the many landfills throughout the region, although the quantity of waste per capita may be declining with awareness and recycling.

New technology has been a primary force for change for decades; but some technologies, like computing or genetic engineering, may lead to opposite effects from the intended ones. The use of new tools may have unexpected effects. For instance, mass-produced computers may lead to individual autonomy, as well as invasion of privacy. New energy technologies could have the same effect. Small-scale water power plants could lead to decentralized living; or energy-saving devices could result in more energy being used.

6.8.2.4.2. Choosing Technologies

We assume that improving human lives requires new materials, machines, and techniques. But, we do not have reliable measures to judge whether technologies are beneficial or harmful. We could start questioning technology more rigorously: Who it benefits, what the negative side or cost is, how it fits in a network of technology, and how can it be reversed if necessary. We could assume that technological changes are always somewhat harmful and study them for a long time before implementing them. Technology is not neutral or value free; there are inherent social consequences.

As Palouse cities become more sustainable their forms would change. They would be more compact, with more multiple-use streets, as a focus for human activity (less for cars); buildings could use solar power, efficient heating, perhaps integrate roof-top crops in an urban agriculture; older buildings could be integrated into new groupings to integrate services, play, and work with living; local public spaces and services could be developed; derelict land could be regenerated, either as green area or croplands.

Personal transportation, for instance, is problematical, especially cars. In a similar ratio to livestock, the number of vehicles in the Palouse exceeds the number of people, contributing disproportionately to air pollution, acid rain, and gases that contribute to ozone depletion and greenhouse effects. By allowing changes in distances and by forcing dispersed needs, the car becomes indispensable. Nor have we considered what changes in social mores and even physical health result from our embrace of the car. Trucks and planes have become romantic as well. Perhaps we should consider restoring and expanding rail transportation in the Palouse, then adding bicycle and walking paths. The number of paved surfaces, however, must be aligned with land use.

A favorite Indian pastime was the telling and retelling of stories. Television also has repetition, but not the same depth of involvement. Radio stimulates images in the way books do, because neither impose images, although neither of these forms may be as involving. We have assumed improvements in technology are improvements in human existence, but we must

examine them constantly, if we are not to lose some of the characteristics, such as empathy, that we value most highly. Some communities may wish to examine cars, computers, and television, and eliminate them or modify their use.

The earth is finite and its resources are finite for human purposes. It is very difficult to quantify the limits exactly. We do not know what the limit of productivity that can be taken over is or what the limit of energy use is before a system is disrupted. Nor do we know the limit of interference in an ecosystem to avoid collapse. The trend is towards increased disturbance of natural systems.

The Nez Perce, for instance, had limited energy sources, but were able to change or move to avoid declining marginal productivity—this was only temporary as the region is finite. Now we have access to fossil fuels, but have not learned the lesson of limits. Every case involving growth is only temporary.

Within unknown limits, we need to establish a pattern of use that is sustainable and flexible, leaving other possibilities open. Mineral resources, like aluminum and copper, although finite and nonrenewable, may have indefinite cycles of use. Resources are used more efficiently, but then there are fewer reserves or flexibility in allocation of resources.

Technological multipliers are efficiencies that allow a limited increase in the carrying capacity of the entire ecological system. The load on the system can be expressed as the resource demand multiplied by number of people. Trade diminishes some resource or food capital, but can be used to avoid some minimums. The Critical Minimum is a factor limiting carrying capacity. We do not know what it is. Assigning a multiplier to the effect of technology is difficult due to the contradictory impacts of technology, as well as its high operating costs; it is estimated at 1.2, which is to say that technology has a small overall benefit.

6.8.3. *Cultural Values*

There have been two cultural patterns on the Palouse. An archaic one that offered tribal egalitarianism and limited impact and a technological one based on republican democracy and industrial consumption. The first could not compete against the second, but it has not been completely eliminated either. The monoculture of coke and cars tends to overwhelm the subtle adaptations of the Nez Perce, for instance. A coherent culture provides a secure platform for exploration and open-mindedness; it provides criteria to judge the 'special effects' like television. A conscious culture, perhaps with elements of native American and early American traditions, with appropriate technology and knowledge, could improve and guide the culture of the market place; television, as does telephone and radio, unites people through information, but a common culture is indispensable for uniting their hearts.

Athelstan Spilhaus suggests that a good index of the quality of life is the number of choices a society provides for its individuals. Western culture has valued the pioneer life of the individual—independent, self-sufficient, free to choose different life styles—but with more people, the choices are being subtracted. The more we value open spaces, the fewer people the area can support and still have the open spaces.

It may be that the Indians of the Palouse require 10 times the space as rural settlers; and, it may be that these settlers require 10 times the space as their urban counterparts. Or, it may be that people would prefer to have more discretionary time and less work time, as was possible in archaic societies.

There are numerous advantages of way of life of Palouse Indians: Fewer working hours

(about 4 per day); more leisure to talk, sleep, engage in rituals; a diverse and healthy diet; deliberate underproduction, below the maximum levels; deliberate control of population growth below maximum levels; and deliberate under use of resources, resulting in small ratio of people to resources. Subsistence economics means simply that surpluses are not accumulated. This might make them more vulnerable to food shortages, although the ratio reduces the possibility; furthermore, industrial cultures have far higher incidences of starvation. Our industrial culture is approaching a form of subsistence now, in the sense of a source or minimum of necessities—we cannot leave after we have eroded the soil. Perhaps we will be less tempted to exploit the land for short-term profit, since we remain after the profit leaves.

The greatest happiness for the greatest number could be achieved by devising a measure of quality of life from the accumulated wisdom of nutritionists, medics, psychologists, and sociologists. It could yield an optimum quantity and quality of the commodities of life: how much space, how much food, how much air and water. But would that be enough? Indicators of the quality of life cannot all be expressed numerically; they are elusive. Quality depends more on the spirit of the society than a count of material possessions. Even orthodox ecological criteria are not adequate to evaluate the quality of a particular environment for human life. Nevertheless, we can try to assign a cultural multiplier to our aesthetic and support space needs; it is estimated at 0.83, which means that the industrial culture does not satisfy our frontier mentality or our new requirement for things and luxuries.

6.8.3.1. Other Economic Considerations

Traditional economics does not consider real economic goals, much less ecological goals over a very long-term. What would these goals look like? An economics based on ecological understanding would have many different assumptions from our current economics. For instance, the capital of an ecosystem would be its physical environment and its gross primary productivity; interest would be the net ecosystem productivity. The production percentage would be the amount necessary to keep the ecosystem healthy. Cultural capital would be the wealth of human knowledge about environments, and cultural interest would be experimentation. Specific goals for economics could include: Expanding capital, diversifying institutions, and stressing the development of wealth over economic growth.

The distribution of symbolic and real wealth is very inequitable as the result of historical trends, old economic rules, and cultural confusion. The inequity could be reduced in the Palouse with caps on top salaries, a minimum income (or negative tax), and a simplified 10 percent tax on income. The services provided to society by some groups, football players and veterinarians, for instance, are paid for disproportionately well compared to those of others, such as teachers or nurses. Recognizing that the market is not the best judge of social value, local government could set minimum or maximum salary ranges.

The Palouse could have an administrative department to handle taxation, budgeting, and purchasing. It may wish to coin local money, perhaps on the model of the Local Employment and Trade System—LETS—on Vancouver Island in Canada, which records credits and debits on a computer, which can then only be used locally. There may be a department to protect the civil rights and liberties of the people and a department to protect the environment. Environmental disputes could be resolved by mediation (as was developed in Seattle in 1980s).

We make trade-offs in social systems without assigning dollar values. We could do that with ecosystems. The valuation could be scientific or be based on human labor. New values

of natural resources are being recognized now by economists, such as option value, that is, reserving a resource for future use or existence value or paying for something to exist that will not be used (see Section 6.8.3.1.4 for an expanded discussion of ecological economic goals).

One thing business can do is put a price on nature. But, let us make it a real price, reflecting the real cost of replacement. Let us base the cost on human labor and technology, so that 1 gallon of oil is worth a million dollars, as Buckminster Fuller once calculated. Let us make all those prices high, too high rather than too low. A tax of \$3.00 per gallon could finance the renewal of the transportation infrastructure in the Palouse (and still be cheaper than it is in Europe).

Preconditions to a sustainable, steady state economy include pollution control and some redistribution of resources. The redistribution of resources and the improvement of environmental quality are more important than increased production by sophisticated technology. This strategy calls for improved social and educational organization more than technological style. Styles of technology must be determined by culture and context. Development requires a local authority working with suitable economic and ecological conditions. No authority can be effective without the participation of the people.

Sustainable development requires recognition of the large number of limits. The ecological approach to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant to a majority of people. The Palouse, for instance, faces very real limits in rainfall and minerals. Regardless of how much food exists, people will starve unless they can get it (as is happening so often, now, elsewhere). Every community is forced to accept some upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of the community and natural communities on which it depends.

Complex societies depend on production from resources. Increased complexity requires more information processing and more integration of disparate parts. The costs of communication increase. Complex societies need control and specialization. Yet, investment in complexity yields declining marginal returns because of the increasing size of bureaucracies, increasing taxation, and costs of internal control. If complexity can be restrained, the society may be healthier.

6.8.3.2. *Political Things*

The Palouse Indian nations governed their areas of the Palouse independently. Their political principles were similar: All land is communally owned by the tribe, although household goods may be personally held; all decisions were made by consensus in which everyone participated; chiefs were not coercive rulers, but teachers and leaders with specific duties limited to their realm—medicine, social, war, or ceremonies for example.

When the Europeans settled the area, they brought their centralized, representational government. The original goal of the American republic, according to Jefferson, was to make each person a participant in the everyday affairs of government. But the government (state and federal) has become gigantic, managing the area from remote locations of power, and participation has dwindled. Despite recent emphasis on personal responsibility and international cooperation, our political institutions have not responded.

Political institutions are not givens or timeless. Taking from the strengths of these earlier forms, it might be possible to modify government to be more effective. The first step would be to form an independent regional government for the Palouse.

The Palouse is a good candidate to be an independent political unit. It is a governable size, with over half a million people in 6 million hectares. It has clearly defined boundaries, as an ecosystem, that is the ecological community including humans, and not a state or county whose boundaries have been determined by rectangular grids for convenience. The Palouse has a history of democratic representation.

6.8.3.2.1. Goals of Politics

The government of a community is a framework to maintain the people. For the original archaic peoples, tribal teachers were adequate. The adequacy seems less in our representational republic. Specific political goals could include: Expressing the original purposes of government, taking and yielding appropriate powers, and increasing the participation of constituents.

Spending on education, roads, welfare could be done at local level. There is some risk, especially with education or wilderness restoration, but the breakdowns and errors would not be devastating as with centralized planning. Citizens would need to do the work of government as well as make the decisions. They could have total control over some things. The judgments of the people are more important than the efficiency of those judgments. It may not be necessary to have many separate authorities or committees; it might be better to integrate policy making bodies so they are not too specialized (highways, schools, and waste, for instance, are related).

6.8.3.2.2. Limits of Government

When a place has a reputation for being small and livable, as many towns in the Palouse do, it attracts more people, until it is no longer small and livable. How do we impose limits? How do we keep things from growing? Limits on birth through licenses? (leading to rebellion?) Limits on housing and public services? (causing shanty towns?) Peer pressure? (contributing to social disorder?). Nature is self-organizing, and society is self-organizing, but we need to recognize some limits and define others, and then take responsibility for keeping to those limits.

6.8.3.2.2.1. *Limiting Size.* To restore participation, we have to consider the limits of participation. The current population of 682,000 seems to be too large for direct democracy, as does any of the projected optima. Even 25,000 is large for direct democracy. Many of the cities and towns in the Palouse are approaching or have exceeded this size. The size has to be small enough for people to meet and “exercise government,” in James Madison’s words. Kirkpatrick Sale concludes that the optimum size for direct meeting is 500. Probably participation becomes more difficult as the size increases. Bryan and McClaughry suggest 2,500 as a maximum, since in larger groups people cannot all know one another and the assemblies become a debating forum for a few. Putting these figures together, we expect good sizes of neighborhoods to be 500-2,500; these would make up communities of 5,000-25,000. Differences in size seem to be a unit of 10. The size of a Palouse legislature would be about 50. Perhaps these sizes are close to the optimum. The population distribution of much of the Palouse may cause some difficulty, however. People will not be within walking distance, but may have to drive 20-30 miles to meetings or communicate remotely through telephone, computer, paper, or friends.

6.8.3.2.2.2. *Protecting Ways of Life.* One way to protect a style of life is to put a limit on the intensity of development of the entire area with Transferable Development Rights (TDR) assigned to each unit of area. Any project would have a TDR value (25 for an apartment

building, for example); TDRs would have to be bought or traded from other landowners. All land could be held in communal ownership and leased to farms and businesses, except preservation and conservation lands.

The landscape needs to be zoned (compartmentalized) to provide a safe balance between protected ecosystems and used ones. Restrictions on land and water are one means of avoiding overpopulation or overexploitation. Compartmentalization avoids the need to compromise every ecosystem for human use. Multiple use systems should only be part of the picture—with protected mature ecosystems, then productive systems, multiple use, and urban areas.

6.8.3.2.2.3. *Paying Costs and Leveling Extremes.* The communities could levy taxes on property. But there is a discrepancy in the wealth of communities. The Palouse could collect income taxes, and communities could claim a percentage of taxes collected. The community and Palouse could both tax the same bases: Pollution, wasteful land use, sales, meals, property, and fuel. The Palouse could set a ceiling on each; the community rate could be zero on some. Or the communities could do all taxes and give the Palouse government a percentage, although differences in wealth might be maintained; then, the state could return a percentage to make up equality in education or environmental protection. The important thing is that taxes are used to direct development and reflect the true costs of the society we want.

Similarly, property taxes could be appropriately scaled to use. One way to keep farms as farms is to tax land by use. The more important the use, farming for instance, the lower the taxes. Buying farmland for shopping centers would result in discouragingly high taxes. It is difficult to persuade people to pay more in taxes, to vote to keep less. We could, through education, expand the understanding of the self and expand self-interest in that way. We could let some catastrophe work towards equality, but that might have other high costs to society.

6.8.4. *Summary: Recommendations & Planning*

A number of concrete recommendations can be made to address the goals of the Palouse: (1) educational campaigns for public awareness of the uniqueness of the Palouse and of the effects our lifestyles have on it, (2) the promotion of equity in opportunities and rewards for all people, (3) the offer of tax incentives to private and public corporations to redesign their paths in the community, (4) the gradual increase in preservation of wild and restored grasslands, perhaps up to 20 percent by 1999, to protect ecosystems and resources, and (5) a geographical and environmental database for the intelligent management of the land.

There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. We need an ecological awareness at all levels, a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; we may have to legislate limits or induce adherence with economic incentives, if awareness and reasoning are not enough.

The goal of planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in agriculture, and self-limitation in size and desires. If human patterns were based on mature ecosystems, civilization would be far more complex; human values would allow for the welfare of humans, animals, plants, and land. We have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for ourselves. Planning must include every dimension of human life. This plan is such an incomplete framework, open to improvement and suggestion. You can add to it—

6.9. Mixed Regional Patterns (& Maps)

We rarely look at layer-cake diagrams of large-scale patterns. Although we are entranced by light patterns all over the planet from cities, campfires, and various burnings, we less frequently see the flyways of the Monarch butterfly or the smaller semi-annual paths of salamanders. Most of the paths of wolves or bears are invisible to us, although we sometimes walk on deer trails or try to follow the migrations of whales (the more expensive ecotourism).

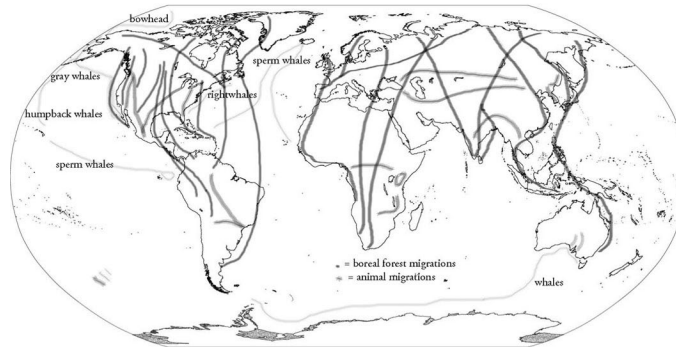


Figure 690-1. Composite paths (Birds, whales et al.)

6.9.1. Wild areas

Wild area may still occupy over 30 percent of the planet, but they are mostly in less desirable territories, covered by mountains, ice, and sand. There are some areas that have been protected by their danger from flies and infections; these are thorn forests, wetlands, and remote jungles, and many of these are being identified as hotspots for biodiversity, with more recent efforts to save them through purchase or trade.

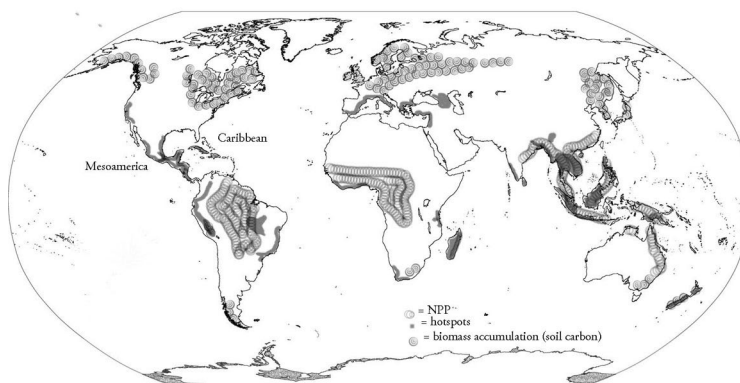


Figure 691-1. Hotspots / Net Productivity / Biomass

6.9.2. Paths of Animals

Animals create paths for their regular movements between habitats (in fact, many of these were used by Archaic peoples and then by industrial highways). Some animals migrate hundreds of miles. Birds may migrate hundreds or thousands of miles. We have identified many of these

paths and flyways and can see them on maps (See Figure 692-1).

Many of these could be left in place, or many human roads could be intersected carefully with them (See Section 4.8 on Wolf Paths).

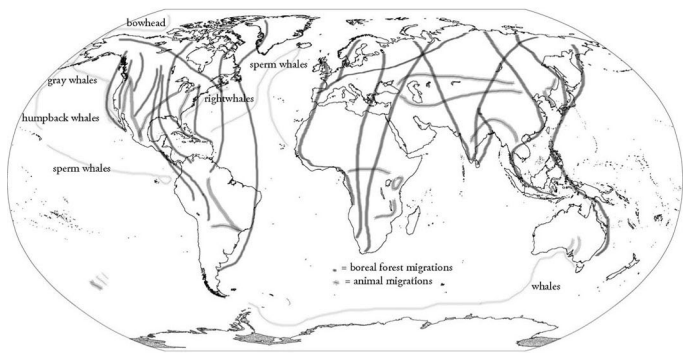


Figure 692-1. A few larger flight ways and paths

The use of wild animals, such as elephants, and domestic animals, such as cattle or camels, creates large-scale patterns. Many of these patterns have been changed by human exploitation of the species. In Figure 693-1 gray areas show the native ranges of selected species while black circles indicate highest density of similar domestic animals.

By shifting agriculture to a more wild agriculture, or conversely, a more urban agriculture, many wild ranges could be maintained, and even exploited reasonably for ‘bushmeat’ or exotic foods. Changing the locations and densities of cities would permit many more shore, shallow water, and prairie species to make comebacks.

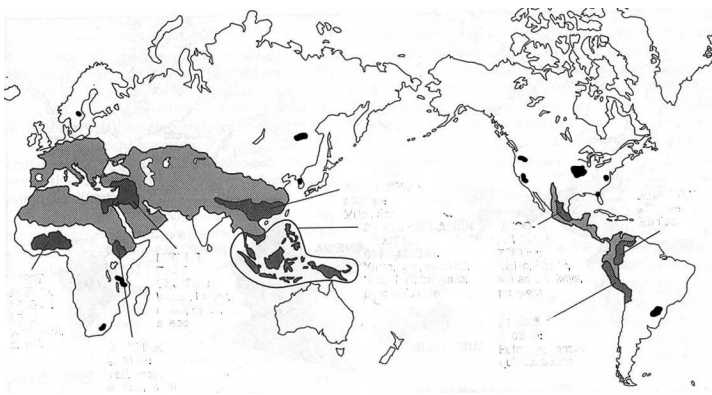


Figure 693-1. Areas of exploited animals

Domesticated animals have truncated ranges, although some animals are herded for hundreds of kilometers. Although most wild animals, plants and microbes have territories within specific regions, many others, such as whales, birds and viruses, range through several regions; their patterns have global influence.

6.9.3. *Contrasting Patterns of Agriculture*

There have been two dramatic paths for traditional agriculture, starting with dryland agriculture using human labor and eventually leading to industrial agriculture, monocropping supported by fossil-fuel inputs using a variety of sophisticated, expensive machinery.

6.9.3.1. Two Islands: Ireland & Sri Lanka

Ireland is approximately 35,910 square miles, compared to Sri Lanka, with 25,332 square miles. Sri Lanka has been dominated by the Sinhalese (primarily Buddhists who emigrated from India after 500 BCE) and the Tamil (primarily Hindu who arrived after 200 BCE), except for brief periods of Portuguese, Dutch or English colonization. Parts of the Island were developed for coffee, tea and rubber plantations by the British. Since the most recent independence in 1956, the rule has been contested by the Sinhalese and Tamils, who want a separate nation in preference to domination. Both ethnic groups are encouraging breeding as a political strategy to keep a majority. The fighting and bombings are bad for civilians and ecosystems.

Foragers settled Ireland after 6000 BCE, as the last ice was melting. The Celtic-speaking Gaels arrived after 600 BCE. After attacks by Vikings after 800 CE and invasions by the English (1168 CE) and Normans (1400 CE), the Irish were dominated by the English. The distinctions between people changed from Irish and Anglo to Catholic and Protestant. After centuries of resistance and claims, the Irish won home rule, which went into effect after 1918. The violence continues (as of 1983).

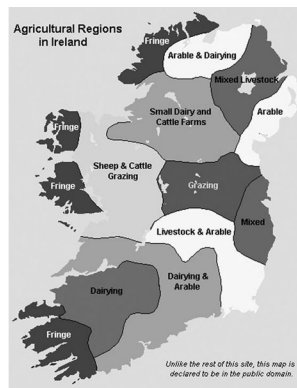


Figure 6931-1. Irish Agriculture Areas

6.9.3.2. Historical Differences

Due to late ice, Ireland's flora and fauna are less than Sri Lanka's. Ireland's forests were cut to under 1 percent of the land area (possibly only 80,000 hectares) during its history. Because Sri Lanka became industrialized much later, it has 32 percent of its land area in forests (2.1 million hectares as of 2000, 1.58 million in closed canopies and 0.7 million in sparse forest).

Land holdings in both nations were controlled by the British for significant times, and the land was used to grow commodities for export. Even during the Irish potato famine, good potatoes were being exported to England. Although the Irish subdivided land for inheritance, under English rule they followed the law of primogeniture (inheritance by the oldest son or rarely oldest daughter), which kept land holdings larger. Rice farming in Sri Lanka had

different tenancy systems, from single ownership (now predominant), joint-ownership, and sharecropping to rotations, lease or mortgage systems. This kept productivity relatively low and resulted in landless peasants. Rice is cultivated in small holdings, but occupies 34 percent of the land area. The climate is wet and good for rice. But, paddy farming is very labor-intensive.

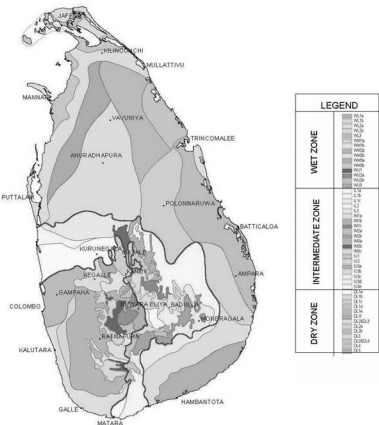


Figure 6932-1. Sri Lankan Agriculture Areas

6.9.3.3. Which Direction to Take?

Ireland adopted more technology sooner, partly because it was easier to use with dryland farming. Sri Lanka stayed with human labor supplemented by water buffalo labor. But, their agriculture is adopting technological changes, such as direct seeding and chemical ‘weedicide’ (which is also depressing wages, since much of it still requires more direct labor). Families can survive on low incomes, but most of the young are attracted to cities to earn a living.

Irish agriculture has been switching from tuber-based to grass-based, although both crops can rely on new technologies for plantings and harvests. Almost 65 percent of the area is devoted to agriculture, including beef and milk production. Most of the farms there are also small (less than 32 ha average). Although as critical source of income, most farmers are over 35 years old and many have off-farm employment. A lot of foods are exported (higher than the European average). Sheep and pig raising have also increased in the last 50 years. Although farmers can make more than factory workers, 75 percent of that income is direct payment from the EU as compensation for poor prices. Farming has become a form of business, although prices rarely reflect real value.

Partly because of climate, Sri Lankan agriculture is more productive, when considering economic and ecological costs. Irish farming is more efficient per person, but not when considering energy subsidies. Both styles of farming seem less attractive than city work.

6.9.4. *Regional Transport Corridors*

Surprisingly, the effect of transportation on ecologies is so dramatic that road ecology has become an academic subject. Roads of all kinds, rail corridors and even logging trails and work paths can fragment ecosystems. Roads are too wide and too different in materials for many insects and amphibians to cross. They become too compact for water to penetrate vertically or horizontally, and this changes the flow of water in a landscape, often resulting in closed pools or ponds. Systems of roads criss-cross virtually every nation, through snow fields, deserts, swamps and grasslands.

These corridors could be planned on a regional scale to diminish the problems they create. Simple bridges or tunnels would allow many species to disperse for new territories or mates.

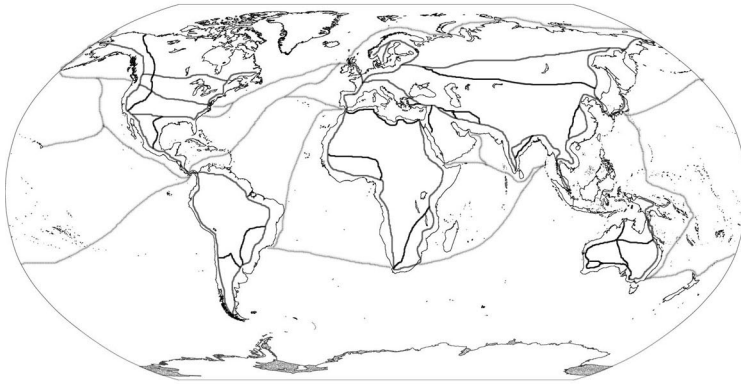


Figure 694-1. Transport corridors (Ocean, Air & Land)

6.9.5. *Regional Patterns of Cities*

Over thousands of years, people created good communities in good places, often by accident, sometimes by intent. These places developed on a smaller scale, such that people learned to fit their activities to the place. Often, their cultures expressed unconscious ways of ecological adaptation. Myths and taboos limited the taking of rare or overly-desired species. Human technology and tools increased productivity without interfering with ecosystem processes, although there were some social and environmental changes.

We can use such societies as examples for some of our modern communities, with the understanding that the scale has changed, our technology is far more effective, and our cosmology has become more mechanical. For a modern community to prosper into the distant future, the community has to adapt a conscious ecological plan. It has to learn to mimic a mature ecosystem in terms of diversity, balance, flow and waste. Not only do houses and buildings have to fit the greater environment, from geology to climate, but economic efforts have to minimize exotic elements and waste, then work to fit with other efforts in the equivalent of a food chain.

6.9.5.1. *Ecovillages*

To some extent since the 1950s, intentional communities have allowed people to consciously address the creation of good places with concern for scale and fitness. Somewhat later, the ecovillage movement addressed these concerns of community, ecology, and spirituality by

trying to create intentional, small-scale villages, within an urban or rural setting, within the matrix of other communities and places, which would be more sustainable. Many such villages are intentionally created as models of sustainability in action, for the purpose of working against the degradation of the overall cultural and ecological environments.

Principles can be distilled from these efforts. There are Ecological Principles: (1) The scale of the village and its impacts must fit the ecological context, (2) human interactions should be integrated into ecosystemic interactions, (3) the health of the system is important as social and individual health, (4) maintain the natural level of diversity, (5) ecosystem exploitation and modification has to be limited to known flexibility or limits, (6) Protect heritage areas.

Then, there are Social Principles: (21) The village should foster a sense of ownership through participation in design, building and maintenance, (22) the village should be self-sufficient and self-reliant as a settlement, depending on local resources, food and capital as much as possible, (23) the village must maintain the infrastructure of all its facilities, (24) the village must allow order to be visible with known rules, shared values, moral order and authority figures, from older people to police, (25) the village has to allow initiative to come from anyone, from the bottom up, (26) allow a range of people to live there, (27) governance has to have some form of consensus decision-making, and (28) the health of all is as important as individual health.

Finally, there are Design Principles: (31) Define spaces clearly through design, signage, and landscaping, (32) design for appropriate levels of privacy, (33) design for integration of all aspects of society from hospitals and prisons to schools and factories, (34) design for access, warmth and beauty—and not just visual beauty, but for the music of sounds and the harmony of smells and tastes.

Of course these principles do not exhaust the number that can be used, and many of them have been expressed as principles of ecological design. And, many of them could be enhanced by the use of specific strategies for action, such as ecoforestry, permaculture, natural farming, and industrial ecology.

These principles can be related to the properties of ecological systems and can be expanded into standards that facilitate opportunities to everyone. These standards would have to do with energy conservation, renewable energy, the use of local resources and materials, the importance of scale for walking, the incorporation of native species and habitats into the structure, the creation of new kinds of domestic ecosystems, the protection of wild areas, providing a safe stable environment, providing a variety of building and living choices within a good range of affordability, and offering a mix of economic opportunities.

6.9.5.2. *Ecocities*

Doubtless, many of these ideas and principles can be applied at larger scales. Paolo Soleri started to create designs for ecological cities intentionally on a larger scale. Ecological cities would be designed to minimize environmental impacts. Partly, this would happen through density and intensification. Such a city would also try to be self-sufficient in the production of energy and food, using many areas and rooftops for agricultural production as well as for turbines and collectors. Green plant canopies on rooftops could reduce the heat island effect of large urbanizations. Air conditioning, for instance, could be accomplished through design with the chimney effect, which Soleri has integrated into most of his designs. The

arcology could collect the water from evaporation and rain. It would minimize pollution. It would recycle wastes with interconnecting links in an industrial ecology. Transport would be improved through proximity and internal design. In addition the unfinished Arcosanti, there are other examples of ecocities in the making, including Curitiba Brazil, Alvstaden Sweden, and Kalundborg Denmark.

6.9.5.2.1. Goals & Enantiodromia

The goal is not only to create good places, and be connected with other good places, but to express meaningful ways to live. Unfortunately, goals are shifting patterns that are different for different images in different times, and also become responses to the fitness of past goals (see Tables 69521-1 and 69521-2).

Table 69521-1. Goals of modern urban individuals (or the small picture)

<i>In</i>	<i>Neighborhoods</i>	<i>Housing</i>	<i>Transportation</i>	<i>Jobs</i>	<i>Leisure</i>
<i>Goal</i>	Separation	Size	Personal	Money	Fun/rest
<i>What's Missing?</i>	Community	Comfort	Usefulness	Meaning/ pleasure	Fun/rest
<i>What's the Result?</i>	Isolation	Waste	Spread	Dissatisfaction	Fatigue
<i>What's the Response?</i>	Violence	Unhappiness	Pavement	Sabotage	Ennui
<i>What's replacing that?</i>	Ecovillages	Small homes	Light rail	Self-employment	Hobbies
<i>And, what's replacing it?</i>	Villages in arcologies	Self-built	Walking	Satisfaction	Watching

For instance, in neighborhoods, the goal of separation resulted from older traditional urban neighborhoods with some crowding. The achieved separation, however, lost the feel of community, as people had their own quarter-acres and personal cars to reach the local malls and supermarket complexes. They felt more isolated and more vulnerable to fear and violence (especially the middle classes). Many of these people decided to intentionally bring back the sense of community as well as reduce waste and vulnerability to violence by creating intentional communities, such as ecovillages. But, these did not always have the density that inspired creativity and invention. An arcology could provide a better context in most cases.

Table 69521-2. Goals of modern urban institutions (or the big picture)

<i>In</i>	<i>Science</i>	<i>Technology</i>	<i>Management</i>	<i>Corporations</i>	<i>Religion</i>
<i>Goal</i>	Data	Technique	Efficiency	Money	Truth attendance
<i>What's Missing?</i>	Knowledge	Appropriateness	Humaneness	Real cost	Meaning
<i>What's the Result?</i>	Irrelevance	Mass produced	Bureaucracy	Conversion	Rock & roll in services
<i>What's the Response?</i>	Personal search	Simplicity	Law suits	Activism	Personal religion
<i>What replaces that?</i>	Astrology	Wood shop	Computers	LLC	Scientology
<i>And, what replaces it?</i>	Ecology	Personal	Work effort	Nonprofits	Loose associations

Goals are obviously imperfect. There is always some element missing that results in a suboptimal condition. And, the resulting dissonance prompts a response, which may result in an improvement or a less satisfactory element. Perhaps with continued experiments on ways of living, combined with an ecological perspective and forms of ecological design, communities can optimize human happiness or at least satisfy it minimally. What do we design for? Maximum numbers? Maximum luxuries? Maximum happiness? Based on our knowledge of systems and maxima, it is dangerous to design for maxima of any kind, or even for optima—perhaps it is best to aim for a satisficing level. New local village and city patterns have suggested that we can design for safety, design for peace, and design for health.

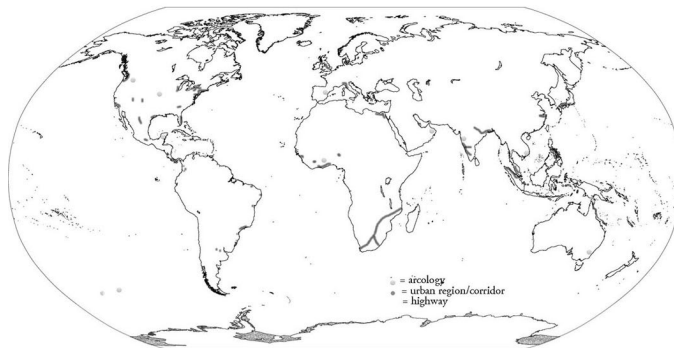


Figure 69521-1. Arcology Planet

6.9.5.2.2. Designing Local Communities

In designing local communities, with properties, principles and standards, three approaches (and possibly more) can be used. Design can immediately address safety, peace and health.

6.9.5.2.2.1. Designing for Safety

Public health officials started requiring design changes in buildings to prevent injury and disease. Buildings had better lighting and guardrails. They had closed trash rooms and regular pickups of trash. Later, automobile accidents prompted officials to require higher-impact bumpers and seatbelts; these technological changes reduced injuries and deaths. Through an ecological design model, Ian McHarg started tracking broad social factors, such as poverty and exposure to violence, related to the urban environment and its history and inequalities.

At about the same time, sociologists noticed that some environmental characteristics were associated with crime and suggested that the physical design of urban spaces could influence behavior. C. R. Jeffrey suggested that the proper design of the built environment could reduce crime and the fear of crime, by minimizing opportunity and promoting positive behavior. His idea of ‘Crime Prevention Through Environmental Design’ (CPTED) was guided by five principles: Natural Surveillance, Access Management, Territoriality, Physical Maintenance, and Order Maintenance. Surveillance maximizes visibility through the use of design features, such as windows; access management directs people through signs and markings, but can also use landscape features to guide people to entrances and exits as well as limit access to some areas; Territoriality is confirmed by delineating spaces—although there is an emotional element that can allow people to feel warmth, belong or pride, instead of disgust or anger; Physical

maintenance requires regular repair and upkeep of facilities; Order maintenance requires attention to disruptive or damaging behaviors, as well as rules stating what those behaviors are.

Much later, sociologists noticed that the isolation and design of prisons and jails may have contributed to a worsening of crime. Architecture has begun to promote better conditions and better placement for some jails and prisons. Jails especially are being integrated into the community, to reflect their function as short time, locally controlled holding facilities. For instance, the Brooklyn House of Detention is expected to reopen in 2012, with an improved façade and street-level stores, at its current location close to the courthouse and police station. Ken Ricci notes that jails are a legitimate buildings in an urban environment, part of the whole civic landscape. Ricci, of Ricci Greene Associates, has designed inmate quarters with larger views of a recreation yard under an open sky. Jail housing is changing from a linear cell model to units facing a central day room. Jails are like ecological buffer zones that allow transition between systems with protection for both systems. Some prisons are being designed to fit into their local environment in the countryside. Of course, design cannot be isolated from inequity or violence, much less laws and the justice system itself, which might also benefit from social design. For example, the War on Drugs and Three-strikes legislation exhibit system flaws. We need to find alternatives. Jails and prisons need to be appropriate sizes for communities.

Now, we are noticing that with rapid changes in societies and immigration, more holistic approaches are needed for design. The entire environment needs to be addressed in design. A participatory ecological forestry could not only restore the biological wealth of a community; it could involve more people and perhaps reduce some forms of violence (and this has been the explicit goal of ecoforestry movement in several nations). Neighborhoods could become more aware of their environment; their efforts may increase native tree cover and reduce the damage from invasive species. The Urban Community Greening (UCG) effort in Cape Town South Africa reports that it has been successful in using community agriculture, horticulture and forestry to reduce violence in informal settlements of Black Africans and refugees near the metropolitan area. Community greening efforts may reduce the risk of violence, even from new patterns of violence. After Apartheid, according to Harris (2003), new forms of prejudice and conflict emerged, including xenophobic hostility to foreigners, vigilante acts, and economic struggles around land and service issues. These new patterns merge with the old ones to complicate political change. Many other places are facing a 'culture' of violence' that may result in 'feral' cities or failed nations. The collapse of civil order threatens all residents and many larger levels of security, including global security.

The social production of criminals through prison culture could be transformed with different opportunities and involving designs. Glass walls on a street showing prison work in glass or art? David Orr has written that with only minor modifications, university buildings could be converted for use as factories or prisons or vice versa.

Urban planning considers buildings, groups of buildings, parks, streets, walkways, transit areas, business areas such as automatic tellers, industrial structures—in fact any structure that is not operating on 24-hour cycles—and all shared places. All community buildings, such as schools, might be used for other purposes at other times of the day. Especially auditoriums and gyms. They could be round the clock community centers, as some are in Sao Paolo Brazil. Urban planning addresses the safety and security of all those places. Given the large number of old structures, these can be retrofitted and redesigned to new standards along with new structures made to those standards.

6.9.5.2.2.2. Designing for Peace

Given that there will always be violence, it can be reduced, diminished, and localized. It can be more integrated into a community, or rather allowed at certain levels. Some kinds of violence might be reduced through participation and understanding. Community greening might work to redesign the community environment through participation and cooperation. Reducing violence results in more peaceful activities. These peaceful activities can restore environmental damage, as well as instill greater trust and create cooperative links. It can promote changes in perception and beliefs; for instance, ecological understanding increases the time-horizon of our influences and our decision-making, and it allows us to broaden our identities and norms.

In general, ecological understanding and peaceful activities can reduce the risk from violence, as well as from larger ecological catastrophes. Groups and societies can develop resistance to violence and resilience after catastrophes. Both resistance and resilience, remember, are aspects of the ecological stability of ecosystems. Developing a community, like developing a muscle, gives it more strength, which allows it to address inequities and conflicts—and catastrophes—without falling apart.

Starting in Mesopotamia, and the storage of food and luxury items, cities built walls to protect their people and resources. Farmers and the poor were protected within the walls or just outside. This design feature continued for thousands of years until technology finally rendered walls impractical. Without walls, cities had to resort to different methods to deal with attacks and crime. Improved armies and weapons reduced attacks. Public welfare institutions were developed to reduce crime and poverty. Later the ‘City Beautiful’ movement rationalized that in a more pleasant environment, people would be less likely to commit criminal acts. Beauty seemed to be ineffective. Urban planning still often uses walls and beauty to address crime. It was recently thought that the medium of television, by showing so much violence, increased violence in the community. Then, it was thought that by showing absurd levels of luxury, television instigated violence from people who had no such luxury but desired it. Disenfranchised individuals, or individuals from disenfranchised groups, may be more likely to use violence to attain success, at least success defined by money and luxuries. Much violence results from the perceived need to use violence as a path for economic improvement; more violence results from the easy access to modern weapons.

Perhaps architecture itself can be related to violence. Hard, large, cold, threatening—biologically and mentally—buildings reflect our cosmology of the machine and that depresses our spirit. But, as the British and Japanese, to some extent, have learned, it is important to rebuild in the same form, with the original materials, wood or stone, to make sure that our buildings shape us in ways we want.

Tom Vanderbilt rewords Clausewitz to consider war as an extension of architecture by other means. Perhaps, but before that, architecture was an extension of war by other means. Vanderbilt points out that architecture is defensive structure and target. That aerial warfare and urban planning even share language and tactics. Architecture can also be used as a weapon, Eyal Weizman suggests, as when Israeli settlements in the West Bank tower over Palestinian villages or a superhighway soars over Palestinian farmland.

Decay is a problem related to violence. Some cities, such as Detroit, are shrinking cities. Other cities, such as Beijing or Beirut, are fragmenting or hollowing out. A few cities, such as New Orleans are breaking down. Others, such as Leipzig Germany or Ivanovo Russia are

disintegrating. Unless cities can maintain their infrastructures and be perceived as desirable locations, residents leave or fight.

Our landscapes have become as artificial as our cities as they are converted to farmland or grazing lands. Can ecological design, community greening and urban planning make communities, cities and nations more peaceful? Maybe design can reduce the desires (or motives) and the opportunities for crime (it may not ever reduce abilities, as they evolve with the improvements)?

6.9.5.2.2.3. Designing for Health

The purpose of housing is to provide shelter from the elements, which is basically the atmosphere. The purpose of business or industrial buildings is the same, although it may be extended to separating business actions or dangerous processes. But, buildings also have to provide safety from disease; they should be hygienic, providing clean water and air, channeling dirty water and polluted air. They need to provide areas for food consumption and waste. They need to encourage social and mental well-being—that is, they cannot be too ugly or noisy.

The design of many buildings contributes to isolation. The sprawl of cities, lack of public transportation on the streets, deserted streets, and tall buildings all imply or demonstrate lack of access. The urban environment includes the effluents from buildings, the waste water, pollution from products or generation of electricity, dangerous chemicals, noise, vehicle activity—roads are a problem to safety.

One design solution is density, as envisioned by Soleri and others, that is, moving things closer together. The entire city needs to be considered as a design project, vertical and horizontal, below ground and above, self-sufficient or highly connected with trade.

Feedback is also an important component of behavior. Buildings that have daily readouts or visible monitors might influence people to turn down the heat or turn off lights, to save energy or reduce waste. The design includes a system of participation with feedback loops.

Human feedback is critical, also. Design needs to be user centered. It needs to achieve ease of use as well as ‘ensoulment,’ in the words of Naoto Fukasawa. It needs to be nonneutral as well as persuasive with its values. It needs to be participatory for the residents and designers, with everyone performing some active role. The goals of design have to include the social transformation of consciousness and positive behaviors as well as more efficient and beautiful shapes. Community engagement with designers and designs can be encouraged through cognitive dissonance. And that can be created with notices, posters, events, and prizes. Participation encourages enthusiasm for the project. Performance design creates more empathy for other participants, where the affects of actions are anticipated and the emotions of others are experienced. Community and online networks allow observation of various kinds of consequences under different conditions. This is what thought experiments are!

Specific buildings need to mimic local landforms or vegetation. They need to perform natural functions, such as damping the wind, holding water, and preventing erosion. The native vegetation surrounding needs to be restored so it can function as wind barriers or shades. Rainwater collection systems, permeable paving, and appropriate structures have to be considered. Design needs to address ways to move people outdoors more often. It can do this with in-outdoor transition zones and areas for outdoor activities.

All of this basically has to do with health. Health is the harmony of conflicting elements, such as disease, joy, selfishness, and altruism. Ecosystem health envelops the health of species

and individuals, human and other. It is not enough simply to reduce disease and violence. Health has to do with the environment. It has to do with aesthetics, and that includes all the senses—humans need music as much as beautiful forms; they need stimulating smells and tastes, as well as clean water and clean air. Sounds and smells, for instance, can complement and enhance any building or area, whether the sounds are symphonies or leaves rustling.

True sustainability requires integration with regional and global cycles. It may require tradeoffs of wilderness and waste sites.

6.9.5.3. *Conclusion: Intention & Integration*

Intentional communities, such as ecovillages and ecocities, find a basis for sustainability in appropriate properties and standards, as related to ecological, social and design principles. The basic concern has to be with ecosystem health, with the operation of global cycles. This will not happen without an expansion of consciousness that is required for ecological understanding at larger spatial and temporal scales.

Even arcologies need to be designed for exposure and lack of isolation, that is, they need to consider how the interior barriers, walls and open areas are situated. Both ecovillages and ecocities need to be aware of their influences on the larger scales of patterns of exploitation and interference. Unless the local patterns are integrated with regional and global ones, local improvements may not withstand stresses and collapses elsewhere.

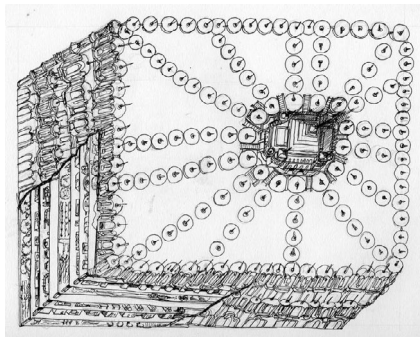


Figure 353-1. Shell Arcology design for Mumbai, India (in *RDP: Local Systems*)

7.0. Managing Design Levels

Even after heroic designs have been composed and applied, they have to be maintained and managed. Management is a continuous requirement. Management is necessary to keep the designs from being abandoned or subverted. Human settlements can be managed in small-scale ecovillages and communities. Large human settlements, or urban areas need to be managed in watersheds and regions.

The history of human use has resulted in numerous problems, which could overwhelm any attempts at frameworks or designed landscapes. For instance, the continual growth of industrial societies, not just populations but the entire infrastructures, could overwhelm any design. The historical inequities between cultures, and even within most cultures, unless it is addressed, could tear apart the society before it could improve circumstances with designs. Thus, design has to include such things as poverty and unfairness, bad distributions and human greed. Corporations are examples of situations where legal changes and scale have released an entity from any normal ethical or legal restraints. Corporations have to be limited before designs can be effective.

Many design factors have to be considered, from economics and city shapes to religion and the power of religion to bind people into voluntary limited arrangements. These factors could distort a design, so design must account for them, also.

7.1. *Regional Problems: Growth, Inequality, Poverty, Dominance & Slavery*

Growth serves as a mechanism of evolutionary adaptation, by carrying out genetic instructions in the environment; but growth is also conservative and stabilizing rather than innovative and reorganizing. Growth is homeorhetic; in a homeorhetic process, the flow is constant, not a stationary state. Flow processes follow fixed trajectories, called chreods. Growth, from fertilization, embryo states, birth, youth, and maturity, represents a homeorhetic process following more or less fixed chreods, programmed genetically and conditioned environmentally. Chreods seem to be like electron paths, that is, probabilistic. Sometimes, growth can be problematic, when a physical body grows too much flesh or a population keeps growing past the carrying capacity. Other things, such as ideas, and wants have no natural size to exceed, but can cause other kinds of problems at inappropriate scales or locations.

7.1.1. *Economic Growth & Population Growth*

Although economics is a social science that studies human behavior, it considers itself a positive science, that examines “what is” with theories, as opposed to a normative science, which addresses “what ought to be.” Keynesian economic theory, the predominant theory in industrial countries, holds that the full utilization of resources is necessary to ensure full employment and the maximum social good. This economics depends on economic growth to avoid crisis. The major premises assume that: Population will grow, that social good is related to the equitable distribution of material products, and that if resources are limited, technology can erase the limits. The economist Kenneth Boulding referred to this as a cowboy economy, an economy that has yet to bump against real limits.

M.D. Mesarovic and Eduard Pestel stated that “the issue for the economy is not to grow or not to grow; it is how to grow, and for what purpose.” They claim that a workable world system must establishment of an organic pattern of growth. Due care is devoted to describing such a pattern and contrasting it with other, tragically inapplicable patterns of growth. Their treatment of the world system itself was regionalized and multileveled. They recommend that the establishment of organic growth was necessary with no need for special no-growth policies for populations or economies. They assume that further industrial growth will continue, that economic growth is good, and that this growth solves human problems as long as it is organic.

Exponential growth is said to be bad, and organic growth is said to be good. In fact, although organic growth is better, there is little difference during a world crisis; both reach asymptotes of suffering. One need only regard the population crashes of lemmings and others to see how organic growth can go wrong. In the organic world, growth is healthy only when the rate of change is decelerative in the long run; cancer and population are constant or accelerative. Mesarovic and Pestle fail to realize that continued economic growth in any form is a threat to the stability of the biosphere.

Economics became enamored of growth during a critical time in history. Rapid European expansion occurred at rates rarely exceeding a growth of one percent per year, and with unparalleled opportunities for expansion into sparsely settled areas, such as North America, Australia, South America, and South Africa. Many cultures now do not have these opportunities; the continents are claimed, and violent population growth may have wrecked their hope for development by ravaging every resource.

The metaphor for the economy used to be a simple mechanical model for turning resources into products. It was assumed that to be successful, the economy had to grow and turn a profit continually. Unfortunately, the assumptions of the model were also simple and failed to consider human needs and natural cycles, causing great suffering and great disruption. These assumptions resulted in overgrowth, with increases in complexities and costs. Overgrowth contributes to economic and ecological instability (Refer to Section 6.6.2).

We have economic growth; we can see the numbers. But, the growth is premised on saving costs by forcing down wages, or by reducing the number of workers in the name of efficiency, and forcing overqualified workers into service jobs. The growth promotes inequality, improvement for a few and impoverishment for most. It is the growth of a tumor, issuing a healthy glow from a fever and the false image of health. Profits go up, but public services decline for lack of funds. There is no money for schools, none for libraries or parks, little for private institutions, and little for national, state or local governments. Where did it go? Profits? Profits for individual corporations, profits for individuals? Could we find them, if we had the will to.

It has been said that international goals are best realized through national self-interest. This must be the old wisdom. It might have been true, if nations were perfectly rational and knowledgeable; they do not seem to be. Nations now seem to be the handmaidens of corporations, whose interest is only in profits for shareholders. The views of shareholders are notoriously short-sighted. The UN is limited by images and ideals of progress. The UN's solution to economic problems is “sustainable development”—that is, “growth that respects environmental constraints,” as if growth respects any constraints. The Bruntland Report indicates a five to ten-fold increase in world industrial output within the next hundred years before population stabilization occurs. While the appeal of growth is unarguable, it is really

not likely to be sustainable in any meaning of that word, since sustainable growth does not recognize known ecological limits. Furthermore, the UN has no power to coerce its members to follow good recommendations.

Continued growth of the “free market” is amoral and pathological, benefiting the elite of authoritarian regimes as much as the oligarchs of democratic ones. It refuses to recognize, much less to pay, all of its costs, such as depletion, loss of security—which may be most important—or extinction. The entire system perpetuates mass poverty and justifies it by blaming individuals, but the system itself fails to reduce inequity or poverty. This loss reduces effort; it is responsible for tiredness and low kinds of health, productivity, and esteem, things that are necessary for personal and systemic renewal.

Some theorists, like Paul Samuelson, have concluded that growth is necessary to rid the economy of disparities. The need to grow is intrinsic in this kind of economic system. A large literature has treated perpetual growth as the only conceivable state of affairs. Capitalism depends on growth for stability. In an organic system, however, growth contributes to early stability, but it cannot continue beyond maturity, due to real physical and biological limits. Mature organisms grow to maturity, but then they can keep developing without growth during maturity. The economy has been growing almost constantly since it has been studied. We have been trying to force it to grow, rather than let it stabilize or contract. Even if it stopped growing, the economy could still develop.

7.1.1.1. Growth or Development

Many physical structures, such as talus slopes, grow by addition, until some physical limit, such as gravity or the coefficient of friction, is passed, then they stop growing. Some stability can be gotten from growth in early stages; later stability must result from limits and metabolism. Growth in plants can delay the onset of senility by ridding the plant of waste products in more diluted form. However, too much growth produces a strain on tissues and early decay. In fact, one herbicide promotes excess growth as a means to kill weeds. A biological organism grows to maturity, which is a stopping point for size. The organism continues to develop, however, experiencing and learning the environmental complexities through mating and then to the end of life. Development may include growth at some stages, but development refers to the continued change after growth has stopped. Mechanisms for growth can become pathologies when central authorities meddle in stable lower orders.

Development instead of growth would equalize wealth more efficiently—after all, economies have been growing for at least 400 years and increasing the disparities. Traditional reciprocal economies were stable and relatively static for over 10,000 years. There is no necessary association between development and growth in economics, as Daly and others have shown. Growth means increase. A community is forced to accept an upper limit, beyond which it cannot grow any further. Further growth results in destruction or disruption of itself and nature.

There is another distinction between growth and development. The ecological social approach (or a redistributive environmental strategy) to development makes it irrelevant to discuss global limits to growth. Local limits are far more significant to majority of population. Regardless of how much food exists, people will starve unless they can get it. Redistribution of resources and improvement of environmental quality (in the home environment) are more important than increased production by sophisticated technology.

The natural capacity of regional photosynthesis must be limiting factor in development, especially in tropical and subtropical areas.

7.1.1.2. Growth of Populations

Agriculture, growing crops and raising animals, provided more food, but it was less nutritious and less palatable. By increasing the population, agriculture increased widespread hunger. The reduction in biodiversity by monocropping caused some ecological crises, that resulted in periodic and devastating famines.

Despite famines that caused hundreds of groups to wobble or collapse, the overall human population has kept increasing. The world population is increasing at an alarming rate. By 1900, the rate started to increase steeply. At a rate of increase of two per cent per year—below the current rate—the earth's human population will reach 50 billion by 2100. By 2280 it would be 1.2 trillion. That is 300 years from now (1980).

Nations that seem to have adequate resources, may be growing too fast. Even the Union of Soviet Socialist Republics, with all its potential agricultural land, and its uncertainties of drought and frost, may be increasing their population too fast, as may Canada and Australia. Population growth can become a political weapon, in a democracy, when two groups coexist, with neither ecological differentiation nor geological separation, and only breeding control for coexistence. For instance, in Sri Lanka, the Sinhalese and the minority Tamils, breed for political control, ignoring population control. Voluntary controls fail; the population increases by almost two and a half percent per year. The problem of population control is a tribal problem, not a racial or economic one. It is a local problem, more than a global one. Even with trade and charity, in most areas population is limited by local resources and local limits; only in a few cases, such as the Netherlands and Hong Kong, can a population be supported by massive ghost acreage elsewhere.

Sir Charles Darwin's view of humanity was that it was not domesticated. Humans were still wild. Unmastered, they have no breeding control; therefore, they will eat to the limits of the natural food supply and press against social and biological limits. The global population explosion, an example of autocatalytic nonlinearity, is not considered a problem for many thinkers, such as Eric Jantsch, who believe that this growth constitutes an essential factor in the creative act of gestalt formation. Growth does lead to intensity at some stages of development in the life of a species, but growth can stop, and development can also lead to the kind of creative intensity that is identified by Jantsch and others with mindless growth.

The principles of ecology can help guide human societies. For instance, the principle of competitive exclusion states that two dissimilar races cannot occupy the same niche in the habitat. If humanity is wild, and not domesticated, this may help explain war and racism. Territoriality is no longer a rule in human ecology, though the instincts may still be operative. Human ecology defies maintaining its population at a lower level. The young are overproduced and protected; the least fit are not eliminated. Medical science has increased the number of old and maladapted dependents of society. Problems with populations bristle with social and political implications. A balance in birth and death rates is necessary for ecological stability. We have controlled epidemic death and infant death diseases. We need to correct the overbalance in births. Toughness and ingenuity might be required. As it is, population and economic growth without fairness or adequate distribution leads to inequity.

7.1.2. *Inequality—Economic & Social*

The assumption of inequality is new with agricultural civilization. At the time of Bacon, it was assumed that there was: An absolute, immutable, omnipotent God, everything was sorted into a great chain of being, economic subsistence was preferable, and social inequality was unavoidable. Later, Darwin incorporated a different set of assumptions into his theories: Absolute space-time; atoms as discrete units; economic discrimination, and continued social inequality. These assumptions likely contributed to the misuse of his theories to justify social and economic conditions at the time.

Many modern political ideologies and economics have been shaped by the principle of endless wealth. Adam Smith once calculated that the real price of anything was just the toil acquiring it. Under this principle, inequality in a world of abundance could only exist through human suppression and exploitation of other humans. The invalidity of this principle of plenitude came with the recognition of limits.

With surplus, came redistribution and the beginning of inequality. By 4400 YBP in Mesopotamia, there was status differentiation, as evident in the sizes of homes. Since then, government has become subservient to economic actors, according to John B. Cobb, Jr., partly because the ideology of economics is so positive. It proclaims that continued growth will solve most of the problems of modern civilization, from poverty to conflict, although the promise has not been fulfilled. The problems have increased from food shortages, housing shortages, and energy shortages, to unemployment, inequality of opportunity or goods, environmental deterioration, increase in weapons, and insecurity.

Economies are out of balance. Modern economies, embracing the idea that “nature is capital,” draw on the accumulated “capital” of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth—similar to the healthy flush of a fever, perhaps—and a long-term imbalance. When an economy falls out of balance with its local environment, massive disruption often results; industrial economies have only avoided disruption by trading advantageously with other economies, by using fossil fuels, and by promoting general institutional inequality.

The economic government, according to Robert Reich, creates a corporate hierarchy, with pervasive inequality between all levels, rather than a democracy. To keep profit growing under any circumstances, corporations have been willing to accept damage and conflict.

Nations are basically exploitative of other nations and smaller cultural groups, which may not be considered nations because they lack a permanent military. The reasons for this continued behavior include: The rapaciousness of society; the acceptance of war; and the economic advantages of large-scale operations. The cultures of industrial nations are based on unethical accumulations of materials. Inequality is maintained by power, not persuasion, and also by the assumption that solutions are extrinsic and external and have to be found by spreading out rather than intensifying efforts to find solutions at home.

The predominant value in small cultures, and then large, was harmony. This minimized conflict that might have resulted from inequality. Confucian concepts of ritual and etiquette helped to regulate social conduct and made people feel good about their station. For example: “Inequality is the nature of things” and “seek no happiness that does not pertain to your lot in life.” This may not work at the scale of nations and global corporations.

7.1.2.1. Distribution of Wealth

The philosopher J. S. Mill narrowed the scope of economics to production and the scarcity of means; he considered distribution to be a political process, since it depended on laws and customs that varied widely in different cultures and ages. One function of culture is to distribute material goods or energy. Economic culture defines the means of production and livelihood, techniques of distribution, and values and norms underlying economic behavior (can be more closely related to kinship). Order is a cultural problem. Order provides stability and security. Cultural order is necessary to deal with the redistribution of wealth and power.

With the creation of more wealth or new wealth, the distribution becomes skewed. Accumulation increases. More kinds of wealth become invented and more skewed. But, as long as an economy does not reach the limits of wealth, it can keep growing; these new kinds of wealth allow that. Cultures encourage the unequal distribution of resources.

Wealth is based on production in capitalist countries. The production of wealth from growth depends on technology. The technological perspective is oriented toward materials and not humans or ecosystems. Nature is considered to be a resource to be exploited. The immediate objective of technology is to create wealth through knowledge. Technological activities are justified on humanitarian grounds, scientific discovery increases the well-being of human society, yet the social consequences of scientific activity are ignored; short-term suffering will be offset by long-term benefits, it is claimed. But, without a long-term view, long-term benefits will be worse.

7.1.2.2. From Difference to Inequity

Inequity is more the result of differential development than of exploitation. According to Boulding the greatest source of the differential is different rates of accumulation of knowledge, capital and organization; the rates are essentially internal properties of cultures. Although a minor element in terms of transfers, it is a large psychological perception, which may need to be compensated for in a global community.

Most of the wealth used by modern economies is nonrenewable. These resources are limited, interrelated and distributed unevenly. Forests are a special problem; although trees can grow to a good size in 30-40 years, forest ecosystems may take 300-600 years to develop and then last for thousands of years. Oil, coal, peat, and some woods are functionally nonrenewable. Geological time periods are required to produce them.

The distribution of symbolic and real wealth is very inequitable as the result of historical trends, old economic rules, and cultural confusion. Karl Marx considered that misery is caused by class conflict about distribution of material things. Some of the problems of distribution have to do with the size of society and the scale of its operations. For instance, in Hutterite communities, usually less than 150 people, the distribution of goods rarely failed; people got their share, rarely less or more. With a larger group of Hutterites, the distribution started to fail, and the group divided.

The modern market distributes some benefits to all, but its scale allows unfairness. Economics are the harmonious distribution of wealth among people. But, problems increase outside small-cell scales. Kohr points out that Marx failed to link misery to the scale of economics rather than to the system. The problem is with overgrowth more than style, which is why socialism based on overgrowth looks the same as overgrown capitalism. Both simultaneously increase consumption and poverty.

7.1.3. *Poverty & Consumption*

Poverty can be defined as a lack of needs, such as food and clothing. Affluence and inequity seem to be producing new forms of poverty, such as lack of use (the use-value of feet in Los Angeles) or the potential poverty of not having what is possible elsewhere in NY or Paris. Modernizing needs creates these new dimensions of poverty, and this leads to new forms of discrimination. Violent cargo cults can seize traditional cultures. The opposite of this is new forms of wealth, such as useless wealth or harmful wealth that actively subtracts from the enjoyment of life.

Ecological analysis would force us to look at the obvious—generating nonmarketable use values occupies the center of every culture because it provides a satisfactory life to its members. Needs are almost completely defined in terms of commodities. Even relation needs a commodity, travel, to be fulfilled. Once the need is defined and partly satisfied, it becomes a right. From walking to the right for passenger miles at high speed in a mere fifty years. Stung by the suffering of people with new unsatisfiable needs, we have offered to produce more, safer goods. Instead of ecologically analyzing the relationships of needs to satisfactions.

Consumption is touted as the solution to poverty. We all live, thanks to modern advertising, in a dream world of mass consumption. The purpose of expositions changed gradually from instruction in wonder to simple entertainment and buying. The Crystal palace in 1849 shows the former and the 1855 Exposition in Paris, the latter, where they put price tags on things and charged admission. The first department store opened in 1853; this changed the tone of shopping from haggling to inspecting a fixed price item.

Consumers are trained to enjoy waste, violent speeds, harsh medical treatments to extend life, and standard rations (McRations?). The state has to try to discourage the lack of patriotism that comes from deserting standard needs diets. The military is actually a symptom of the orientation of the state. Health and education use a military rationale. Industrial society is constantly mobilized for emergencies, in the battles against, noneducation, poverty, diseases, terrorism. Industrial development has never been nonviolent to people.

Specialists incapacitate people's autonomy by forcing them to become consumers of care, instead of learning to care for themselves. Half of our needs are made by armed bureaucracies that have been growing since Louis XIVth Empire. Industrial services see state security the generator of society's production patterns, even if it is a spin-off of military needs.

7.1.4. *Cultural Dominance: Colonialization*

Dominance is a social phenomenon that describes social relationships. Dominance in animals is related to a social hierarchy that allows the dominant animal to feed first. Dominance in plants is often related to mere numbers or the ability to grow faster and reach the light first to spread more leaves to catch light. Dominance in humans is more complex. Like wolves, human beings interact with the individuals of other species or with entire species. Like other mammals, humans change their habitats to suit themselves. Humans have modified animal and plant associations in a different way from other mammals, simplifying patterns of energy and chemical exchange and solidifying themselves at the end of many food chains as a dominant species. A dominant is a species with greater influence than any other in its biotic community, changing the lives of other species and the character of the habitat.

Human populations have increased exponentially, with billions in giant urban

ecosystems. Agriculture has produced monumental yields, but only at the cost of tremendous erosion and great subsidies of fertilizers and pesticides. Dams have been built all along rivers, and riverine forests have been cut, altering rivers and fishing grounds. Changes have been made without regard to the long-term impact on the ecosystem or on its human population. We dominate entire ecosystems.

By its influence of all ecosystems, humanity has become a predominant species. As such, humanity reclaims, overgrazes, clears, depletes, and wastes at a level that threatens the stability and existence of many systems. This predominance has major effects on ecosystems: Transient perturbations in energy relations (from oil spills and burning); chronic changes/shifts of systems (from dams, irrigation, and chemical wastes); species manipulation (from the import and export of exotics); and interference competition with wild species. One of the ecological consequences of human activity is the degradation of wild habitats for human developments and the introduction of novel elements into the biosphere—elements that have not been harmoniously worked in over time as a result of natural processes. The biomass, or demomass, of the human species probably far exceeds the biomass of any nondomestic species, and that biomass is supplemented by the tremendous biomass of domestic animals, which is four times greater (G. Borgstrom 1975). This biomass forms an equivalent population that consumes much of the same food, such as milk, fish, and grain.

7.1.4.1. Cultural Status

Like many mammals, human beings create social hierarchies, which allows some individuals to get more food and better mates. Status is also assigned according to the hierarchy. Although, in primates, the largest, fastest and usually younger males often dominate, old males can sometimes dominate with the help or permission of females who may prefer an old predictable leader to a young unpredictable one. Status has to do with standing in human society, and with appearance and ownership. Status may come from longevity, of the self or ancestors, as well as from the results of good decisions, from hunting for example, or from owning more than others, or just more things or more people. Status is a powerful human need, and may drive the growth of goods or populations. Perhaps related to population growth and size, changes in cultural status become related to equity, distribution, and dominance. As distribution becomes more unequal and as conflict occurs more between groups, dominance and slavery appear, and are both related to status.

Status is a social need, which is justified by a culture. Status levels in traditional society included: Nobles, commoners, and slaves. Slaves were captured or purchased. In earlier days, people were sometimes captured by enemy tribes. The return home of the captives, either through payment of ransom or owing to a retaliatory raid, was a special return. Like other property, slaves were given away as gifts.

Inequalities of status and wealth became associated with permanent settlements. Furthermore, other social things developed such as complex division of labor, with castes and slave labor. Trade increased and competition increased. This may have had to do with resources that were abundant and could be stored, and transformed into political prestige and power. Agriculture provides more status, more wives, and more things. It allows armed struggle, also. Art, in addition to luxuries and profits, was tied to status.

7.1.4.1.1. Status & Distribution

In almost every size of human groups status is divided unequally. In hunting groups, better hunters become the hunting leaders. The success of a hunter allows the hunter to distribute the cuts of the game between others, often according to an understood set of rules. In larger groups, with a surplus of materials, the materials are distributed according to status. People have equal access to status positions in society. The number of positions of prestige is adjusted to the qualified candidates. Status is separate from wealth. An animal is divided up according to ratios regardless of who kills it.

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7.1.4.1.2. Status Dominance

Strength or status can give rise to dominance. A dominant is an animal or person with greater influence in the community. Dominant behavior may be biologically-based or cultural. Dominance gives priority of access to food, sex, or space. In a majority of primates, males are not dominant over females, except where there is a large size difference. Where sizes are roughly the same and where female coalitions occur, there is not much sexual dominance. In some human groups, males may attempt to dominate females with the threat of physical violence, for instance, among the Yanomamo. Among other Amazon peoples, such as Mundurucu, it may be due to control of ritual objects and rituals, for dominating ceremonial life. In spite of the cultural forces dominant at any moment, an individual has the potential to determine a different course of action.

7.1.4.2. Colonialism

The Phoenicians sent out colonists to found Carthage. Settlers from Carthage founded Barcelona. The Greeks made colonies in Italy, Sicily, Turkey, Libya, and Spain. Norway sent people to Iceland and Greenland, France, and Ireland. India sent colonists to Sumatra, Borneo and Java. The Inca moved villagers to Ecuador from Bolivia. Southern Indians called Tamils, crossed over to Ceylon, which was occupied by the Sinhalese. And, of course the Europeans tried to control all of their global trading by controlling the people and the resources in Africa, the Americas, Asia and the Pacific.

Colonial countries introduced new ethnic rivalries wherever they took over. English imported Indian people from India to work sugarcane fields. By 1970, half the Fijians were

Indians. Fijians tended to eat strangers and castaways, sometimes enemies from raids (and some recipes were the same for pigs). But, only men could eat human flesh because of the strong manna.

In Tasmania, aboriginal people had woolly hair rather than curly, were shorter, had brown skin rather than the matte-black of the continental Aborigines. In technology, they had digging sticks and spears, but not boomerangs or woomera (atlatl). They understood curating fire, but could not start it. Their 12,000 year separation from any other people or culture is the longest for any people, even Rapa Nui. The English wanted to create or recreate a European world, without savages. The native peoples did not fit. All of Tasmania was first made into a prison; all the native people killed off. The culture was destroyed. The environment was destroyed. The English were not tolerant of dissent, variety or diversity. Neither seems to be the modern civilization.

Colonial administration required central government and strong armies. The Ottoman expansion into Europe annexed one food-producing region after another. Sustainable intensive farming was abandoned as colonialism gained. There is a direct connection between colonialism and the abandonment of land, possibly having to do with immigration or slavery.

7.1.5. *Cultural Dominance: Slavery*

To be enslaved means to be owned as property and divested of freedom and rights, or it means to be completely dominated. The word slave comes from the old Slavic word for the Slavic people, who were among the first slaves to be held in Europe.

Slavery is the idea that people can be held in bondage to perform work. The Greeks thought that freedom depended on some slavery. Some societies thought that their economies depended on slavery. It was actually thought that slavery improved the lives of slaves, since they were often considered to be from subhuman groups. It was also thought that it was a personal decision or personal right, although the slave might feel differently. There are of course, different kinds of slavery now. For humans, there are living slaves, but future generations might become enslaved to the decisions of their parents, especially as regards losses and debts. Animals have been enslaved. Machine slaves were the next economic boost. Finally, industrial societies have energy slaves, ten to twenty for each person. Slavery is based on a number of assumptions, such as contempt for the enslaved, or denial that there is wrong.

Different kinds of slavery can be distinguished: Opportunistic, institutional, or comprehensive. Opportunistic slavery was the result of raids or conflicts with other bands in archaic societies. Institutional slavery included labor force collection, as practiced in Egypt in 4500 YBP, or economic slavery for labor collection, as run by the British 300 years ago. Comprehensive slavery refers to the use of wage earners, animals, and energy.

7.1.5.1. Opportunistic Slavery

Many archaic cultures had slaves, who were usually the victims of conflicts between bands. In Nez Perce gatherings and celebrations, slaves were exchanged, along with furs, roots, berries, and fish. Slaves could often intermarry with their captors and acquire status; their children were almost always free. Slaves became a separate social class in some archaic societies. By 5000 YBP a stratified class society had developed in places like China—slaves at the bottom, then peasant farmers, craftsmen, then the elites of administrators, religious and military. In Assyria, slaves could not wear veils. Slaves worked everywhere in Assyrian society, for instance, even

running businesses. Some people entered slavery voluntarily to pay off a debt.

7.1.5.2. Institutional Slavery

For the Tukano of Peru, the Maku group was a slave class, that is, a source of slaves. The Kwakiutl also had slaves, who were captured or purchased. Like other property, slaves were given away as gifts. Usually, they were captives kept near the door to guard the house. Occasionally, they were killed and eaten during the cannibal dance. Viking raiders and colonists owned their own land and used Irish slaves for work and for wives specifically (based on genetic evidence). As the number of slaves diminished through death or marriage, some farmers lost their land to absentee landlords, who, without ecological or personal feedback, would make poor decisions about crops and practices.

Economic slavery occurred in Mesopotamia. Slaves worked in all levels. Many were prisoners of war; some were criminals being punished; some entered slavery to pay off a debt. But, slaves could also own a business. If a slave married a free person, their children would be free. Slavery became specialized with agriculture, in China and Egypt.

In China, by 1615, slavery was hereditary, for agricultural or household slaves. Slaves reflected the stratification of society as it became more complex. Slaves in the Americas were considered to be needed because the amount of acreage increased with the discovery of new lands; the acreage and the slaves were considered necessary to develop more wealth. Slavery kept labor artificially cheap. This dampened the incentive to develop new technologies, but, new technologies eventually surfaced because they proved to be cheaper than slaves.

The appearance of mechanical devices such as the sugar mill and the cotton gin helped to support the system of large plantations based on a single crop. The Industrial Revolution after the late eighteenth century swelled the population of towns and cities and increasingly forced agriculture into greater integration with general economic and financial patterns.

Internal slavery was a feature of Europe from the Romans to Middle Ages, but disappeared when feudalism disappeared, and labor was no longer the scarce factor in production. With the opening of America, however, land opened up—or rather was claimed and conquered—faster than it could be filled with European people. Therefore, colonists tried to force native Americans into labor. Native Americans, however, were still dying from European diseases, which made them unsatisfactory as slaves. Europeans looked to another tropical continent, Africa, where the people were resistant to old World diseases. Less than thirteen years after Columbus, in 1505, African slaves were introduced into Haiti. Over 350 years, ten million more people were brought over, in a large trans-Atlantic trading circuit that involved rum, sugar, cloth, and timber as well.

In the American colonies, the independent, more or less self-sufficient family farm became the norm in the North, while the plantation, using slave labor, was dominant, although not universal, in the South. With the British, Americans, Africans, and Spanish, slaves became a commodity in a trading empire.

7.1.5.3. Comprehensive Slavery

After the enslavement of peoples, some dominant cultures turned to the enslavement of nature and then of energy. The English treated tropical lands as enemies to be defeated, then enslaved them in plantations. Their cultural attitude as conqueror of nature led them to treat biogeochemical cycles and soil requirements as temporary obstacles in a world where

everything had its price.

The new economics of the industrial age depends on wage slaves, that is, people who need jobs to get necessities in urban areas. An overeducated labor pool led to secretaries and then managers, and to the fulfillment of the managerial revolution. Now, industrial society is able to use energy slaves to accomplish work. Energy, in human work equivalents, from animals, natural and fossil fuels, is used to perform work.

The concept of slavery need not be limited to plants, animals or humans. Considering machines as “energy slaves,” then Americans each use the equivalent of fifty slaves per day. The computer is an information slave and must be the equivalent of at least three other human slaves. Slave owners love the privilege. And the exploitation of inanimate slaves is more easily justified. In fact, to some extent, the culture of arts and sciences may not be possible without machine slaves. But, at some point, slavery corrupts the owners, making them physically or mentally soft. What is the exchange for summoning these information slaves so easily? The failure to develop intellectual ingenuity? Loss of imagination? Lack of trust in intuition? Let us consider an earlier exosomatic adaptation that helped humanity. Knives permitted hunting larger game animals or deeper roots, but the long-term anatomical result was partial degeneration of the human jaw. Garrett Hardin notes that all exosomatic adaptations bring about “a corresponding degeneration in the endosomatic function,” i.e., knives change the function of teeth. The species is then more vulnerable to accidents, since external adaptations, like pacemakers or artificial kidneys, become required for the health and maintenance of civilization. Perhaps writing has changed the function of human memory. Perhaps computers will change the structure of thought and maybe reflective consciousness.

7.1.5.4. A Question of Consciousness

The institutions of slavery raise questions about our relations to each other and to nature. What is our human relation to reality—slave, master, participant, or partner? Cosmology describes the place of a culture in reality. Cultures can determine inappropriate attitudes towards nature and that can result in ruin for the air and land. The worldviews of many people defined other people as nonhumans, who could therefore be improved by being allowed to work for true humans.

Although slavery is officially condemned in virtually every nation, the inappropriate use of people, animals, machines and energy continues, as a necessary part of the agricultural and industrial economies. And, it will continue to be until there is a shift in consciousness that would let us consider the ethical implications of our uses of everything and everyone, especially how these uses perpetuate patterns of domination and inequity, as well as contribute to the degradation of ecosystems and geocycles.

The ideas of dominance and slavery have been integrated into many kinds of designs, from the design of housing and chains to clothing, roads and auditoriums. Changing some of the traditional designs may reduce feelings of inequity and perhaps the actual inequity.

Religion could help control disruptive forces, especially those that result from distribution and power. Religion coerces people into a social contract. Religion and storytelling reduce the variability of individuals wants in a group. The introduction of new stories and myths, concerned with partnership and equality and with the value of other places, species and people, could change our attitudes about them into a healthier context.

7.2. Regional Solutions: Avoiding Adaptations & Traps

Human groups have adapted to their environments, have changed them and have been changed by them. Some human groups were trapped by their environments and could not change. Sometimes the adaptations themselves can act as traps that limit human behavior. Perhaps education can be designed to afford understanding of adaptations and traps.

7.2.1. Adaptation & Drift

The physician Rene Dubos suggested that humans can adapt to anything. Humans adapt rather than plan. Are we genetically hard-coded to do that? Overpopulation is adaptation to an uncertain environment (or is it an expression of expansion of all life?). Agriculture is an adaptation to diminishing game and slow overpopulation; it is stable source of lower quality, lower diversity food. Irrigation is an adaptation to growing exotic crops under low moisture conditions. Permanent settlement is an adaptation to more abundant local food supplies. Large buildings and cities are an adaptation to permanence, slow overpopulation and uncertain environmental conditions, such as droughts. Coal is an adaptation to overuse of wood, oil to overuse of coal. Forest over cutting is an adaptation to environment and increased demands for houses and glass, but it changed the environment and made it more variable. Ecoforestry and conservation biology are adaptations to the overuse of ecosystems.

Our genetic make-up predisposes us to some things and pushes us in some directions. It makes limits on our plasticity. It could promote behaviors that damage the environment, and hence our long-term interests. If limited by stone-age genes, then some pro-gene behaviors may be ineffective, others effective. For example: We must have contact with natural environments where we evolved or suffer psychological and physical harm. Behavior is determined by immediate personal consequences (short-term egoism), regardless of its consequences in modern world.

Places that have been successful for a long time, or that are likely to continue to be successful, may well have another quality, which may not be immediately apparent—the places adapt easily to changing circumstances. Finally, places that are successful in the long term, and which contribute to the wider quality of life, will prove to make good use of scarce resources. They are sustainable.

Adaptation is a response to changes in the environment and the evolution of organisms. There seems to be no direction in evolution other than to live with a changing environment; genes become plans on how to live from experience; drift is selected to fit an environment that is evolving. Nature, that is the planet as a whole inclusive of many subsystems, regulates the stability of the climate and environment. Plant diseases, plagues, floods, volcanoes cannot occur too often, or nature could not purify air and water or reseed devastated areas.

Evolution is an integrated process, partly open-ended, involving choices, and the selection of whole individuals in whole environments. The cost of evolution by selection is so heavy that most of the time most populations are not perfectly adapted to changing environment. For the evolutionary process, Varela suggests the metaphor of “bricolage,” which is the putting together of parts in complicated arrays because they are possible (rather than an ideal design). He calls his alternative view evolution by natural drift.

Change is inevitable and we have to adapt to it, but we must make sure that we do not

adapt to a low-level style of living, to drifting lower standards and performance, as Donella Meadows warns. We must not try to adapt, for instance, to an impoverished world without wilderness that we could preserve or keep separate. Some human systems get worse, that is, they drift to low performance. Rivers get dirtier, hospital service gets worse. Rather than adapt to these conditions, humans need to create goals and plans to avoid the drift to low performance. Similarly, our many individual enhancements to the human body, especially mechanical replacements of organs, without consideration of changed interactions or consequences may result in what William Thackera calls 'Borg drift' (from the word cyborg). Drift is a systems trap.

7.2.2. *Drifts & Traps*

Meadows calls the systems structures that produce common patterns of problematic behavior 'archetypes.' These archetypes are traps. A trap is a device for catching or holding animals (from the old English word 'to step'); it can also mean a stratagem for catching people. Many things can act as traps; many situations can act as traps. Other systems traps include: Addiction, policy resistance, arms races, and the tragedy of commons.

There are energy traps for instance. Agriculture traps energy for people, but it also an energy trap of people, because it allows a concentration of energy, that is, higher yields, but then it requires more energy be put into the system to maintain it. The system has to produce more energy than it uses to be useful. And be sustainable, with a surplus for trade. The use of energy in general creates an entropy trap, since most of the energy (84%) is wasted, and it creates disorder in the surrounding system, making it harder to get more energy.

Agriculture could be considered a population trap, also. Not being limited by having to move or carry children, also, being sedentary, farmers had more kids. More kids required more food, which could be provided by agriculture. But, because of the surplus, farmers could out-compete foragers on a smaller territory, so if agriculture collapsed they could not go back to foraging. Perhaps the trap was also a material trap. Things required storage or transportation. Storage was cheaper and easier.

There are serial traps, also. An example of a serial trap is the use of resources by a people, where the replenishment rate is constant, and the rate of use exceeds it. This trap results in ecosystem degradation that may be irreversible. Industrial strategies sometimes mistake the rate of discovery for the rate of recovery. The two are different.

The rate of population growth can act as a trap, and the shape of population pyramids can act so, since it can change the reproduction rate dramatically. There is nothing to constrain humans in their growth. We could even adapt to too many humans and too much suffering, perhaps through abstraction and art. But, art could also be survival technique to being to adaptive. That is, it undermines the paradigm by showing the invisible effects of adaptation.

Culture can be a tool, an external set of memories and guides, but it can also function as a trap. The human culture that allowed humans to survive rapidly changing environments seems to create crises during more benign climates. In small scales, culture can be very flexible. But, with changes in scale, culture can be very inflexible and wrongheaded. Although culture is loose enough to incorporate medium-sized changes, such as automobiles, it may still be rigid enough to act as a self-perpetuating, inflexible monster when dealing with large challenges. Traditions, especially those reinforcing identity, can force people to keep to old ways that are inappropriate in new situations. For instance, the Vikings in Greenland tried to maintain a

style that involved raising grasses for cows in a cooling climate, with disastrous results; they refused to learn from the Inuit style that was effective under those conditions. Culture can be a mental trap that limits choices and actions. People may become fixed in permanent roles and personalities. Even if cultural attitudes are appropriate, they can trap a people if there are no longer functional reasons for the practices. The Nembi of Papua New Guinea may be trapped in their system; making stone axes is difficult, when thousands of steel ones are available. There are other cultural traps, such as slavery and brewing alcohol (or drugs).

Humans developed as generalists, using creativity and flexibility to cope with unstable conditions following the glacial climate of the last ice age. If the future returns to the climatic variability of earlier interglacial times, this variability would impose difficult conditions on agriculture and cities, which developed in the relatively mild past 5,000 years. The recent trends of interdependence, just-in-time supply, and globalization are not adaptive to instability.

Global capitalism undermines traditional cultures by offering consumerism in the place of guides for behavior. Social roles seem irrelevant by comparison, if the good life can be bought without effort. Yet, it does not seem to be working in Europe and the US. Instead of being free from economic want to develop their potential as creative human beings, people are trapped in a consumer cycle. Self-actualization is postponed for self-gratification.

Capitalism is as massively adaptable as other human behaviors. Instead of being chastised for its weaknesses, it has incorporated the criticism into its advertising program. Protesters are shown drinking Pepsi. Aborigines and polar bears are shown drinking Coke. The computer revolution, once thought to become the backbone of creative anarchy, is absorbed into corporate service. People become addicted to new commodities.

Addiction is a trap, since it requires higher rates to appease the need. Addiction can appear in human social systems as well, such as dependence on government subsidies or reliance on chemical fertilizers to improve crop yields. Cheating is a trap, that is avoiding the rules for personal or social gain. We are changing conditions so fast that new adaptation is necessary to fit into conditions we cause through growth and adaptability. What is the solution? Plan or adapt?

Violence might work. War has been a way to get out of traps. War can also destroy filters. But, there are other ways to change filters—by perception or thought. War can destroy cultures and ecosystems, so it may be too destructive to work as a solution.

Growth is a way to get out of some traps, but sometimes it leads to a larger trap. Meadows notes that because of the reinforcing positive feedback loop in the market, or 'success' to the successful, for example, US automakers were reduced to third place. This is a trap also. It can be broken, in species as well as corporations, by diversifying—and how does one diversify? Find the differences in the environment through education, specifically through ecolacy. Another way is to legally level the playing field with antitrust laws. One solution to growth is mature development within limits of age and size.

Traps can be escaped by reformulating goals, or by weakening or straightening feedback loops, by adding new feedback loops, or by recognizing them or altering the structures. The way out of the trap of escalation is to avoid getting in it, refuse to compete, negotiate, or interrupt. This is where education can offer alternatives, through the filters of numeracy and literacy. The solution to cheating is to redesign rules in a direction to achieve the original purpose of the rules. In fact, design and redesign are ways to remove traps.

7.3. Regional Design Solutions: City Shapes

Since the beginnings of settled agriculture, humans have been altering the landscape to secure food, create settlements, and pursue commerce and industry. Croplands, pastures, urban and suburban areas, industrial zones, and the areas taken up by roads, reservoirs, and other major infrastructure, all represent conversion of natural ecosystems. These transformations of the landscape yield most of the food, energy, water, and wealth humans need. Of the planet, humans have converted approximately 29 percent of the land area (about 3.8 billion hectares) to agriculture, roads, and urban or built-up areas. Agricultural conversion to croplands and managed pastures, alone, has affected approximately 26 percent of the land area (about 3.3 billion ha). Agriculture has displaced a third of temperate and tropical forests and a quarter of natural grasslands. Agricultural conversion is still a critical pressure on natural ecosystems in many developing nations; however, in some developed nations agricultural lands themselves are being converted to urban and industrial uses.

Urban and built-up areas now occupy more than 471 million hectares (about 4 percent of land area). Well over half the world's population live in cities. Urban populations increase by almost 200,000 people daily, adding pressure to expand urban boundaries (UNEP 1999:47). Suburban sprawl magnifies the effect of urban population growth, particularly in North America and Europe. In the United States, the percentage of people living in urban areas increased 10 percent, from 65 percent of the population in 1950 to 75 percent in 1990, but the area covered by cities roughly doubled in size during the same period.

These patterns are the result of historical processes relating to the availability of land, technology, and dominance. They do not need to be preserved. New patterns are possible that respect limits, that keep populations and impacts in balance with the rest of the planet. Arcologies may be the best design.

7.3.1. Shaping Cities

Cities miniaturized nature, W.I. Thompson suggested. They miniaturized wildness and displayed it in parks, zoos, and even buildings. Cities, the largest of human structures, have resisted conversion to arcologies. The size and investments required for arcologies discouraged investors and builders from creating them. Is it that ecology as a science is too daunting?

How is a city like an ecosystem? Does it have borders, flows and cycles? Early cities had a balance and relation with wildness and country. Now, the change in scale to empires as well as just growth of populations and cities has unbalanced this. Cities still have to follow the laws of physics, as well as the laws of chemistry, biology and ecology. Before the change in scale to cities as homes to millions, cities could waste and pollute, and the waste would be thinned out by the tides or winds. Essentially wilderness did the housekeeping and provided the sink. No longer. Cities have to embrace an industrial ecology that recycles things within the city.

The edge of the city, more than a wall, is like a membrane that allows cycles, water, resources, and people to move in and out. But, the membrane kept out exotic and dangerous animals and people and it kept the concentrated organization inside.

We should not be overwhelmed by having to meet limits. What is a limit? A crushing wall? Is a limit not like a grid or a poetic form? Something that has to be met yet forces or inspires creativity? The surrounding ecosystems provide constraints to the size and kind of city.

We should not be overly concerned with the material size of a city. How much of nature is organic? 1%? How much is material and elements? Biomass is 1 ten billionth of the earth mass. Most of the materials that make up a city can be neutral.

What are the trade-offs of living in an arcology? People would be required to give up many of their habits and addictions, but these would be replaced with new patterns of moving and dwelling that might be much more enjoyable, much more open to a civilized conversation with others. What should cities look like? A collection of buildings? One large complete building? The mushroom of an underground network?

7.3.1.1. *Reshaping Buildings*

Instead, architects generally remained at the building-size projects. Some architects have suggested altering the design of buildings and combining uses. For example, an apartment building block typically encompasses one square hectare of land. At best, in most cases, the block is 50 percent structure, and 50 percent surrounding yard, lawn, patio, or sidewalks. This footprint has 0.5 hectare enclosed space, and 0.5 hectare open-sky space. Rooftops as designed, however, are rarely usable for additional “live loads” of constant use activity nor dead loads of landscaping and outdoor furniture. By moving to a “stepped pyramid” form, it is possible to have a footprint of 1.0 hectare of enclosed space plus nearly one hectare of open-sky space.

The stepped pyramid form, or modern ziggurat, casts minimal shadows on its own tiered plazas, and does not influence the solar access of neighboring buildings. A structure with twelve floors casts a smaller shadow profile than a six-story block building. The street-level of a pyramid would have one hectare of shops, offices or workshop businesses. The second level would have offices. The higher levels could have apartments with garden areas.

Buildings designed as boxes with “square-shoulders,” reduce the open-sky area of the maximum possible solar penetration. This reduces the solar gain for patio gardens as well as reduces the possible locations for solar-power panel positions. In worst cases, blocky buildings cast shadows which not only darken the adjacent streets, but also shade lower portions of buildings at nearby distances. Skyscrapers and high-rise buildings can put large zones in shaded darkness, especially at higher latitude locations in winter, which ensure that the buildings have to use more utilities and can raise heating and lighting expenses for lower levels.

Manhattan Island has a night-time residency density of 1.5 million people. The area of the island is 67.34 square kilometers. A reasonable building density would be 45 buildings per square kilometer, assuming that 20 percent of the area would be reserved for industry and public access. Replacing blocks with pyramids, the potential population of Manhattan would be about 2.23 million people without any building being taller than six levels and no building shading any other. There would be 2,800 hectares of commercial space on the street level, ample for transportation, services, shopping markets, and workshop businesses.

7.3.1.2. *Reducing Footprints of Cities*

City and artificial areas should be restricted to the remaining small percentages, of the least productivity. In cases where the city area exceeded that maximum percentage, an equal area of rooftops or pavement areas would have to be dedicated to agricultural activities. Thus, there would be no limit to house density, only coverage area, and that would be directly related to natural primary productive areas.

7.3.1.3. *Retrofitting to Arcologies*

Arcologies are based on an optimum size, related to productivities, limits and values. Arcologies are planned so that the management of elements and order of patterns form a balanced system. Arcologies integrate farming and wilderness into the city and the city into the environment.

Individual buildings could be retrofitted to be part of a single arcology. Perhaps a Buckminster Fuller style geodesic dome could be erected over the parts of the city to be converted. The remainder of the city would be taken apart and recycled.

7.3.1.4. *Design for Miniaturization & Intensity*

The success of life depends on miniaturization, where a prodigious number of overlapping mechanisms are packed into a small space. These mechanisms persist through built-in regulation circuits, but the systems are open enough for novelty. As an emergent form of life, cities have packed patterns and increased their intensity. Arcological cities have the potential to increase it still more, while decreasing their impacts on the environment.

John and Nancy Jack Todd claim that living machines could miniaturize the production of human services, thereby letting nature develop wild systems that would provide global services. They say the designer could set the tasks for the machine and let it develop its own biotic complexity. Living machines would not need to be isolated from natural systems. However, it seems that whenever these living machines interface with living systems, there would be a potential for domination, collapse or hybridization. Such machines would fit well in the urban environment, which is already miniaturizing our relationships with nature, but not necessarily with wild systems.

The world has already been miniaturized in our imaginations, as well as by some technologies and in some urban environments. The effect of some of these technologies, such as television and movies, is that many who once accepted their lots of hunger and disease have seen western affluence and desire to share in it. Not to share equally with them now would be inhumane. Miniaturization seems to promise intensity in ethical decisions and behaviors also.

7.3.1.5. *Design for Integration*

Integration is one of the basic properties of a field. The processes of differentiation and integration, where the processes interpenetrate, run simultaneously from top and bottom, and shape a hierarchy from both sides, allow complexity to emerge. As we have seen, a city is a design that has emerged from the properties of a culture in a place, both of which are embedded in ecosystems and its enveloping field.

Many of the problems of modern urban societies, such as alienation, insecurity, and homelessness, do not occur in archaic societies. If we could recover the security and integration of these societies, with their unity of work and life and of economy and morality, we could extend economics beyond capitalism.

Global exchange, however, occurs at a different scale and a much faster tempo, so that cultural elements often sit beside one another without any kind of meaningful integration. In these cases, the scale of exchange may overwhelm a holistic culture with an assortment of materials that are personally chosen. Some items, such as blue jeans, give a superficial uniformity to all cultures. Global exchange seems to create a tight integration of economics

and cultures.

However, the integration may not be coherent. Ecologists call the excessive integration of a system hypercoherence. According to Holling, a system that is too-highly connected is an accident going to happen. Rigidity increases vulnerability to change. The number and strength of all the connections is a problem if disruptions occur regularly, and they do in modern cities.

Arcological cities might be able to reduce or strengthen connections in a more flexible pattern. Of course perception is a large part of patterns. And, we perceive the direction as being towards more complexity and more integration until we have megacities in a global society, coordinated on several levels, within a more complex biosphere. An arcological pattern would allow local cities to maintain their diversity be optimally integrated into new global forms. Self-sufficient cities would allow residents to start thinking locally and acting locally, within the ecological designs of the cities and within global constraints.

Ecological design, described by Fritjof Capra, is a systems-based approach to economics integrating human activity and natural processes. Capra states that it reflects the basic principles of organization of nature that have evolved to sustain life. Ecological design has an important role in sustaining, developing, and integrating residents into broader ecological and cultural environments, shaping these environments and being shaped by them in reciprocal actions. Bricolage is a way of synthesis and a technique to integrate historical and cultural knowledge into an urban form that is an optimal fit into its place.

7.3.1.6. Advantages of an Arcology

With an arcology, the city can change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation. An arcology is a monumental design, which appeals to human desires for creating monuments.

The size of an arcology would allow great diversity in retail stores and job opportunities, especially those related to running the arcology. The shape will allow optimum use of sunlight. Common areas will be designed in.

The siting of an arcology, with its ability for self-sufficiency, leaves large contiguous areas of wilderness nearby; this would allow people to access wild areas, which would meet their needs for being in nature. The arcology would have a very small footprint compared to traditional cities. Although generally self-contained, an arcology could be open through local gardens and fields, which would be part of the design.

7.3.1.7. Disadvantages of an Arcology

Being optimized for size within a place, an arcology would not be expandable, although that may not be a disadvantage. The outer or inner shape of the city might not be flexible. Like any building that relies on complex technologies, regular breakdowns are expected. How would the arcology allow people to fend for themselves in terms of warm, energy and food? If the arcology does not have enough internal or nearby external agricultural areas, then food may have to be imported.

Reliance on traditional technologies, such as concrete manufacture or energy generation from fossil fuels, might contribute to environmental problems, such as carbon dioxide release. The shape of the arcology, along with interactions, may not solve the problem of the disparities of wealth. Although the design may encourage interaction and sharing, people will always be

able to choose separation. Although the design may reduce crime and violence, people will be able to choose those actions also.

Some people may suffer psychological problems from intense living in a planned environment, but perhaps no more so than in any other city. Arcologies may not be able to solve the problem of increased movements of people, who may commute regularly between other cities and nations.

7.3.2. *An Arcology is a Wild City*

What should cities look like? Can we place them around mountains? This would solve the problem of interior space and lighting; everyone could have a view. Arcologies complete the idea of the city and make it ecological, frugal and exciting to live in. The pattern of an arcology is integrated into natural processes and cycles.

How big are arcological cities? How big should they be? How big is too big? How small can they be? Is there an optimum size? Is it determined by wilderness? Is the city dependent on wilderness? What does it need? What does it take? If it is dependent, how should it show that? Should wilderness dominate the city and force every design? What is wilderness? Thing, Idea, process, life? Is wilderness the center of life? Is the city? Should we withdraw human presence from wilderness?

Do cities answer deep needs as readily as wilderness? Can we ever go back from cities or fields to wilderness and rural communities? Are cities traps? Is the city an evolutionary dead-end or horrible mistake? Created with the principles of ecology, cities could be the ultimate human creation. The city now provides a place of danger, for hunting and excitement. But it rests on wilderness and fields, so it is artificial excitement. Cities allowed us to be more abstract and to abstract the culture from nature to make a second nature. Our imagination took over with cities, with technology which changed cities and increased luxuries and artificial habitats. A second kind of diversity was created, of habitats and niches (for mice, rats, weeds, and pests).

Arcologies have progressed from a thought experiment to experiments with specialties and specializations. An arcology creates a separate ecosystem like an ecosystem that participates in the cycles of nature but spins new fabrics and elements, as well as new ideas and adventures.

The whole premise of arcological design is that it has to be balanced with wild ecosystems, that is, nature has to be woven in with the city or vice versa. The scales have to match. They have to be balanced. That does not mean that every part of the city has to have wild tendrils in it. We can still have solid concrete and glass. Perhaps some of the parks can be truly wild. But, evening out the whole might make it unworkable.

7.3.2.1. *Nature in Cities*

A construct as large as a mountain could support the vegetation of a mountain, from grasses and trees to lichens and annuals. More importantly, the vegetation would contribute to atmospheric and edaphic cycles. It would attract complements of birds, insects and animals.

7.3.2.1.1. *Forests in Cities*

Forests are wild ecosystems. To thread them throughout a city requires leaving space for spontaneous, dynamic, autopoietic changes. Trees in interior spaces could be incorporated into the structure of the arcology itself.

7.3.2.1.2. Streams in Cities

Wastewater could be directed into courses through small forests, grasslands or aquatic wetlands to be purified by the plants and soils. These course could look like natural streams at the middle of recycling, and enter houses and buildings as waterfalls or rivulets at the end of the process; or they could be contained in pipes for showers or toilets.

7.3.2.1.3. Agriculture in Cities

The top of the arcology, or the tops of buildings offer potential surfaces for growing crops, as do balconies, windows, community gardens, or the sides of some buildings or the front of an apse. Providing enough area to feed the entire city might be an engineering challenge. Many foods can be grown in vats or hydroponically, but these areas would not require a large footprint, as would grains or fruit trees.

Vertical agriculture could offer some extra space, even potentially enough to feed the entire population, especially on exterior surfaces. However, to create entire floors or moving conveyer belts of surface might require extra technology and energy.

7.3.2.1.4. Recreation in Cities

Arcologies could offer virtually every kind of recreation found in any kind of habitat, although most likely on a smaller scale. For instance cross-country skiing might be quite limited. Many other activities, from climbing and swimming to running or golf, could be accommodated. Of course, special urban forms of recreation, such as free-racing or basketball, would be natural in such a large building. Even exploring would be stimulating, especially in the service or manufacturing areas.

7.3.2.1.5. Wildness in Cities

Like any human aggregation, an arcology would attract wildness in the form of commensurates, such as rats or cockroaches. Bacteria and viruses are always part of any concentration of people. On a more formal level, we would use wild processes to help create an open ecology that would connect the city with its proximate environment.

7.3.2.1.6. Participation in Building

Participatory architecture can be one of those processes that allows citizen participation in the design of their communities. An open ended participatory design process can lead to a great diversity of all forms being used in the architecture, also more diverse pattern this may result in more diverse patterns of social interactions, such as nurseries located near administrative offices or a bar located near a work area. The network of working and living can become much more dense if it includes pedestrian paths gardens and public spaces. Within each building walls and floors could be movable so that people could customize their own living or working spaces. As part of the participatory process that workers and builders can be simply given design principles and constraints rather than complete final absolute blueprints.

7.3.2.2. *Cities in Nature*

Every city, including an arcology, exists in a natural and wild context, depending on the services of the environment for resources. The siting of a city would be much more important

in a cell-phoned, internetted world. Not less important because of technology, but more important. For instance, there would not be the requirement or reason to have the city on a fertile grassland or wetland, or on a shore or river. Cities could be located in geologically stable areas, to minimize the natural threats of floods, earthquakes, firestorms, or volcanic eruptions. Cities could be located at equidistant nodes for trade or communication, according to size or requirements.

7.3.2.2.1. Forbidden Sites

There should be places forbidden for cities. Many of these have been too obvious for millennia. We should not build on flood plains, even if we could create a floating city. Although perhaps some classic cities such as Venice or New Orleans, could be saved with surrounding dikes or higher technology possibilities. Cities could be kept off tectonic faultlines, and off fertile grasslands and prairies, which could be restored or used for natural restorative agriculture or common or wild lands. New locations could be dictated by new transport corridors, especially new kinds of rail or mag-lev lines, but not necessarily places that required river or ocean transport.

7.3.2.2.2. Regional Patterns of Arcologies

Using theories of central places and networking, arcologies could provide a planned solution to population areas. They could replace failing cities in dangerous areas. Arcologies could also be raised in deserts; their internal closure would permit enough water efficiency and cooling to make their survival in rough climates practical. In some cases, for example parts of the Sahara or central Australia, an arcology could be the center of restoration for part of the desert, starting with the reforestation of the fringes of the arcology (and there are already examples of restoration in the Sahara, using less sophisticated techniques). Arcologies could also be built in mountainous areas or rocky shores, if they were stable enough.



Figure 7322-1. The Antarctica Pyramid Arcology (in *Redesigning the Planet*)

7.3.3. A Regional City: The Palouse Hill Arcology

The Palouse arcology would be built into the rolling hills of eastern Washington—in fact, it would be a hill, covered with native plants. The Palouse arcology would be located in the eastern Palouse Grassland, along highway 8, between Moscow, Idaho and Pullman, Washington (for a full description of the Palouse, see Section 6.8). In fact, the location of the arcology would be at a gravel pit by the highway, where basalt is broken up for highway and building materials.

7.3.3.1. General description & Design of Arcology For 50,000 People

The arcology would require an internal floor area of 50 million square feet and a volume of 500 million cubic feet. The footprint would be relatively small at 2.5 million square feet (58 acres or 24 hectares), with 20 stories, 10 of which would be underground in the basalt, 4 within the profile of the ground and six above the surrounding hills. The grassland is deep loess soils on a basaltic base, developing in a modified Mediterranean climate. In essence the entire arcology would be shaped like a loess hill, with a smooth rise from the southwest to the northeast, where the slope would be steeper. Much of the surface would be planted in native bunchgrasses. The density would be 862 people per acre (2083 per hectare). The overall height would only be 120 feet (37 meters), well within the variations of the grassland elevations.

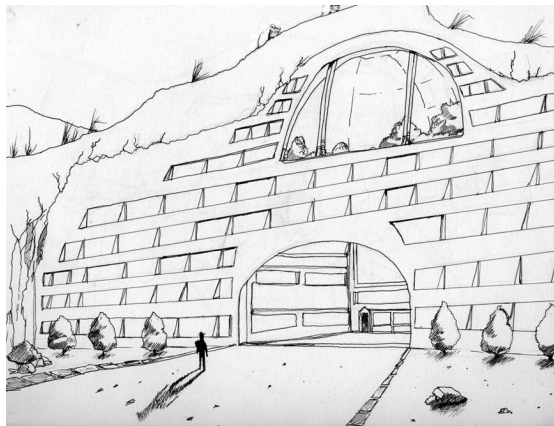


Figure 7332-1. South Elevation of Palouse Hill Arcology

7.3.3.1.1. Site

The Palouse Grasslands is a short-grass prairie that is determined by climate. Dune-like hills were formed by wind-deposited loesses on a basalt foundation over a period of 500,000 years. The soils are fertile, with a loam and silt-loam texture, as they developed in a semiarid Mediterranean climate. The landscape has moderate to high relief; elevations range from 540 to 3700 feet. Annual precipitation varies from 7.9 to 31.5 inches—a high proportion (45-65 percent) of which falls during the winter months. Maximum temperatures coincide with minimum precipitation during late summer, producing intense drought.

By Highway 8, the soil is 40-50 feet deep. Since the basalt was exposed during the construction of the highway, it has been mined regularly for pavement materials. The pit is over 3 stories deep as of 1992. Further excavation, down to 100 feet below the current ground level, would form the basement of the arcology. Basalt blocks could be carved out for building

materials. Other gravel materials could be used in the concrete mix.



Figure 73311-1. East of Site of the Palouse Hill Arcology

7.3.3.1.2. Populations

Over 12,000 years the local human population grew from perhaps 1000 people in the Palouse region to the current local population of approximately 70,000 in the Moscow-Pullman area. The wild animal and plant populations were reduced then partially, mostly replaced with domestic plants and animals. Domestic plants include wheat, barley, lentils, and rape seed. Domestic animals include cattle, pigs, and sheep, along with companion animals such as horses, dogs and cats.

7.3.3.1.2.1. Human Population

The human population target is a 50,000 people. Many of this number would be recruited from surrounding cities and towns. The rest would come from population growth and immigration. The population of the arcology would be a part of a calculation of an optimum number of people for the region, which would depend on limiting factors such as net productivity and water availability.

Paolo Soleri notes that the intensity of life in an arcology could be overwhelming with the sheer human magnitude, but that this possibility is diminished by the design of neighborhoods and the positive nature of the Urban Effect. Semi-self-sufficient, three dimensional and overlapping, these areas include housing with amenities and necessities. Schools, parks, retail stores, cafes, offices, and other complex components of the city would distribute and absorb the daily flow of people.

About one-third of the population would participate in public work or service activities during daylight hours. With another third of the inhabitants at home, involved in home life or home work and thus out of the flow, and another third traveling to other areas for agriculture or research, human movement display a rhythmic pulse.

7.3.3.1.2.2. Animal & Plant Populations

The Palouse is a short-grass prairie, also called a shrub steppe. There are no stands of forest, although there are willows and hardwoods around rivers and streams and the decorative, fruit, and plantation trees that people have planted and maintained. There are relatively few lakes and wetlands; there are few high elevations. The primeval vegetation was composed of dense stands of perennial bunch-grasses (caespitose grasses, such as Idaho Fescue, Bluebunch

Wheatgrass and June Grass) and shrubs (including Snowberry and Wild Rose). There are at least 25 mosses and 9 lichen species.

The original grassland supported good numbers of mammals, from mice and coyotes to deer, antelope, and elk. To some extent they have been replaced by domestic species: Dairy and beef cattle, swine, sheep, and poultry. Livestock in the Palouse numbers over a 1.3 million individuals, over twice the human population, although that declined from earlier numbers. Over 60 percent of the cropland production is devoted to feeding them, and over 30 percent of raw materials to housing and transporting them (for example, it takes 5 to 20 calories of fuel to produce 1 calorie of meat).

7.3.3.1.3. Spaces

The Palouse Arcology would offer generous spaces for public activities as well as parks and food growing areas. These might be contracted or expanded as the population changes.

Table 73313-1. Division of Space

<i>Spaces</i>	<i>Area (Square feet)</i>	<i>Percentage</i>
Living space	15,000,000 sq ft	30%
Public/commercial space	9,000,000	18%
Civic functions		
Commercial		
Public circulation services	8,000,000	16%
Utility		
Paths/rails		
Food-growing space	9,000,000	18%
Public Parks/wild areas	9,000,000	18%
Total Area	50,000,000 ft ²	100%

The percentage set aside for parks is higher than for most cities (good cities usually set aside 10-15% of their area). Deciding how much area for food-growing is difficult, as most cities trade and import their food, much of which, like wheat, corn, melons, or tomatoes, require large areas; however, for greenhouse, hydroponic, or small truck gardens, eighteen percent should be enough.

The figure for circulation is a hybrid figure, since many utilities can be underground. Using alternative technologies, perhaps 1-5% of the area is needed for electricity generation, much of which would be the surfaces of other structures.

In a modern city such as Los Angeles, 59 percent of the ground area is dedicated to streets and parking (other cities such as Detroit, Chicago and Dallas use 48-41 percent). By comparison, traditional walking cities were always more compact; the arcology simply eliminates cars, trucks, buses, and trains. However, walking paths, sidewalks, as well as light rail and escalators are expected to take up 5-7% of the total area.

Areas set aside for civic and commercial functions are relatively generous. Most of the entire population of the arcology, as well as external workers or visitors would be 'housed' in these areas for 8-11 hours per day. Assuming that each business had 3-9 employees, perhaps as little as 3-5% of the area would be reserved for commercial enterprise.

Civic functions would also be relatively dense and so require less space over shorter

times. This would be for public meetings, city meetings, celebrations—but it would also be for heroic meetings or presentations, so the spaces would need to be larger and more dramatic, perhaps 4-10% of the area.

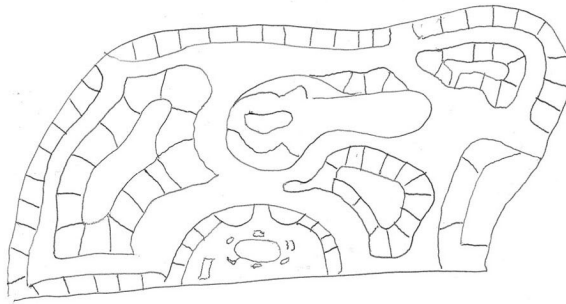


Figure 73313-1. Floor plan, Upper level

7.3.3.2. *External Description*

Except for the south-facing entrance apse to the arcology, the arcology would resemble a large hill among other natural hills. The depth of the soil would range from 1 foot to 7 feet and be planted with native grasses. The apse would have a tile face over concrete. The inside of the apse would have over a 50% glass cover. The apse enters the space of the arcology, starting with the public atrium.

7.2.3.2.1. Building Process

Building the arcology would proceed from building the main apse, using a ‘silt pile’ manufacturing technique, that is, the current ground (even if piled to a much larger mound) would be painted, then covered with rebar or fiber, then plastic, before receiving the final concrete shape. The soil would be bulldozed out. The basalt, except for the support columns, would cut and excavated down to the basement level.

Concrete is a versatile and stable building material and the second most widely used resource in the world (after water). Concrete can produce a lot of carbon during its manufacture. One of the most important factors is that cement, the main energy-intensive binding component of concrete, is made from crushed Limestone, one of the most common minerals found. Limestone is generally be harvested and processed locally, which reduces transportation costs. Alternatively, cement could be made wholly or partially from waste products from other production processes such as fly ash (waste from electricity generation), silica or slag (waste from steel manufacture), which could reduce its carbon footprint by 80 percent.

Despite its carbon costs, concrete has many advantages over wood or plastics. For instance, it is durable, and sustainable design and green building emphasize long-term solutions and products over cheap, short-term products that generate waste. Concrete can last for many times longer than conventional building materials, such as wood or drywall. It is resistant to insect activity, rot, rust, and fire. Concrete also forms airtight seals, which minimize drafts and reduce air-conditioning costs. Although concrete is naturally light-colored and can reflect light and heat, it will also take colors so its dark surfaces would absorb heat. Concrete

acts as a natural insulator and retains heat, which is useful in cold climates. It can absorb warmth from the sun and keep the heat inside.

The goals of sustainable design and green building are to reduce the negative impact of human actions by reducing, reusing and recycling. The use of fly ash or slag in place of cement results in a low-carbon intensive concrete used in Britain and Ireland.

On a global scale, concrete is the most commonly used material for building infrastructure. The manufacture of 1.5 billion tons of cement generates approximately 5% of global carbon emissions. Low-carbon concrete (LCC) could save over a billion tons of CO₂ emissions, billions of tons of quarrying, and thousands of years of electricity use. Like normal concrete, LCC offers fire resistance, sound and noise insulation, thermal mass, ease of construction, and availability. LCC, however, is stronger, more durable, and lighter in color than normal concrete. LCC can last twice as long in aggressive environments, such as those found on farms, in marine environments or under harsh climates. LCC shows greatly improved strength after fire, which can reduce the strength. Acids such as those found in farms and wastewater treatment plants cause deterioration of concrete. Previously developed sites may contain contaminants in the soil and ground water, which attack concrete, causing expansion and cracking that lead to accelerated deterioration. LCC improves the chemistry and reduces the porosity of the concrete, protecting it from sulfates. Salts on roads and in marine environments penetrate concrete, attacking the steel reinforcement and causing it to expand. This causes the surrounding concrete to crack, requiring repair and, ultimately replacement. Cracking and voids will lead to significant damage in your concrete. LCC has less cracking because of its chemistry, and has a much reduced void ratio than normal concrete.

The use of heavyweight construction materials with high thermal mass can reduce total heating and cooling requirements. Dense, cast concrete has the highest conductivity and heat capacity after water, higher than granite, block or clay, and much higher than plaster, timber, carpet, or fiberglass.

7.3.3.2.2. Surface sheeting

Most of the surface of the arcology would be native bunchgrasses. The concrete would be covered with thin plastic sheets from recycled materials.

The face of the apse would be concrete with many large glass windows. The very large windows would be—not standard glass, which would drain the building of heat—but new ‘Superglass Quad’ windows would reduce the energy costs. The super-insulated windows would consist of two standard glass panels, separated by two tough plastic sheets known as ‘heat mirrors.’ These four layers would create three spaces that were filled with krypton gas, which would prevent the formation of condensation on the glass and heat loss to the outside. Altogether, the windows would have a thermal insulation rating equivalent to a wall insulated with fiberglass bats (with an R-value of about 2.6).

7.3.3.2.3. Membrane Qualities & Insulation

The underground membrane would be impermeable, so that water could be collected and stored before it reached the local aquifer.

The face of the apse would allow exchanges of air and organisms through doors and windows. It would be a relatively open system, especially for bacteria and insects.

One important way to reduce heat loss is to build extremely well insulated structures.

Over 75% of the surface would be covered by over 3 feet of soil, insulating the arcology well, and keeping the internal temperature close to 55 degrees Fahrenheit the entire year. For the front of the structure, the use of commercially available insulating materials like the Thermalkool radiant barrier (which is paper thin and is rated R52) and other materials like Mylar would help greatly. Using these materials in alternating layers with air pockets between them may let the walls be rated at over R300 at less than one foot thick (a typical American home uses fiberglass insulation rated about R30).

7.3.3.3. Internal Structure

The footprint of the arcology would be a wide oval. The front elevation would be the apse of a large dome.

An arcology is a natural place to experiment with a new generation of products, for instance, tools that promote greater autonomy and decentralization, as well as better and smaller communication devices, which is already a trend in technology. Alternative energy sources could be used to power longer-lasting, higher-quality appliances and motors, built with benign manufacturing systems in an industrial ecology. The arcology itself would be a multiple-use building, which would be assembled from mass-produced, modular housing and automated paths, rails and roads, using recycled or biodegradable materials.

The structure would have a central light well, which would be fed by the thousands of light tubes interspersed with the native grasses. In the apse, much light would be allowed by the triple-glazed cladding. Utility shafts would be placed through the vertical solid interior support walls.

7.3.3.3.1. Support Structure

The arcology would be a massive dome structure made of concrete. Floors and walls would also be low-carbon concrete. The apse would cover an atrium surrounded by homes and businesses.

7.3.3.3.2. Modular units

Within the floors, homes would be modular, either manufactured on site or using factory processes. Either cubes or polyhedra, with electrical and plumbing connections built in.

7.3.3.4. Areas

In most proposed arcologies, the areas are zoned according to use, and this is reflected by room-size, utility density and other design features. Special areas for energy generation would not be necessary, since the use of micro-generators and collectors would fit on the internal and external walls.

7.3.3.4.1. Neighborhoods homes

Home size is expected to be on the European or Chinese model in terms of space, although the spaces would be very efficient. We know from studies of prisoners and animals, that crowding produces stress. To avoid the reactions of crowding, we need to design for varieties of spaces. Good designs can change behavior. Open neighborhood or public areas would meet the need for large open spaces.

A central tower 11 units tall for apartments (each unit 38 ft in diameter), and each unit would be trilevel.

Individual homes could display several kinds of wall and floor coverings. For example, lichens are one of the few plants to survive in Antarctica. Paint is traditionally used on walls, but lichen could be applied, and it would grow and change colors with time and season (Papanek lists 118 colors from Lichens). It would save on cost, labor and depreciation. It could be sprayed on with a nutrient solution; it may be patchy at first, as well as shaggy (1.5 inches).

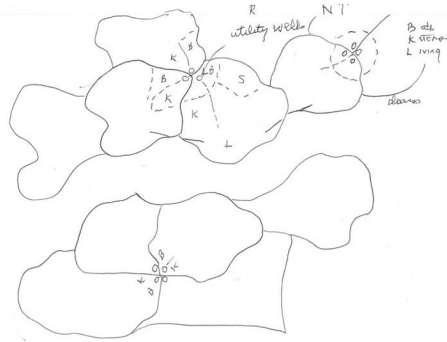


Figure 73341-1. Detailed cloverleaf mid-level floor plan

7.3.3.4.2. Neighborhood public areas

Public areas would be sized according to the floor population, such that there would be a public area for every 250 people.

7.3.3.4.3. Neighborhood stores

In the beginning, the arcology would contract with businesses for small stores for every neighborhood for basic clothing, tools and foods.

7.3.3.4.4. City public

The top level would have a large area for public meetings. The city would have one large sporting arena, although every school and some businesses would have smaller fields for sports.

The Palouse Indian nations governed their areas of the Palouse independently. Their political principles were similar: All land is communally owned by the tribe, although household goods may be personally held; all decisions were made by consensus in which everyone participated; chiefs were not coercive rulers, but teachers and leaders with specific duties limited to their realm—medicine, social, war, or ceremonies for example.

When the Europeans settled the area, they brought their centralized, representational government. The original goal of the American republic, according to Jefferson, was to make each person a participant in the everyday affairs of government.

The arcology would require more participation. Furthermore, the design of public areas would contribute to a more democratic style. It would be a governable size, with clearly defined boundaries. The arcology would specifically work to maintain a framework to represent the people, as well as the other beings in the ecological system, by reemphasizing the goals. Efficiency is less important than participation in good judgments.

The arcology would be a limited size from a calculate optimum, dedicated to protecting desired ways of life, while leveling extremes of wealth and paying all ecological and economic costs (See section 6.8.3.2. in *Redesigning the Planet: Regions*).

7.3.3.4.5. City Large stores, factories

Numerous small businesses have been established in small cities in the Palouse. Some of these might relocate to the arcology. The arcology commission might set up an incubator park for new businesses, and new businesses might serve the needs of an experimental city.

7.3.3.4.6. Food growing

Many fields would be planted in the areas surrounding the arcology. The area is agricultural land, with relatively few animal and plant species. Local food is industrial scale agricultural products, such as wheat, peas, and lentils.

Therefore, it is likely that some food will be grown inside, in greenhouses, either in media or hydroponically. Some areas may have tree or root crops. Individual homes may also plant herb or limited gardens.

A vertical farm would create 'closed loop agricultural' ecosystems, where nearly every aspect of the farming process is recycled and re-used, especially water and nutrients. This and some horizontal farm areas would solve the problem of inadequate expanses of fertile farmland. The Pyramid Farm offers a solution in the form of a complete self-sufficient ecosystem that covers everything from food production to waste management.

7.3.3.4.7. Recycling and Waste

Sewage from Moscow is treated in a natural wetland before joining Paradise Creek.

Internal sewage would be treated with the living machines as envisioned by John and Nancy Todd, and based on many of their suggested principles. The foundation of such a machine is microbial communities. But, the machine would also be a photosynthetic community, and a linked ecosystem with a variety of pulsed exchanges and nutrient reservoirs. They note that the system should have steep gradients for higher efficiencies of operation (for example large differences in pHs).

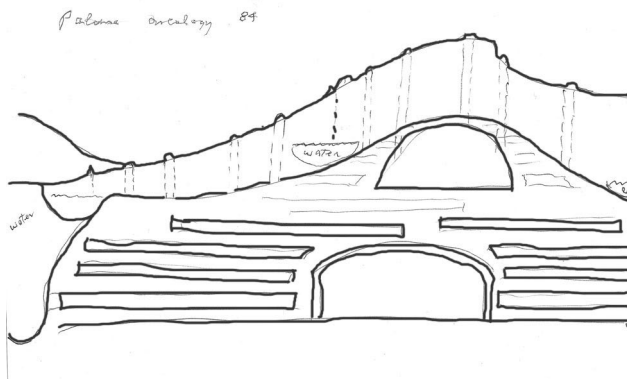


Figure 73347-1. Elevation cut-through showing air & water circulation / storage

7.3.3.4.8. Missing Areas: Roads & Parking

Roads are missing because there are no trucks or cars. Pedestrian paths are wide enough to handle carts, which would be used for deliveries of large items such as furniture, appliances, and large packages (food, clothing, or supplies). Large shipments to the arcology could be by train or truck with access from Highway 8.

7.3.3.5. Infrastructures

Light would come from the front apse, as well as from millions of light fibers interspersed with the covering grasses; this would avoid the need for too many light wells to get light to the interior.

At first, water would be imported from the local aquifer, but after establishment, rain and snow would be collected to make up for interior water losses. Water could be collected from roof level cisterns or from moisture evaporators that take it out of the ambient air. Water might be a problem, since the Palouse has limited rainfall (under 20 inches). Grey water could be used for flushing and irrigating. Water might have to be rationed at times, depending on the efficiency and speed of recycling.

Emergency services would be provided by specialists, given the conditions and isolation of the arcology.

Transportation is an important part of any city. Due to its unique setting, no private automobiles would be allowed in the arcology.

The main terminal on the southwest side of the structure would connect the arcology to the local port. Mag-lev lines would take travelers from the port and from the main station to local stations within the building. Inside the building, travelers, residents, employees, and visitors would shift from mass transit to local elevators. These would primarily operate within public spaces throughout the interior. Within vertical neighborhoods, vertical circulation would be enhanced by extensive use of escalators. Pedestrian movement is aided by escalators, diagonal or spiral escalators, moving sidewalks, elevators, electric conveyances, and bicycles.

Service transportation is provided between floors and in construction yards, warehouses and distribution depots. Freight elevators handle construction materials and large goods, furniture and appliances.

7.3.3.5.1. Horizontal Movement

Paths of various lengths and widths would connect all the areas of each neighborhood. A limited number of moving sidewalks would transportation for the elderly or handicapped.

7.3.3.5.2. Vertical Movement

Vertical, for light, air, interior vistas, travel. Vertical movement would connect upper and lower floors. Five elevators per floor would be located in the vertical structures. Stairways would be located in three areas near the perimeter.

7.3.3.5.3. Utility cores & Air/water Systems

Utility cores would be bunched for efficiency. Airflow and controlled temperature are handled by interior ventilation systems using the Chimney effect (hot air rises).

7.3.3.5.4. Energy Generation

Passive solar heating would be adequate for individual buildings. Electricity would be generated from microsolar collectors in paint rather than from large solar panels. Solar energy might also support hydrogen conversion. Microwind turbines would be built into openings and windows. The arcology would be the highest local hill, which would maximize air flow through the city. Services, such as electricity and water, would radiate out from a central core.

Most residential areas would be intermingled with small businesses and recreation. Light and possibly some heavy manufacturing would be confined to lower levels (in spite of the cultural influence of science fiction stories about underground manufacturing).

Some built-in features of the building itself, from generators from falling water and excess heat (body and thermal), would supplement grid energy. In general, the thermal mass and airflow design of the structure would allow significant conservation of energy, lowering the requirements from fossil fuels.

The design of the structure puts an emphasis on the pedestrian, saving the fossil fuels that would normally power automobiles. The three-dimensional, multiuse design puts the pedestrian within walking distance of most functions, allowing residents to live, work and learn in a densely-packed, lively space. Close access to wild nature gives residents limited recreational opportunities without personal vehicles. Food production in the greenhouses would save fuel by eliminating much trucking of food to the city.

Alternative sources of energy production for the reduced needs of the residents include solar panels with photovoltaic cells on the external glass, which could occupy 500,000 square feet and produce 10 megawatts of low voltage electricity per hour for use in low voltage lighting throughout the building.

Windmills also located to the east of the arcology could produce 10 megawatts of electricity every hour of the operation. A field of solar power generators, 3000 Genset hydrogen conversion units near the south face could take advantage of even low light to produce 100 megawatts of electricity per hour, the bulk of the household electrical needs in the arcology. The structures ventilation system takes full advantage of both rising warm air and sinking cool air, the chimney effect.

7.3.3.5.5. External grid

Most of the regional electricity is produced with waterpower, although some cities and towns have coal-powered plants also. During the development phases, the arcology would participate in the regional grid.

7.3.3.6. Context in Regional Design

The arcology exists in a physical and ecological context, and also a social and political context. The regional design of the Palouse includes the numbers of roads developed to reach farms and businesses, as well as other cities and towns. Because people would expect to use cars to reach the arcology, parking would either have to be arranged at the arcology or in neighboring cities, with bus or rail service to the arcology. A conscious decision was made to eliminate all parking from inside or around the arcology. Moscow or Pullman, for example, would be allowed to decide to 'host' cars and to provide transportation to the arcology (which would provide opportunities for local businesses).

7.3.3.6.1. Cultural

The location of the arcology midway between two traditional towns, each with a land-grant university, would allow the towns to remain relatively small with traditional kinds of housing and buildings. It has been projected by several groups that eventually the towns would grow together as they expanded. The arcology would allow town limits to be made explicit and smaller. The arcology would be larger than either town, with a final size of 50,000 residents.

There have been two cultural patterns on the Palouse. An archaic one that offered tribal egalitarianism and limited impact and a technological one based on republican democracy and industrial consumption. The first could not compete against the second, but it has not been completely eliminated either.

7.3.3.6.2. Transportation regional

The main entrance would be from Highway 8, through a south-facing apse, which would allow good light in summer and winter. The entrance would face the highway and Paradise Creek on the other side of the highway. The biking trail in the Creek area would be moved to the opposing ridge, where the old Moscow-Pullman highway exists.

The old train tracks were replaced by a bicycle/running path in the later 1990s. Part of the local project (proposed in 1990) would be to remove the infrastructure for the path and restore Paradise Creek. A light rail and running path would then be built on the north side to minimize erosion. The light rail would connect Moscow and the arcology with Pullman and could handle the bulk of deliveries and commuting.

7.3.3.6.4. Wilderness location

Most of the grassland has been converted to agricultural production. There are a few remaining areas of the original grasslands, in research study areas. There have been proposals for larger restorations and for one very large restoration. Large wild areas, especially wild rivers and montane areas, can be reached within a day of travel.

The fields and networks of roads offer recreation with motorized vehicles, especially in winter.

7.3.3.6.5. Communications

Inside the arcology, communications would be supported by wired or wireless networks. External communications would depend on satellite coverage and connections.

7.3.3.6.6. Resources

The Palouse has large deposits of basalt. Other rocks are present: sandstone, siltstone, granite, limestone, and diatomaceous earth. A number of metals can be found and extracted: gold, magnesium, and copper. A few others are accessible: lead, zinc, tungsten, manganese, iron, magnesium, and nickel. The most common are zinc (24 million metric tons) and iron (10 million metric tons). There is some oil and natural gas, but not enough to currently keep the region going for even a year.

The Palouse has sunlight, water, and wind; it also has small amounts of gas and oil, but not nearly enough to provide energy to residences and industries. There is some coal, and it is being mined (24 trillion Kcal). Hydroelectric power is well-developed. Wind and solar energy are very abundant but not very well-developed (about 2 trillion Kcal). Power is available from several nuclear power stations (15 trillion Kcal). The research and production of nuclear energy has resulted in over 20 hazardous waste sites being located in the Palouse. So far, over half of the energy production in the Palouse—that from water power—is intermediately renewable (184 trillion Kcal). The big difference between energy resources and energy use is the quantity of imported oil (172 trillion kilocalories).

7.3.3.7. Discussion of the Palouse Hill Arcology

Palouse arcology is partly underground, with similarities to a termite mound, which is often deeper than it is tall. Design makes sure that it is integrated into the landscape, literally, and will not interfere with wind patterns or animal plant and insect migrations. It would be built with basalt, acquired from beneath. Heroic public areas, including meeting areas and large park areas, would be centrally located and near the entrance.

Investigating forms, Victor Papanek suggested that only one shape can make a stable, fully three-dimensional integrated space grid possible, a tetrakaidecahedron, a 14-sided polyhedron with 8 hexagonal sides and 6 square faces. It is rounder than a cube and squarer than a sphere. It resists pressure between the two. A cluster of 30 could make a suboceanic station, a space station, or a cluster within floors of the pyramid. The modular polyhedra could have curved ceilings inside. Curved spaces may have psychosomatic effects on the residents, which will benefit their health.

Greater attention is given to the human scale in an Arcology. Pedestrian distances are measured by walks and in minutes. Other wheeled vehicles, such as bicycles or battery-powered carts, could be available for delivery or recreation. Greater attention is also given to the role of technology. Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, the result is disappointing and does not compare well with traditional methods, using draft animals and human labor (Wittbecker, 1976). There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. We need an ecological awareness at all levels, a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; we may have to legislate limits or induce adherence with economic incentives, if awareness and reasoning are not enough.

The goal of planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in agriculture, and self-limitation in size and desires. If human patterns were based on mature ecosystems, civilization would be far more complex; human values would allow for the welfare of humans, animals, plants, and land. We have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for ourselves.

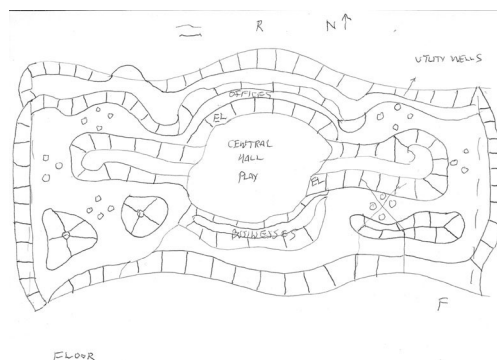


Figure 7333-1. Detail of Main Floor of Palouse Arcology

7.3.3.8. Conclusion: Palouse Hill Arcology

The Palouse arcology would be a self-contained habitat of reduced size, with access to the surrounding common areas and a wilderness restoration. As a single structure, it would integrate the fundamental components of life—dwelling, eating, learning, working—into a frugal form, while accepting a certain amount of ambiguity and disorder. It would be a laboratory for doing and learning, tested through experience, and tempered by the opportunity to fail.

The city has been the most active and dynamic outlet of human life. Soleri refers to the city of the future as an arcology to remind us that a well-built city is always ecological architecture. But, for him it is also the fundamental instrument in the transformation of matter into spirit. The arcology would create a synergy between habitat and nature, body and spirit, and work and leisure. It would generate the urban effect more intensely, which would energize the inhabitants.

The principles of an arcology, from using marginal land and imploding spread to habitat density to internalizing and miniaturizing the urban effect and linking the habitat, energy and environment, serve as a model for a stable, exciting construct. The creation of an arcology in the Palouse would reduce pressure on the landscape from conversion and development.

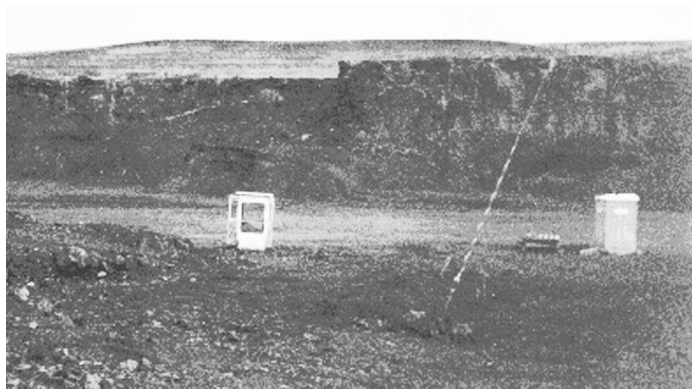


Figure 7338-1. Highway 8 basalt pit proposed as the Palouse Arcology Site.

7.3.4. *African Fractal Mountain Arcology*

Paolo Soleri notes that, as a human product, architecture has to be redefined and reconceptualized, to be as antimaterialistic as the environment itself, created with scientific/religious collaboration. With Soleri, the city becomes a global feature on a planetary scale. An arcology is a proposal for a habitat for living in uncertain times and conditions. An arcology is also a construction process for the ecological city as well as a process for internalizing and transfiguring the world. A city's vitality as an aesthetic phenomenon depends on abstract and concrete elements: Miniaturization, equity, harmony, centralization, chance, complexity, compactness, frugality, the sacred, and integration. In fact, these properties are similar to those detailed for ecological design (See earlier sections in this book).

An arcology is a large dramatic structure that promotes a rational way of life. The concept of a one-structure system is not incidental to the organization of the city, but is central to it, according to Soleri. Such an urban structure hosts life, work, education, and culture in a dense, compact system that is interleaved with domestic and wild landscapes. The compactness of an Arcology leaves ninety percent more land for farming and conservation.

The African Fractal Mountain Arcology is a fusion of three conical masses over three peaks of a mountain range. The peaks would support the connected cones. The overall volume would be less than that of solid cones, but parts of the mountain would be tunneled from the arcology, resulting in interpenetrating spaces such as caves and tunnels.

7.3.4.1. General description of Arcology For 100,000 Residents

The cone shape has a long history. Teepees were cone shape, as were wigwams built by the Micmacs and Sacramento people; these latter were made from wood rather than hide. Whitewashed stone conical buildings, called trulli, were built in southernmost Italy. In Sardegna there are over 7000 conical buildings dating back to 1800 BC. Conical buildings, like the treasury of Atreus, were constructed in Mycenae, about twenty feet wide and fifty feet high, then covered with rock. Thatched conical buildings were built as recently as the 1940s as government buildings in Kenya. The Telem pygmy people in Africa built cone shaped houses with thatched roofs and carved wooden doors. Oast houses in southwest England were conical. Eduardo Souto de Moura completed the Paula Rêgo Museum in 2008, a complex of sienna-hued conical buildings to honor the Portuguese painter.

The African Fractal Mountain Arcology is an attempt to colonize a difficult, inhospitable site with a single integrated ecological city, using traditional forms. The city takes advantage of the mountains for support and exposure to light and wind.

7.3.4.1.1. Site

Although South Africa is generally semi-arid, it shows variation in climate as well as topography. South Africa has seven major terrestrial biomes, broad ecological life zones with distinct environmental conditions and related sets of plant and animal life.

The eastern coastline is frost-free, lush and well watered. The southern coast is less tropical but also green, as is the Cape of Good Hope. The southwestern corner of the country has a Mediterranean climate, with wet winters and hot, dry summers. The wind blows intermittently all year round, from the southeast or the northwest.

The great inland Karoo plateau runs from sparse scrubland to rocky hills and mountains. The plateau is very dry, and gets drier as it extends northwest towards the Kalahari Desert.

It can be icy in winter, despite its extreme summer dryness. The western section of the Karoo extends into the flat landscape of the Free State, which receives more rain.

North of the Vaal River, the Highveld is better watered, and has fewer subtropical extremes of heat. Winters are cold. Further north and to the east, the Lowveld experiences higher temperatures (the Tropic of Capricorn touches the extreme north). This landscape has been called typical South African Bushveld.

The high Drakensberg Mountains form South Africa's eastern escarpment. In some places, notably the province of KwaZulu-Natal in the east, the escarpment is further from the coast. The Drakensberg Mountains (or the Zulu uKhahlamba, the Barrier of Spears) are 200-kilometers long. The largest proportion of the Drakensberg area falls in the province of KwaZulu-Natal. The Drakensberg Mountains (Dutch Voortrekkers called them the Dragon Mountains) form a massive barrier separating KwaZulu-Natal from the Kingdom of Lesotho. The mountains are surrounded by riverine bush, yellowwood forests and waterfalls. The uKhahlamba-Drakensberg Park covers 938 square miles. The park preserves biological diversity. The San people or Bushmen made and left tens of thousands of paintings depicting their daily life on the rock faces. In 2000, the park was declared KwaZulu-Natal's second World Heritage Site.

The elevation of the mountains is over 9000 feet. The width of typical mountains there ranges from 1000 to 9000 feet. The mountain range is basalt over a sandstone base. Features include waterfalls and caves.

The climate is warm temperate, although the elevation of the plateau allows temperatures to go below freezing. The deep interior has temperatures over 100 degrees F. The average annual rainfall (464 mm) is only about half the world average. Most of the rain falls in the summer. Weather is relatively unpredictable in the mountains, with thunderstorms, and mist in summer and snow and ice in winter.



Figure 73411-1. Site of the African Fractal Mountain Arcology

7.3.4.1.2. Populations

The city is designed for a large human population that would be surrounded by wild plants and animals within the building, as well as by domesticated annuals and plants. The outer environment would not be available for agriculture or gardens, although it could offer limited cold weather recreation. The numerous research stations could be better supported from the arcology, which would reduce separate efforts to stock the sites from home nations.

7.3.4.1.2.1. Human Population

The arcology is designed for 100,000 human residents. Most of the residents would be immigrants from rural areas. The core would start from professional politicians and business people.

Soleri notes that the intensity of life in an arcology could be overwhelming with the sheer human magnitude, but that this possibility is diminished by the design of neighborhoods and the positive nature of the Urban Effect. Semi-self-sufficient, three dimensional and overlapping, these areas include housing with amenities and necessities. Schools, parks, retail stores, cafes, offices, and other complex components of the city would distribute and absorb the daily flow of people.

About one-third of the population would participate in public work or service activities during daylight hours. With another third of the inhabitants at home, involved in home life or home work and thus out of the flow, and another third traveling to other areas for agriculture or research, human movement display a rhythmic pulse.

7.3.4.1.2.2. Animal & Plant Populations

The slopes of the Drakensberg Park have 290 species of birds, 48 species of mammals, and rare varieties of plant life. The Drakensberg is considered the 'soul' of the Zulu Kingdom. Elands abound literally. There are three endemic frogs in the streams. Birds also find refuge in the mountains: Bearded vulture, black eagle, and grey rhebok. Other mammals include jackal, leopard, caracal, serval, spotted neck otter, porcupines, rock hyrax, and chacma baboon. The mountains are home to 25 species of amphibians, 18 species of lizard (six endemic), and 21 species of snake.

The vegetation is Afro-montane in the lower foothills, characterized by open grass with protea bushes on north slopes and thick bush or forests on the south. Alpine meadows are colored by yellow irises.

Decorative plants could be grown throughout the structure, in private or public areas. Larger numbers of plant crops could be grown horizontally or vertically. Companion animals in limited numbers would live mostly in private areas. Small numbers of domestic animals, such as small pigs or sheep, might also be kept in private areas. A number of larger animals, such as cows or camels, could be kept in special areas with grasses and vegetation. Animals would be limited due to the costs of feeding and keeping them.

7.3.4.1.3. Design

Natural shapes, such as mountains, were referred to as "rough cones" in Euclidean geometry. Computer graphics can now create fractal synthetic terrain models. Complexity results from the repetition of a form over a variety of scales, leading to the concept of a fractal dimension, which is a spatial dimension intermediate to the more familiar integer-valued dimensions based on 1, 2 or 3. Most fractal terrains are based on a fractal function called fractional Brownian motion, which is simply a sum of randomly phase-shifted sine waves, and which jagged trace resembles the skyline of a mountain range. Mandelbrot reasoned that extending the function to two dimensions would result in a surface resembling mountainous terrain. Observation of natural mountains often reveals natural geometric fractals.

The African Fractal Mountain Arcology is designed as three right circular cone shapes fitted over three mountain peaks. The peaks support the cones and allow the arcology to

expand inside the peaks through tunnels and caves. The arcology is designed to collect sunlight and water in large quantities. Areas below the bottom of the cones is brought into the arcology through the use of cloth/plastic sheets that would cover fields or terraced fields on lower mountain slopes.



Figure 73413-1. Drawing of African Fractal Mountain Arcology

7.3.4.1.4. Spaces

The arcology would require an internal floor area of 208.76 million square feet and a volume of over 2.2 trillion cubic feet. The base footprint would be relatively small at 6.3 million square feet (145 acres), with 50 stories. Each second story would penetrate into the mountain. The arcology would share design motifs with other pyramidal shapes (a pyramid with a circular cross section).

Density would be 717 persons per acre. The maximum height of each cone would be in the range of 700 feet. The radii of the three cones would range from 500 to 1000 feet. The height would be divided into 50 stories.

Table 73414-1. City Space Division

<i>Spaces</i>	<i>Area (in square feet)</i>	<i>Percentage</i>
Living space	62,628,000 sq ft	30%
Public/commercial space	10,646,760	17%
Civic functions		
Commercial		
Public circulation services	14,404,440	23%
Utility		
Paths/rails		
Food-growing space	11,273,040	18%
Parks/wild	7,515,360	12%
Total Area	208,760,000	100%

Over 30 percent of interior space is housing, forming neighborhoods within floors. An additional 17% is commercial space including retail stores, offices, restaurants, grocery stores, and production facilities. Additional office space may be developed in the center as part of the housing area. About 5% is reserved for administrative or civic use, distribution centers and convention facilities. And, another 5% houses utilities and construction yards at eight levels.

Green space for food growing covers about 18% of the total area; some food could be grown on the lower slopes of the mountains. Parks cover 12% of the total area, divided equally, mostly on the outer areas; that area is reduced because of the outdoor opportunities in the environment. These areas include various environmental uses and provide open, public streets and parks. A surprisingly larger percentage, 23 percent is devoted to public circulation services, due to the complex shape of the arcology, based on existing mountain peaks. The public and commercial spaces would occupy 17% of the total area, and include cultural zones comprised by schools, medical facilities, day care centers, theaters and art facilities. And, 10% of that area would be allocated for cultural zones is underground and specifically designated as a Virtual Reality recreational park, similar to what Soleri proposed for his Hyper Building.

The percentage set aside for parks is about average with most cities (good cities usually set aside 10-15% of their area). Deciding how much area to set aside for food-growing is difficult, as most cities trade and import their food, much of which, like wheat, corn, melons, or tomatoes, require large areas; however, for greenhouse, hydroponic, or small truck gardens, 18% should be enough.

The figure for circulation is a hybrid figure, since many utilities can be underground. Using alternative technologies, perhaps 1-5% of the area is needed for electricity generation, much of which would be the surfaces of other structures.

Sophisticated public transportation would be built in; individual transportation would be limited. In a modern city such as Los Angeles, 59 percent of the ground area is dedicated to streets and parking (other cities such as Detroit, Chicago and Dallas use 48-41 percent). By comparison, traditional walking cities were always more compact; the arcology simply eliminates cars, trucks, buses, and trains. However, walking paths, sidewalks, as well as light rail and escalators are expected to take up 5-7% or more of the total area, due to the unique shape of the arcology.

Areas set aside for civic and commercial functions are relatively generous. Most of the entire population of the arcology, as well as external workers or visitors would be ‘housed’ in these areas for 8-11 hours per day. Assuming that each business had 3-9 employees, perhaps as little as 3-5% of the area would be reserved for commercial enterprise.

Civic functions would also be relatively dense and so require less space over shorter times. This would be for public meetings, city meetings, celebrations—but it would also be for heroic meetings or presentations, so the spaces would need to be larger and more dramatic, perhaps 4-10% of the area.

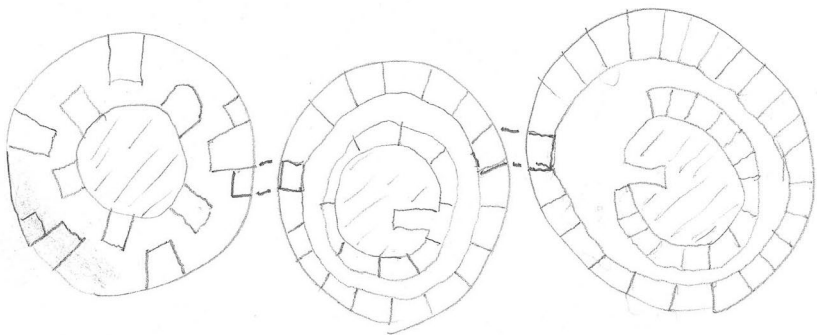


Figure 7341-1. Areas & Floors of the African Fractal Mountain Arcology

7.3.4.2. *External*

The structure would be cones with roughly circular bases. The external surface would be a curtain wall of plastics, glass, films, and stone. Stone might be used to the impression of solid security above the base of each floor. Some of the films would be designed to shade the interior in direct sunlight. Special plastic forms would operate as nictitating membranes admit or reflect light.

7.2.3.2.1. Building process

The structure would be constructed as a skyscraper, using construction cranes to add stories from the bottom. The frame of the building would be steel anchored in the mountain and extending to the walls of the cones. The steel frame of the building would be clad in 6 inches of fire retardant, fiber composite insulation panels.

A phased construction sequence would allow limited operation of completed sections as construction continued. Phase One, the base level, would extend from the roughly circular ring to 200 feet high. It would include the structural base of each cone. Phase Two would continue into the mountains at points. Phase. Three would finish each cone to approximately 700 feet high.

Because of the size, bulk, and complexity of this project, an automated robotic building technology, which continues to evolve as technology develops, would be used. Construction would move up the building on a 'sliding' construction platform, operating much as slip form construction does (perhaps similar to the Luxor Hotel in Las Vegas).

Foundations and floors would be made of concrete. Concrete is a versatile and stable building material and the second most widely used resource in the world (after water). Concrete can produce a lot of carbon during its manufacture. One of the most important factors is that cement, the main energy-intensive binding component of concrete, is made from crushed Limestone, one of the most common minerals found. Limestone is generally be harvested and processed locally, which reduces transportation costs. Alternatively, cement could be made wholly or partially from waste products from other production processes such as fly ash (waste from electricity generation), silica or slag (waste from steel manufacture), which could reduce its carbon footprint by 80 percent.

Despite its carbon costs, concrete has many advantages over wood or plastics. For instance, it is durable, and sustainable design and green building emphasize long-term solutions and products over cheap, short-term products that generate waste. Concrete can last for many times longer than conventional building materials, such as wood or drywall. It is resistant to insect activity, rot, rust, and fire. Concrete also forms airtight seals, which minimize drafts and reduce air-conditioning costs. Although concrete is naturally light-colored and can reflect light and heat, it will also take colors so its dark surfaces would absorb heat. Concrete acts as a natural insulator and retains heat, which is useful in cold climates. It can absorb warmth from the sun and keep the heat inside.

The goals of sustainable design and green building are to reduce the negative impact of human actions by reducing, reusing and recycling. The use of fly ash or slag in place of cement results in a low-carbon intensive concrete used in Britain and Ireland.

On a global scale, concrete is the most commonly used material for building infrastructure. The manufacture of 1.5 billion tons of cement generates approximately 5%

of global carbon emissions. Low-carbon concrete (LCC) could save over a billion tons of CO₂ emissions, billions of tons of quarrying, and thousands of years of electricity use. Like normal concrete, LCC offers fire resistance, sound and noise insulation, thermal mass, ease of construction, and availability. LCC, however, is stronger, more durable, and lighter in color than normal concrete. LCC can last twice as long in aggressive environments, such as those found on farms, in marine environments or under harsh climates. LCC shows greatly improved strength after fire, which can reduce the strength. Acids such as those found in farms and wastewater treatment plants cause deterioration of concrete. Previously developed sites may contain contaminants in the soil and ground water, which attack concrete, causing expansion and cracking that lead to accelerated deterioration. LCC improves the chemistry and reduces the porosity of the concrete, protecting it from sulfates. Salts on roads and in marine environments penetrate concrete, attacking the steel reinforcement and causing it to expand. This causes the surrounding concrete to crack, requiring repair and, ultimately replacement. Cracking and voids will lead to significant damage in your concrete. LCC has less cracking because of its chemistry, and has a much reduced void ratio than normal concrete

The use of heavyweight construction materials with high thermal mass can reduce total heating and cooling requirements. Dense, cast concrete has the highest conductivity and heat capacity after water, higher than granite, block or clay, and much higher than plaster, timber, carpet, or fiberglass. The native basalt could be used in large blocks for vertical building within the cones.

7.3.4.2.2. Surface sheeting

The façade would be glass and stone colored black. Glass of course is a fluid mosaic, with molecules of other materials embedded. The membrane would have potential, that is, there would be differences in charges between inside and outside and between bottom and top, which might be used to generate electricity.

The very large conical window surface would be—not standard glass, which would drain the building of heat—but new ‘Superglass Quad’ windows would reduce the energy costs. The super-insulated windows would consist of two standard glass panels, separated by two tough plastic sheets known as ‘heat mirrors.’ These four layers would create three spaces that were filled with krypton gas, which would prevent the formation of condensation on the glass and heat loss to the outside. Altogether, the windows would have a thermal insulation rating equivalent to a wall insulated with fiberglass bats (with an R-value of about 2.6).

7.3.4.2.3. Membrane qualities and Insulation

Membranes give shape to a structure. As a membrane, the glass and stone façade would be relatively impermeable, due to the climate to limit physical particles or air. There would also be a minimum of plants and animals that would penetrate the membrane. And, there would be a minimum of egress points, such as doors or balconies, which would be in secondary walls within the cones. Some parts of a cone might have large sliding glass triangles that would slide to open parts of the arcology to the outside. Essentially, the structure would be a closed system, and all forms of agricultural or wild spaces would be enclosed.

One important way to reduce heat loss is to build extremely well insulated structures. The use of commercially available insulating materials like the Thermalkool radiant barrier (which is paper thin and is rated R52) and other materials like mylar would help greatly. Using

these materials in alternating layers with air pockets between them may let the walls be rated at over R300 at less than one foot thick. By comparison, a typical American home uses fiberglass insulation that's usually rated R30.

Another way to further reduce heat loss would be to seal the buildings airtight. Preventing air and with it heat from escaping the structure would reduce the energy demands needed to heat it. This would, however, contribute to the problem of maintaining a constant fresh air supply. An air exchanger system, combined with a thermal energy recovery system through the use of Stirling engines, or another thermal energy conversion technology, could be used.

One system would be to have the cold fresh air intake shaft and the warm air exhaust shaft run parallel to each other with a number of Stirling engines sandwiched between them. The temperature difference between the cold outside air and the warm air from inside the buildings could be converted back into electrical power. Also, a small amount of the waste heat would be transferred through the plates on the Stirling engines, providing a small warming effect for the incoming air. This method could be used with large chambers to effect a single large air mass at one time rather than a shaft system. A chambered system could also allow for multiple stages of thermal energy recovery and air intake heating to occur further increasing the energy efficiency of the system.

If the underground structures were well insulated, it would enable the surrounding ground to remain frozen. This would increase the stability of the structures and tunnels with less bracing and support.

Individual homes could include a heat exchanger that would transfer the heat from stale air to fresh air being pumped in. The heat exchanger and a heating coil could warm incoming air and pump it to other areas.

7.3.4.3. Internal Structure

An arcology is a natural place to experiment with a new generation of products, for instance, tools that promote greater autonomy and decentralization, as well as better and smaller communication devices, which is already a trend in technology. Alternative energy sources could be used to power longer-lasting, higher-quality appliances and motors, built with benign manufacturing systems in an industrial ecology. The inside of the arcology itself would be a multiple-use building, which would be assembled from mass-produced, modular housing and automated paths, rails and roads, using recycled or biodegradable materials.

The structure would have a central light well, although much light would be allowed by the triple-glazed cladding. Utility shafts would be placed through the vertical solid interior support walls. Horizontal areas would be extended into the mountain by tunnels.

7.3.4.3.1. Support Structure

Although each structure would have 50 floors, each floor would have an atrium that would be at least 3 stories high, projecting into other upper floors.

Internal volumes, either spaces or enclosed spaces, would be modules for public spaces as well as neighborhoods of homes.

The steel sides of the cones would support many rooms, although the internal vertical elements, braced by direct foundations in the mountains, would allow heavier floor loads.

Carbon tubes would be used for some of the building, but especially for bracing. In

a building that size, a lot of carbon would be sequestered. Some of the tubes would be large enough to house utilities and transportation.

7.3.4.3.2. Modular units

Many home units would be manufactured as plug-in modules, either shaped as cubes or as a favored polyhedron. These could be built in other nations.

Frames for space volumes as well as subunits for research facilities or manufacturing areas would be modular.

7.3.4.4. *Areas*

In most proposed arcologies, the areas are zoned according to use, and this is reflected by room-size, utility density and other design features. Special areas for energy generation would not be necessary, since the use of micro-generators and collectors would fit on the internal and external walls.



Figure 7344-1. Side Elevation of the African Fractal Mountain Arcology

7.3.4.4.1. Neighborhood Homes

Home size is expected to be on the European or Chinese model in terms of space, although the spaces would be very efficient. It is known from studies of prisoners and animals that crowding produces stress. To avoid the reactions of crowding, we need to design for varieties of spaces. Good designs can change behavior. Open neighborhood or public areas would meet the need for large open spaces.

Individual homes could display several kinds of wall and floor coverings. Paint is traditionally used on walls, but the natural surfaces of metal, basalt and carbon may not require protection. Other materials, especially glass can be colored with mineral elements during manufacture. Of, course, here too lichen could be applied, and it would grow and change colors with time and season (Papanek lists 118 colors from Lichens). It would save on cost, labor and depreciation. It could be sprayed on with a nutrient solution; it may be patchy at first, as well as shaggy (up to 1.5 inches).

7.3.4.4.2. Neighborhood public areas

Public areas would be sized according to the floor population, such that there would be a public area for every 250-400 people. The areas would be distributed so that no living areas would be very far from a public area. In living areas and retail areas, the public areas would be larger than in support or industrial areas.

7.3.4.4.3. Neighborhood stores

In the beginning, the arcology would provide small stores for every neighborhood for basic clothing, tools and foods. Some of these stores would remain arcology businesses, although private ownership of others would be encouraged.

7.3.4.4.4. City Public Areas

The top of the cones would be reserved for special occasions. There would be permanent areas there for religious and social meeting purposes.

The arcology would require more participation than a traditional city. Furthermore, the design of public areas would contribute to a more democratic style. It would be a governable size, with clearly defined boundaries. The arcology would specifically work to maintain a framework to represent the people, as well as the other beings in the ecological system. Efficiency is less important than participation in good judgments.

The arcology would be a limited size from a calculate optimum, dedicated to protecting desired ways of life, while leveling extremes of wealth and paying all ecological and economic costs (See section 6.8.3.2. in *Redesigning the Planet: Regions*).

7.3.4.4.5. City Large Stores & Factories

There would be large stores for every three floors. Various trades or industries would be encouraged, to provide the requirements for the inhabitants, but people would be free to establish other businesses that might be profitable, such as small-scale entertainment, such as ballet, or even souvenirs of the arcology itself.

7.3.4.4.6. Food Growing

Due to the limits of the climate and site, very few exposed fields, if any, would be planted in the areas surrounding the arcology. The area is rough wilderness, with relatively few animal and plant species. Therefore, it is likely that food some will be grown on lower slopes, protected by a tent structure, in greenhouses, either in media or hydroponically. Some areas may have tree or root crops that could adapt to montane conditions. Individual homes may also plant herb or limited gardens.

A vertical (or steeply inclined) farm would create 'closed loop agricultural' ecosystems, where nearly every aspect of the farming process is recycled and re-used, especially water and nutrients. This and some horizontal farm areas would solve the problem of inadequate expanses of fertile farmland. The Conical Farm offers a solution in the form of a complete self-sufficient ecosystem that covers everything from food production to waste management.

7.3.4.4.7. Recycling and Waste

Sewage would be treated with the living machines as envisioned by John and Nancy Todd, and based on many of their suggested principles. The foundation of such a machine is microbial communities. But, the machine would also be a photosynthetic community, and a linked ecosystem with a variety of pulsed exchanges and nutrient reservoirs. They note that the system should have steep gradients for higher efficiencies of operation (e.g., large differences in pHs).

Metals, plastics and other elements would be recycled within the arcology. Much of the physical machinery would be designed to be broken down and reassembled. Waste heat, of

course, would be allowed to rise within the structures to heat upper volumes. Some kinds of waste could be broken down into elements; other kinds, such as plastics used to wrap foods or tapes, would have to be treated thermally or compressed by high pressure.

7.3.4.5. *Infrastructures*

The operation of the arcology would initially be managed by a special department of the national government or a new corporation or organization. In a similar way, all services would be provided initially by pre-organized groups. This would be for food and materials, as well as medical and educational services.

Grey water could be used for flushing and irrigating. Water might have to be rationed at times, depending on the efficiency and speed of recycling.

Emergency services would be provided by specialists, given the conditions and isolation of the arcology.

Transportation is an important part of any city. Due to its unique setting, no private automobiles or large vehicles would be allowed in the arcology. Much of the movement of large structures or modules would be accomplished by cranes. Local deliveries of appliances or pallets of food would be done with larger carts with standard wheelbases (not larger than the width of rail cars or golf carts).

The main terminal on the southeast side of the structure would connect the arcology to the local port on the Indian Ocean. Maglev lines would take travelers from the port and from the main station to local stations within the building. Inside the building, travelers, residents, employees, and visitors would shift from mass transit to local elevators. These would primarily operate within public spaces throughout the interior. Within vertical neighborhoods, vertical circulation would be enhanced by extensive use of escalators. Pedestrian movement is aided by escalators, diagonal escalators, moving sidewalks, elevators, electric conveyances, and bicycles.

Service transportation is provided between floors and in construction yards, warehouses and distribution depots. Freight elevators handle construction materials and large goods, furniture and appliances.

7.3.4.5.1. Horizontal travel (Walkways and Tunnels)

Paths of various lengths and widths would connect all the areas of each neighborhood. A limited number of moving sidewalks would provide transportation for the elderly or handicapped. Strictly pedestrian walks would be segregated from those for vehicles, which might be limited to certain times of day or night.

7.3.4.5.2. Diagonal Movement

Diagonal travel, on angled elevators and escalators, would connect the areas near the surface of the cones. Closer to the mountain, the angled elevators might have a spiral shape. Diagonal travel might be limited to the shell (where vertical is not possible) or wider public or ceremonial areas.

7.3.4.5.3. Vertical Movement

Vertical movement would connect upper and lower floors. Five elevators per floor would be located in the vertical structures between the mountain slopes and the cones. Stairways would be located in three areas near the mountain slopes.

7.3.4.5.4. Utility cores /Air & Water Systems

Utility cores would be bunched for efficiency. Airflow and controlled temperature are handled by interior ventilation systems using the Chimney effect (hot air rises).

7.3.4.5.5. Energy generation

One goal for the structure is to generate its own energy. Initially, the structure would depend on energy from fossil fuel. Solar collectors should be efficient in the local light regime, depending on their type (built in to the glass or in a surface treatment like paint might be very efficient). Wind generators can be large and external, but may not be able to provide enough energy for air-conditioning.

Some built-in features of the building itself, from generators from falling water and excess heat (body and thermal), would supplement grid energy. In general, the thermal mass and airflow design of the structure would allow significant conservation of energy, lowering the requirements from fossil fuels.

The design of the structure puts an emphasis on the pedestrian, saving the fossil fuels that would normally power automobiles. The three-dimensional, multiuse design puts the pedestrian within walking distance of most functions, allowing residents to live, work and learn in a densely-packed, lively space. Close access to wild nature gives residents limited recreational opportunities without personal vehicles. Food production in the greenhouses save fuel by eliminating much trucking or food to the city.

Alternative sources of energy production for the reduced needs of the residents include solar panels with photovoltaic cells on the external glass, which could occupy 500,000 square feet and produce 10 megawatts of low voltage electricity per hour for use in low voltage lighting throughout the building.

Windmills also located to the east of the arcology could produce 10 megawatts of electricity every hour of the operation. A field of solar power generators, 3000 Genset hydrogen conversion units near the south face could take advantage of even low light to produce 100 megawatts of electricity per hour, the bulk of the household electrical needs in the arcology.

The structures ventilation system takes full advantage of both rising warm air and sinking cool air, the chimney effect.

Small-scale, pre-sealed nuclear devices, perhaps five for the entire structure, could provide the basic power for heavy or industrial use.

7.3.4.5.6. External grid

The arcology might be connected to the energy grid from the south. Since this city is designed to use far less energy than a standard industrial city, the grid could provide adequate energy, especially during construction and start-up. But, in general, most energy should be provided on site and the grid be used for back up or for dissipating excess energy.

7.3.4.6. *Context*

South Africa is a sophisticated, growing nation, where cultures have mixed and industrial modes of transportation and communications have replaced traditional ones.

7.3.4.6.1. Cultural

The culture of South Africa is based on several native and recent immigrant cultures. The area is also influenced by crude forms of global culture. Some extensions to the culture may be developed in the arcology, given that all inhabitants would be cultured individuals from other nations or cultures.

7.3.4.6.2. Transportation Regional

Most transportation into the continent is by ship or air. There are formal permanent highways or rail throughout the country. With the establishment of an arcology, several short, permanent roads may connect with the grid. The arcology should be connected to an oceanic port by a permanent road (that would limit traffic over sensitive areas).

7.3.4.6.3. Communications

Inside the arcology, communications would be supported by wired or wireless networks. External communications would depend on satellite coverage and connections, as well as fiber optics, and wired communications.

7.3.4.6.4. Resources

South Africa has numerous mineral resources: Platinum, gold, chrome, manganese, zirconium, vanadium, and titanium; the first four account for over 70% of export income. Diamonds are also mined. Coal and gas support various industries, including energy, water services, metallurgical services, and engineering; almost 98% of cement is produced locally.

Organic resources include wild reserves and many domesticated agricultural areas that produce citrus, sunflowers, wine, apples, pineapples, and bananas. Animals raised include cattle, sheep, and ostrich.

7.3.4.7. *Discussion of the African Fractal Mountain Arcology*

The cone has a relatively large surface area, compared to a sphere, for its enclosed volume. In this location, the larger surface area is necessary to capture more solar energy. The shape may be kinder for presenting openings to light and air. Although there are seasonal variations, especially regarding light, the overall climate is temperate.

Greater attention is given to the human scale in an Arcology. Pedestrian distances are measured by walks and in minutes. Other wheeled vehicles, such as bicycles or battery-powered carts, could be available for delivery or recreation.

Greater attention is also given to the role of technology. Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, the result is disappointing and does not compare well with traditional methods, using draft animals and human labor (Wittbecker, 1976). There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. We need an ecological awareness at all levels, a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; we

may have to legislate limits or induce adherence with economic incentives, if awareness and reasoning are not enough.

The goal of planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in agriculture, and self-limitation in size and desires. If human patterns were based on mature ecosystems, civilization would be far more complex; human values would allow for the welfare of humans, animals, plants, and land. The arcological form encourages mature complexity. We have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for ourselves.

7.3.4.8. *Conclusion: Iconic Self-containment*

The city has been the most active and dynamic outlet of human life. Soleri refers to the city of the future as an arcology to remind us that a well-built city is always the result of ecological architecture. But, for him it is also the fundamental instrument in the transformation of matter into spirit. The arcology would create a synergy between habitat and nature, body and spirit, and work and leisure. It would generate the urban effect more intensely, which would energize the inhabitants.

The African arcology would be a self-contained habitat of reduced size, with access to the surrounding wilderness. As a single structure, it would integrate the fundamental components of life—dwelling, eating, learning, working—into a frugal form, while accepting a certain amount of ambiguity and disorder. It would be a laboratory for doing and learning, tested through experience, and tempered by the opportunity to fail.

The principles of an arcology, from using marginal land and imploding spread to habitat density to internalizing and miniaturizing the urban effect and linking the habitat, energy and environment, serve as a model for a stable, exciting construct. The creation of a world arcology as the living headquarters of the United Nations on a separate continent is an important first step to converting the spread of urban growth into intense, rational settlements.



Figure 734-2. Coastal area near African Fractal Mountain Arcology

7.3.5. *Arcology Phoenix & the Campaign to Build America's First Arcology*

By Doctress Neutopia

7.3.5.1. *Arcology Phoenix*

We have mortally wounded this sweet life-supporting planet—the only one in the whole Milky Way—with a century of transportation whoopee. Our government is conducting a war against drugs, is it? Let them go after petroleum. Talk about a destructive high! You put some of this stuff in your car and you can go a hundred miles an hour, run over the neighbor's dog, and tear the atmosphere to smithereens.

Kurt Vonnegut

From the documentary film, *Making Sense of Place—Phoenix: The Urban Desert* there is much to learn about what the future could hold for this region of the world if developers continue to bulldoze the precious Sonoran Desert. The film's narrator stated that within the next ten years, Phoenix will draw one million new people.

At the time the 2003 film was made, one acre per hour of desert land was being bulldozed to build houses, roads, and shopping malls to accommodate this massive growth. There were 3,300 new homes per month being built and 150 lane miles of road being constructed each year. As soon as highway lanes are added, more lanes are needed to deal with increasing traffic. Phoenix is a car-dependent city, which, of course, means it is a city dependent on foreign oil.

Phoenix now has a total of 3.3 million people making it the 6th largest city in the United States. Within the last ten years it has had a 45% increase in population. To cover all the water requirements of this megalopolis, a canal system was engineered to divert 1/8 of the Colorado River for its needs. Even though urban growth seems limitless, the resource of water is not. But the limited future of that resource doesn't seem to phase developers, and the politicians who support them, as colossal growth continues.

What attracts people to Phoenix is partly its sunny climate and the advertisement of developers like Del Webb who have manufactured a lifestyle of "resort style desert living" as part of their marketing propaganda. Using marketing research, they found that most people everywhere want the same things: good schools, quality parks and fun things to do. Their strategy is to draw people to their development by selling an "enhanced piece of shelter." They do not just build houses, they build communities. Their newest development, Anthem, has 50,000 homes built on virgin desert, and is 35 miles from downtown Phoenix.

Such development on the fringe of the city is called leapfrog development. Developers go where the land is cheap. They get subsidies from the government for the cost of building the infrastructure needed to construct communities in new areas of desert. Since the federal and state governments also subsidize water costs, water bills are still misleadingly low for this arid environment. And since migrant labor is inexpensive in Arizona because of the illegal Mexican labor force, developers can continue to build and make huge profits. In developments like Anthem, golf courses are designated as open spaces. People move from parking garage to parking garage, commuting an average of two hours a day, never having time on a daily bases to get in touch with the desert.

Like every megalopolis in the United States , greater Phoenix is composed of a number of cities that have grown into one another. Phoenix is actually a patchwork of 25 municipalities. Even though there is need for regional consensus on how to deal with the problem of titanic growth, there are territorial conflicts and self-interest that arise from the 25 different cities. Terry Goddard who was mayor of the City of Phoenix from 1984-1990, said “There are more and more elected officials saying . . . not ‘no to growth,’ but no to the way we are growing, and yes to a look at what our other options are. And that means, I believe, more cooperation between the cities - and we’re seeing some - and ultimately some kind of an over-arching planning process. We can’t do that as 24 [25] warring communities.” But what exactly are the ‘other options’ that could give us an over-arching planning process?

When Arizona became a state in 1912, it set up State Trust Lands with the purpose of selling land to fund public education as a secure source of income in the future. Then, land was viewed as a commodity, dirt to be used for development. Now many believe the State Trust Lands should not be sold to developers, but should be bought for open space and valued for its desert beauty. Environmentalists and Native Americans argue that the human spirit needs such connection with the wilderness as much as the animals and plants need the land protected for their survival. Such sentiment was reflected when a referendum was put before citizens and 80% voted to increase sale taxes for funds to buy land for open space.

Even though the Sonoran desert is the second most diverse ecosystem in the world after the rainforest, housing patterns continue to ruin the land. People want direct access to the Sonoran desert and this pushes developers to seek land on the city’s edges to give home owners the open space vistas that they want. But what happens, of course, is that since everyone wants this connection with the desert, the fringe eventually becomes new suburbs with traffic jams. Thus, everyone loses the natural treasure. Architectural critic Howard Kunstler writes in *The Geography of Nowhere*, “Eighty percent of everything ever built in America has been build in the last fifty years, and most of it is depressing, brutal, ugly, unhealthy and spiritually degrading.”

Selling off the State Trust Lands creates a battlefield, pitting educators against environmentalists, and environmentalists against developers, creating a situation where no one is happy. Land use attorney, Grady Gammage said, “so instead of taking this land that is this incredible asset that ought to be a laboratory for the best development practices on how to balance growth and the environment to produce the best kind of place to live, it’s just a football that we fight over all the time.”

At some point in the film, I was half-expecting filmmakers to bring in the work and ideas of architect Paolo Soleri, who is known for his vision of arcology. His urban laboratory is located perhaps 30 minutes north of Anthem. He has been developing his concept of a car-free urban structure, arcology, for 30 years. Terry Goddard, Attorney general of Arizona , who was quoted in the film, has been on the Board of Trustees at Soleri’s Consanti Foundation for years. Arcology is a high-density structure designed to allow people the best of both the natural world and the built human environment through its pedestrian-centered blueprint. People would live and work in the same place eliminating the need for commuting.

Using alternative energy and clean, cradle-to-cradle industries, an idea conceived by architect William McDonough and his partner, chemist Michael Braungart, Arcology Phoenix would be a model that could eliminate sprawl and industrial pollution saving the Sonoran

Desert from further destruction. In their book *Cradle to Cradle*, McDonough and Braungart write, “If there are three times as many cars in twenty years as there are today on the planet, of course, it will not matter very much if they are highly efficient ultralight cars made from advanced carbon fibers and get a hundred miles to a gallon, or are even nutrivehicles. The planet will be crawling with cars, and we need other options. A more far-ranging assignment? Design transportation, Sound fanciful? Of course, But remember, the car itself was a fanciful notion in the world of horse and carriage.”

Building on the cradle-to-cradle industrial principle that “food equals wastes,” that in nature nothing is wasted, shifts industry away from producing products that end up in landfills to industries designed to recycle products. Such a shift requires us to understand that Planet Earth is a closed-system meaning that the basic elements found on Earth are all we have. They will not go away. What we make is here to stay. Consequently, our resources have limits. McDonough and Braungart write,

If our systems contaminate Earth's biological mass and continue to throw away technical materials (such as metals) or render them useless, we will indeed live in a world of limits, where production and consumption are restrained, and the Earth will literally become a grave. If humans are truly going to prosper, we will have to learn to imitate nature's highly effective cradle-to-cradle nutrient flow and metabolism, in which the very concept of waste does not exist. (p. 105).

McDonough and Braungart have worked out a new concept for industry using natural systems as a guide. In order to create a healthy, striving system for generations into the future, we have to understand that products are composed of either biological material that biodegrade, or technological nutrients that need to stay in closed-loop technological cycles. These valuable technological nutrients can be reused in industry.

Products that are designed from biological nutrients are called *products of consumption*. Products of technological cycles are called *products of service*. Organic metabolism within the biological cycles should not be contaminated with carcinogens, persistent toxins, mutagens, or other elements that damage them, if they are to stay healthy and successfully function.

For this to occur, McDonough and Braungart have introduced the idea of evolving into a *product of service* economy. This means that products of service such as a computers, TV sets, carpets, refrigerators would be purchased for a defined user period. The user would be paying for the service of the product, not the product itself. When the user is finish with the product or wants an upgraded product, the manufacturers takes it back or replaces it. Breaking down the old model, the industry would be able to reuse the valuable materials.

In a world where technology is continuously perfecting products, using rather than owning products only makes good sense. Manufacturers will be in a position to recycle materials assuring that materials are reused or go back to the earth in a healthy way. Such a user system would provide us with the way for our material resources to be accountable and no useful material contaminated.

I have elaborated on the topic of cradle-to-cradle industry as one of the important building blocks of arcology because the purpose of arcology is to ecological architecture. It is a whole-systems approach to design. It can only be successful by using a recycling model of development that creates no harm to the biosphere with which we are profoundly connected.

How deeply disappointing it was when the film failed to mention the idea of arcology as an option for building an urban laboratory on the State Trust Lands. I wondered why Terry Goddard didn't talk about arcology when he was interviewed by the filmmakers since as a

member of the Board of Trustees it is part of his job to promote the arcology concept. Or, if he had in fact brought up an arcology, why would the filmmakers cut it out of the film?

Searching for answers for this grave oversight, I went to the film's web site. Underneath the link to *Making Sense of Place: Planning and Making Communities*, there is a commentary by John Meunier who was quoted in the film but did not mention Soleri's concept during the taped interview. He was the Dean of the College of Architecture and Environmental Design at Arizona State University from 1987-2002. In his written commentary he writes about Soleri's idea, "Arcology retains its fascination and tugs on our environmental consciences, but it remains a distant and unrealized vision. We have to recognize that our existing economic and political systems could not generate it, and there is an even more substantial reservation; does it map on American cultural values?"

Humankind is at a turning point and only education with action is going to save us. No one in the film suggested an answer to the long-term problem about what to do about sprawl and its consequences such as: social isolation, alienation, crime, lack of meaningful civic life, water and air pollution, habitat loss for indigenous species, hyper-consumerism, car dependency and all the array of health problems associated with it, from childhood asthma, to obesity, to traffic fatalities. Kunstler writes, "the living arrangements Americans now think of as *normal* are bankrupting us economically, socially, ecologically, and spiritually."

Building an arcology for the million people who are estimated to come to Phoenix within the near future on the State Trust Land, is the only plan that makes perfect sense to me. It is perfect in that arcology is the ultimate architectural foundation necessary to teach us how to live at peace with the desert. Thus, the State Trust Lands' goal of supporting education would be fulfilled. Environmentalists would be happy because the project would build a new relationship between people and nature in which the health of nature would be the bottom line principle over short-term profits. And architects and developers would be liberated to think outside the box and develop an ecocity that matches the beauty of the desert by constructing an arcology founded upon humankind's most noble dreams.

Arcology Phoenix would be advertised to those with a pioneering spirit who want to be part of an urban laboratory. Its purpose would be to manifest an ecological and creative lifestyle. It would attract not only green architects, environmental scientists, solar-power engineers and construction workers who want to use their skills on building a beautiful city, but also professionals in the healing arts who understand the role holistic thinking has in maintaining healthy bodies and minds, who are part of the emerging new industries of health and sustainability.

Arcology Phoenix would also attract anthropologists, sociologists, and economists who would work closely with other artists and scientists to devise a social architecture that would eradicate the ancient social ills of 20th century urban environments such as classism, racism and sexism, creating America's first socially conscious intentional ecocity. It would set in motion a way for a cross-discipline dialogue to begin which is necessary for collective action to grow. The Arcology Phoenix infrastructure would be based on the principles of water conservation, which would greatly reduce Phoenix's water needs in the future and on using solar energy, since in Arizona, the sun is almost always shining.

Wired with 21st century technology, Arcology Phoenix would be designed to allow robots to do much of the manual labor so that we can experiment with redefining work. Theologian Matthew Fox writes in *The Reinvention of Work*, "Our work is meant to be

beautiful, to increase the beauty of the world, of one another, of the worker.” He says that the environmental crisis gives us the opportunity to ask deeper questions into the how, why and to whom do we do our work. He writes, “It also clearly opens the door for inventing new kinds of work—work that will develop sustainable energy, sustainable agriculture, sustainable minds (that is, education) and spirits (that is, worship). Ours is a time for the emergence of totally new forms of work. The decline of the ‘defense’ industry understood as war making can make way for the emergence of a defense industry whose task is to protect the Earth (a ‘green army’) one might call it.” Moving the defense industry away from violent pursuits towards a green army can only help us move towards the direction of world peace.

Other solutions to the problem of sprawl such as the New Urbanism or Smart Growth are mere variations of the same underlying dysfunctional urban pattern that created sprawl in the first place. Smart growth is a step back in time to when main streets had apartments over shops and they were in walking distance to home, school, and entertainment areas, a time when families had access to parks and outdoor recreation. Smart growth and the New Urbanism rejects the suburban, car-dependent lifestyle, but it does not eliminate them from the plan; it only reduces the need for cars by building suburbs closer together so that light rail and bicycle paths can allow people to have alternative transportation choices. Soleri calls such planning, “a better kind of wrongness.” Smart Growth exemplifies “why being less bad is no good,” a phrase used by McDonough and Braungart.

I see the Smart Growth vision as only a partial solution since it only reduces automobile usage. When the suburban house was first developed people were living in two parent families. But now, only 25% of Americans live in traditional households. The suburban house no longer works for the majority of Americans especially considering that when the baby boomer generation becomes elderly and unable to drive, millions of old people will become isolated in suburbia unless this dysfunctional transportation pattern is stopped.

Projected population figures indicate that by 2030 the American population will have 94 million more people than it did in 2000. Such figures make Smart Growth seem like an inadequate vision to successfully fulfill our needs. With such a rise in population in the next 25 years, half of our future buildings need to be constructed. Presently, construction patterns in the United States are developed on prime farmland, which brings into question our future food needs. The American Farmland Trust did a study of the problem in 1997. They found that 1 million acres of productive farmland are being turned into unfertile sprawl each year. That is 50 acres an hour. At this rate of losing farmland and with our population rising, America would soon become an importer of food rather than an exporter. This could be disastrous for the American economy. Farmers are forced to farm on less fertile land requiring more chemicals. Chances are the runoff of the chemicals makes their way into our water supply, which is disastrous for the health of the ecology.

It is time for a fresh design that envisions a futuristic 21st century city rather than the traditional American main street. Arcology is such a fresh idea. Meunier stated that arcology is a distant and unrealized vision because our existing economic and political systems could not generate it. But let’s take a closer look at the economic costs of car-dependent sprawl to understand how it is “bankrupting us economically, socially, ecologically, and spiritually.”

The average American household spends \$6,000 a year on each vehicle it owns and operates. This includes gas, insurance, repairs, parking fees and highway tolls. Since each household owns an average of 1.77 motor vehicles, they spend more on transportation than

on housing. Transportation has become even more expensive than food. In David Bollier case against sprawl in *How Smart Growth can Stop Sprawl* he writes that housing costs even go up because of the automobile. A single garage adds about \$7,000 to a house and a double car garage adds \$9,000. Garages, shelters for cars, are superior structures to what most of the poverty stricken people of the world live in. A government report found that in Los Angeles County there are 88,345 homeless people.

There are secondary costs to owning a car such as parking lots, highways, law enforcement and traffic control, traffic accidents and more. In the 1990s these costs paid by the federal taxes, states and municipalities, and others were estimated at \$300 billion a year. More than \$16 billion a year is spent by the Federal Highway Trust Fund to maintain and improve existing highways. Routine maintenance of roads cost state and local tax payers \$20 billion a year. All total, Americans are paying \$200 million a day on streets and roads. And there is no such thing as a free parking lot. Each parking space cost around \$1000. There are 200 million motor vehicles in the US , each having an estimated seven parking spaces. Worse of all the Federal Highway Administration estimated car accidents each year cost \$358 billion. Bollier writes, "The much-touted American love affair with the automobile is sustained, then, by economic subterfuges that disguise the actual costs of our car dependency."

But perhaps the greatest deception of the American people has been about the "cheap" cost of energy. American taxpayers are spending billions of dollars "defending" American access to foreign oil. Not only have billions gone into fighting the war in Iraq , but thousands of lives both Americans and Iraqis have been lost in order to keep the American lifestyle intact.

As we drive around to grocery stores, schools, churches, and soccer games, the toxic fumes from our cars are causing more greenhouse gases to be released into the atmosphere. Since these gases know no boundaries, we are threatening the entire biosphere with global climate change because of our lack of collective wisdom. Defending the American lifestyle has not made the world any safer from weapons of mass destruction, terrorism, or ecological holocaust because it is the American lifestyle that is causing our critical problems.

There is broad scientific consensus that greenhouses gases released into the atmosphere by humans from fossil fuel-burning industries and cars in the last century has caused a 1 degree Fahrenheit increase in the global temperature that has disrupted the global climate. Since the Kyoto Protocol on global warming doesn't require developing countries like China and India, two of the world's biggest producers of greenhouse gases, to cut down emissions, President Bush did not sign the treaty, saying it was fatally flawed. Instead, he has agreed to work on climate issues on a bilateral or on a regional basis using voluntary approaches. To combat global climate change by the U.S. , Bush pointed to the \$3 billion a year it spends on research and development of energy-saving technologies. Bollier writes, "Sprawl is a major reason why motor vehicles emit one-third of the nation's carbon dioxide, one-quarter of all chlorofluorocarbons, 40 percent of nitrogen oxides, and most of the carbon monoxide." It makes sense that not only do we need to develop energy-saving technologies, but we need to put them within the context of a new ecocity design.

With the destruction of New Orleans, due in part to global climate change and unsound eco-construction practices, now is the time to think outside the pattern of big box developments, beyond the endless, senseless, and meaningless miles of asphalt that tangle them together. We need to move light-years from the tyranny of automobiles and their clouds of toxic fumes, and plan for a network of arcologies. Then we can breathe fresh air again and see,

at night, the constellations of stars in the cosmos.

Today while listening to the Arizona news on the radio, the broadcaster announced that the air quality in Phoenix was so polluted it was unsafe for those with lung ailments or heart conditions to leave their houses. He requested people car pool or ride the buses if they needed to travel. Another report was about the state having a surplus of tax funds this year and that a discussion at the Capital in Phoenix was taking place about what to do with the funds. Governor Janet Napolitano wants to put the surplus into highway construction.

At the beginning of the *Making Sense of Place-Phoenix: The Urban Desert*, Terry Goddard said if someone a hundred years ago had said that Phoenix would become a great city, they would have been called crazy and sent into an institution. As it tears down the ecology, the way Phoenix has grown *is* insane. To build the great city that Goddard talks about can only be done by acting in the present to plan for Arcology Phoenix, a magnet for the best minds in the world to be drawn to so that our most innovative thinking for the good of humanity can have a place to materialize.

Soleri has shown that arcology is evolutionary architecture. But, perhaps it is not only evolutionary, but revolutionary in that it changes American values that have been driven for far too long by fossil fuels, the war machine, and the car industry, to values that truly care for the ecology that would allow us to achieve an equilibrium that assures our own sustainability.

We are victims of land wars going on in our cities that have resulted in the ignoble war going on overseas. Do we want to put an end to war, the domestic one going on over the last remaining wilderness areas on this continent as well as the war we are fighting over oil? If we want to end this war, then we need to think in terms of evolving civilization towards arcology. As German sociologist Deter Duhm says, "Peace is no longer the renunciation of violence; true peace is the revolution of our entire way of existence. Those who do not like the word "revolution" can replace it with the word "transformation." With this we do not mean escapism from reality, we mean the real transformation of our life conditions."

For the filmmakers to have focused on Anthem and not to mention the urban laboratory down the highway, Soleri's Arcosanti, seems socially irresponsible. It is not giving the American public a chance to know about viable alternative visions to sprawl. It gives the public no chance to use their imaginations to conceptualize a healthy lifestyle change living in a 21st century arcology could create. Futurist Barbara Marx Hubbard says there is a need to envision the ideal state and then to create design spaces to work toward that state. She writes, "We 'image in' our potential future that attracts us based on imaging what it will be like when everything we know we can do works in harmony with nature and our highest aspirations." The film left arcology out of the discussion needed to achieve a democratic ecocity. This is a tragic mistake and could be corrected by making a sequel that focuses on the arcology concept.

At the end *Sense of Place—Phoenix: The Urban Desert*, the narrator asks us to imagine Phoenix becoming an urban complex of 10 to 15 million people. He asks, "Will it evolve into an endless grid of asphalt, office parks, shopping centers, and housing developments?" But he failed to ask us to imagine Phoenix evolving into an arcology that lives in balance with the wondrous desert.

One frequently asked question on the *Making Sense of Place* web site was if there will be a sequel to the Phoenix story. The answer was no. I am asking the film makers to imagine making a film that shows the American public real alternative visions from our most brilliant creative minds such as Paolo Soleri, William McDonough, Richard Register, Barbara Marx

Hubbard, Matthew Fox, Hazel Henderson and others who have all written extensively about building a new ecological paradigm.

Isn't it obvious why a sequel is necessary? Do we continue to tell the story of the disaster of the car or is it time to depict a new era of arcology?

7.3.5.2. *Campaign to Use Arizona State Trust Land to build America's First Arcology*

There has been much debate going on between land developers and conservationists on how to develop or protect Arizona State Trust Land. To comply with the Arizona State Constitution that declares that the land should be sold to those with the "highest and best use," then the land should be kept by the State of Arizona and turned into a State Land Trust with the purpose of housing one million people in a model solar-powered arcology. Arcology, a word coin by world famous architect Paolo Soleri, is a car-free ecological city.

By building an urban laboratory of solar engineering and "cradle to cradle" ecological design on the land, its creation would fulfill the mission of using the land to support education in Arizona because arcology is a new kind of educational structure; every part of the arcology is a place of learning to live in harmony with the environment. Unlike the development pattern of car-crazy urban sprawl, the land surrounding an arcology remains wilderness, allowing for a new harmonious relationship between urbanism and the ecology to arise. Similar urban experiments are being conducted overseas under the direction of William McDonough.

Its time to illuminate the phase "highest and best use" in the Arizona constitution, not in terms of money, but in terms of our survival. We must save the ecosystem from being destroyed by the ugly, meaningless, and deadly pattern of strip-mall urbanization that has already destroyed most of our planet. We can design new type of city that matches the beauty, awe, magic, mystery and wonder of the Sonoran Desert.

The time is now for environmental lawyers, environmentalists, conservationists, hydrologists, ecological designers, social architects, community activists, and evolutionary-minded politicians to challenge the current interpretation of the Arizona constitution on what to do about the remaining State Trust Land. By putting our heads and hearts together we can construct an evolutionary architecture of our finest dreams to overcome the crisis of our times.



Figure 7352-1. Site of an Arizona Arcology

7.3.6. *Virtual Arcologies*

There have been some interesting suggestions for arcologies on the SimCity blogs. Arcology design could benefit from harnessing the science fiction imagination displayed on the internet. A Shellarcology might work as a plug-in platform for more upscale, wealthier, communities. Since arcologies would be highly connected, there is no reason that all of them have to be of a heroic scale. They could be mini-arcologies linked closely by rail, not totally separate but clumped in the area, like a mountain range.

Perhaps an arcology could be covered by living bark, like one tree. A living tree has expanding bark, so it can spread with growth. Everything inside is inorganic, just the phloem and xylem are living, and the bark protects those tubes. The tree arcology could be 400 feet tall, the limit for trees to vacuum water to the top, and any large circumferences as long as the roots connect. Arcologies could be a better response to drought than traditional cities. Cities have been promoted as being efficient concentrations without size limitations (by Stewart Brand and others). But, if cities are organic, then they might have organic limits to overall size and density, as do bee or termite colonies. Aggregation does enhance group survival, for instance, many bees can create more heat in a hive than an individual—but, when the hive gets too big, a young queen leaves to start a new colony.

7.3.7. *Regional Arcologies*

In some places with a light human population, an arcology could be the only urban structure in the region. This would decrease the human impact on the region, especially if it was a hotspot of wild diversity or if its productivity was low due to climatic or soil limitations.

One regional arcology, based on an understanding of the regional traditional settlements, of their patterns of interactions, and of their expressions of cultural values, would be a preferred alternative to the wide-spread ugliness and waste produced by auto-driven cities with malls, weeds and villas. Size would be a minimal problem, as an arcology is designed for various scales, linked by cycles of water and materials and by modular neighborhood units. Because of the availability of poor soils on every continent, the arcology could be centered in the network of human movements.

7.3.7.1. *A Canadian Wild Mountain Arcology*

The Canadian arcology would be built into the foothills of the Rocky Mountains in eastern British Columbia on the west slope—Shaped like a ridge itself, it would extend into the plains. From a distance, it would appear to be part of the mountain, although some regular features, such as the its peak and curvilinear windows, would be evident. One of the principles of arcologies is to use marginal lands.

Designed for 50,000 people, it would require an internal floor area of 50 million square feet and a volume of 500 million cubic feet. The footprint would be relatively small at 2.5 million square feet (58 acres or 24 hectares), with 20 stories, 3 of which would be underground. Much of the lower surface would be planted in native grasses. The density would be 2083 per hectare. The overall height would 70 meters, well within the variations of the mountain slope.

The Wild Arcology would offer generous spaces for public activities as well as external parks and seasonal food growing areas. These might be contracted or expanded as the population changes. Large wild areas, especially wild rivers and montane areas, can be reached

within an hour of travel.

The arcology would have unique external features. Except for the west-facing entrance apse to the arcology, the arcology would resemble a large ridge running down a ridge below. The surface would slope at 55 degrees. A stream running down the slope would be channeled through the arcology and create a waterfall for the bottom two stories, before continuing into the local river. The surface would be rock embedded in concrete. The rock would be of variable sizes and house hollows for birds, bats and small animals. Swifts and canyon wrens would find some holes suitable. Many kinds of lichen would colonize the surface within years. All three sides would have regularly-spaced nonreflective glass windows for admitting light and allowing people to observe from their apartments. Some windows could be opened; then, the rest of the rooms could be sealed off from weather or visiting animals. Every group of apartments would share a large balcony, for plants or chairs.

The upper two stories, which would house public meeting areas, would be constructed of fitted rock. These would house the largest open rooms, which would be supported by a kitchen and offices. The lowest two stories would be open to some animal traffic. It would also have areas for elevators and stairs. The apron of the arcology would have a cover of soil; depth of the soil would range from 1 foot to 3 feet and be planted with native grasses. The west-facing apse entrance would have a tile face over concrete. The inside of the apse would have a 50% glass cover. The apse enters the space of the arcology, starting with the public atrium.

The road leading into the arcology would enter a tunnel a kilometer from the structure. The tunnel would be covered with dirt and rock. In fact an elk trail would go close to the side of the structure and would be most active in early autumn. Other animals, including woodland caribou and brown bears, would be passing visitors. Hawks and Ospreys would nest nearby. The area around the arcology would have coniferous trees (Douglas-fir, pine, larch), native plants such as kinnikinnik, and wildflowers including bunchberry, rhododendron, and ragworts. For greenhouse, hydroponic, or small truck gardens, 18 percent of the floor area is dedicated. Individual apartments may also plant herb or limited gardens with fruit or nut trees. A vertical farm would create 'closed loop agricultural' ecosystems, where nearly every aspect of the farming process is recycled and re-used, especially water and nutrients. Using alternative technologies, perhaps 1-5% of the area is needed for electricity generation, much of which would be the surfaces. A small self-contained nuclear plant could power the entire arcology.

The arcology is not very remote. It is near the city of Golden and close to the Trans-Canada Highway. It would have advanced communications, such as the Internet and cell phones. The arcology hosts living, work, education, industry, and culture in a dense, compact system that is interleaved with domestic and wild landscapes. Its shape and density would generate an intense urban effect to energize the inhabitants to be productive and creative.

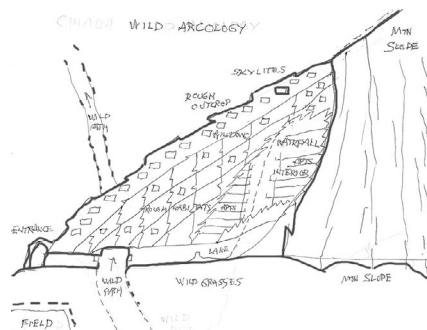


Figure 7371-1. Sketch of the CWMA

7.3.8. *Leaping to Sustainable Urbanization in China*

By John B. Cobb, Jr.

All over the world, forests are disappearing and agricultural lands are eroding. Aquifers are being exhausted. Fish stocks are diminishing. Land, water, and air are being poisoned. Many species of living things are disappearing. The planet is getting warmer, resulting in increasing storms and changes in rainfall. Those who study natural resources and the condition of the earth issue warning after warning. They tell us that some time ago humanity crossed the line into unsustainable living. Catastrophes loom ahead and sometimes break into the present to surprise us.

However, governments look elsewhere for guidance—primarily to economists. Economic theory has no place for resource limits. It assumes infinite supplies. Of course, economists do not mean that there is an infinite amount of any one resource, like petroleum in the Earth. What they mean is that as one natural resource is exhausted, technology can provide us with replacements. Obviously, this is often true. If the only shortage were petroleum, as it grows more expensive, replacements would, undoubtedly, be found for its multiple uses. The transition would be difficult for many people, but if the economy was sufficiently healthy, economists assume, society as a whole would do well.

We have, therefore, two views of sustainability in our society. One view calls us to find ways to live within the context given us by nature, destroying as little as possible. In this view human life adjusts to its natural context. It seeks ways to improve its condition that also benefit its natural environment. We will call this the ecological understanding of sustainability.

The other view is of sustainable growth. It calls for continuing increase of economic activity, accepting the losses to the natural world that such growth entails. It is believed that this growth will be sustainable as long as there are sufficient economic resources to fund the technological research and development needed to transform the natural environment so that it will meet human needs. I will call this the economistic understanding of sustainability.

This economistic vision suggests not only that we can substitute new resources for those that are exhausted, but also that we can deal technologically with more fundamental scarcities. The world is losing good soil, and water for irrigation grows scarce. Accepting this as inevitable, technologists can engineer new types of plants that will grow in bad soil and with less water. As oceans become poisoned, technologists will create fish that can survive these poisons. Even human beings may have to be genetically altered to cope with a more poisonous environment.

Economists long resisted taking global warming seriously. Now that some do so, they tend to regard the results of global warming as inevitable, and they once again turn to technology to solve the problem. If ocean levels rise, people will either build dikes along extensive coastlines or learn to use the remaining land more efficiently. If the Gulf Stream ceases to warm Europe, technology will provide Europeans with new crops to grow in a colder climate. New species of animals will be bio-engineered to replace the ones that cannot adjust to climatic changes.

The economistic notion of sustainable growth can appeal to much supportive evidence. It has kept us going through many changes in our natural environment. A good example is found in the field of insect pests and insecticides. Modern agriculture growth has been

achieved by monocultures that are vulnerable to insect pests. Hence, they have required heavy use of insecticides. Insecticides kill most of the pests, but a few survive. These reproduce rapidly. New insecticides are required to kill the new insects. Thus far technology has stayed ahead of insect mutation. The same story can be repeated with respect to herbicides.

These poisons also kill many of the organisms that naturally contribute to the fertility of the land. Accordingly, there is need for more and more artificial fertilizer. This has also been supplied in sufficient quantity to sustain and increase production.

At present, most of this is based on petroleum. Petroleum production globally is at or near its historic peak, and it will soon begin to decline in both quality and quantity. Technology will be called upon to develop substitutes. No doubt it will have some success. Some of this will be by introducing genetic changes that make plants more resistant to particular pests. Some of it will be by finding other ways to manufacture insecticides and herbicides.

Advocates of sustainable growth based on technological innovations are confident that technology will always stay ahead of changing threats. However, this makes the production of food more and more dependent not only on ever new technology but also on the social order that allows the technology to be quickly available wherever it is needed. Further, these problems must be solved by technology at the same time as the problems brought about by global warming, shortages of fresh water, and loss of top soil confront the world. In the past, advances along one line have often made problems of other sorts worse. For example, the Green Revolution required increased inputs of water and fertilizer in order to achieve its increased production. It also made grains more vulnerable to pests and diseases. The technological mindset has always focused on particular problems in some abstraction from the broader picture. To follow the economistic vision of sustainable growth, we must now be confident that in the future technological solutions to diverse problems will be brilliantly integrated.

My own judgment is that the economistic vision of sustainable growth is an illusion and a profoundly dangerous one. The longer we operate on this basis, the more the world is impoverished and the more precarious the human situation becomes. For thousands of years healthy soils carefully tended by individual farmers have produced crops for the families that grew them, with some surplus for others. This has been a relatively sustainable system. The more we continue to husband the soil, maintain supplies of freshwater, slow climate change, and use organic methods to control insects and weeds, the more sustainable our agriculture will be. Thus sustainability is approached, not by shifting from peasant farming to agribusiness monoculture, with ever greater applications of artificial fertilizer, insecticides, and herbicides, but by renewing reliance on nature and on human labor. This is the ecological vision of sustainability.

I do not want to leave the impression that in the ecological vision there is opposition to technological advances. The world urgently needs technological advances that lead toward sustainability. Peasant farmers need technological advances that improve their crops, enable them to survive droughts, and improve the quality of their homes. Society needs technological advances that will most efficiently bring agricultural products to local markets and preserve them while in storage. Rural society needs technological advances that will reduce the incidence of disease and bring basic medical care to all. As families and friends are separated from one another, improved technological means for communication among them are highly

valued. The technology of recycling and other uses of waste products is important. There is much more to be said.

Needless to say, I understand sustainable urbanization in ecological, not economic, terms. From this point of view, any social order that exhausts the resources on which it depends is unsustainable. Any social order that pollutes its environment is unsustainable. The present global order is unsustainable on both counts. In many ways U. S. society leads the way toward more and more unsustainable resource use. A major problem in China is that it follows too much the American lead.

7.3.8.2. II

But what I am calling ecological sustainability is not simply a matter of the relation of human beings to their natural environment. There are also political, social, and economic considerations that interrelate with concerns about nature. A society in which government lacks legitimacy and the basic support of the people is unsustainable. It may sustain itself for a while by sheer force and terror, but this cannot last.

A society in which most of the needs of the citizens are not met by the structures of the society itself is unsustainable. For example, if families and local communities fail to care for the children and to raise them to be constructive members of the society, the society cannot long endure. Governments cannot take the place of families and local communities. U.S. society shows signs of unsustainability in this respect, as family breakdown and economic pressures block the transmission of values from one generation to another and damage the psychic health of children. I hope we are not exporting this social breakdown to China.

A society that cannot provide its members an opportunity to support themselves cannot survive. The present global economy is actually increasing the number of persons who are excluded from economic activity within the official economy. The underground economy, partly criminal, partly simply extra-legal, is growing in much of the world. The official economy is dividing people more and more sharply into the rich and the poor within countries and between them. These trends are unsustainable.

My reflection about sustainable urbanization in China is in the context of these multiple concerns. But why direct special attention to urbanization in China? My reason for special concern about this is that it is now occurring, and is likely to continue occurring, at a scale and tempo never before seen in human history. This is partly because of China's vast population, and partly because of the unprecedented speed of social and economic change in China. It is my assumption that if present trends continue, hundreds of millions of now rural people will have to be urbanized in a decade or two.

Consider, for example, what will be required if 300 million people move from the countryside to cities. In the past 15 years already rural population has dropped from 74% to 53% between 1990 and 2009, affecting perhaps 215 million people, with great disruption. This would mean that China would have to build thirty cities of ten million each or three hundred of one million or three thousand of one hundred thousand. My judgment is that the larger number of smaller cities is far preferable. Moving from a peasant farm to a city of 100,000 people fifty miles away would be less disruptive of human life and family connections than the alternatives. But planning and building three thousand cities will prove a daunting task!

7.3.8.3. III

If Chinese cities continue to follow today's models, the unsustainability of global practices will come vividly into view all too soon. Indeed, I think it is already manifest.

I will cite only one factor in unsustainability. I have commented on the importance at this point in history of avoiding a shift to petroleum-based agriculture. Thus far, China's urban development has shared the global dependence on petroleum. China's increased demand for oil has been cited as one reason for the current spike in oil prices. If order is restored in Iraq and production there greatly increased, the price may come down somewhat. But it is public knowledge that oil is being pumped from the ground far faster than new oilfields are being discovered. Within a few years, global production will probably peak, if it has not already. Even if production continues to rise longer than expected, it will not rise as fast as demand based on current practices and accelerated Chinese development of the current type. Normal market pricing will lead to a further rise in oil prices. It is safe to say that, whatever happens in the short term, oil will be much more expensive ten years from now. It will be still more costly twenty years from now.

Economists assure us that as the market signals scarcity, technology will make more and more efficient use of the resource. Technology will also develop alternatives. No doubt this is true. If oil were the only resource destined to become scarce, the world could make a transition to other sources of energy. However, the more rapid the transition, the more difficult it will be. Chinese cities now being built to operate on oil will pay a high price for this choice. The price signals should already warn even economic thinkers that continuing to build cities to operate on oil is a serious mistake.

China as a whole will pay a high price for continuing to plan on the basis of an oil economy politically as well as economically. The United States intends to control global oil production. It does so in part so as to maintain its own economy and postpone the pain of the inevitable adjustments to come. It does so also in order to secure its global hegemony. If China depends radically on oil, and the United States controls the global oil supply, China will no longer be a truly independent nation. I am distressed by this prospect as an American. I would expect Chinese to be more distressed (although China is now trying to secure oil and other resources through agreements and aid).

What is the alternative? It is complex and difficult, but not impossible. Of course, it includes efficient use of oil and development of alternatives. But these technological approaches can only go so far. Much more important is to avoid not only the development of an oil-based agriculture but also the construction of cities dependent on oil.

Improved agricultural practices that remain labor-intensive and produce food organically, combined with prices for agricultural products that make possible a good living for peasant farmers, will slow the depopulation of the countryside. This could reduce the number and size of the cities that must be built, whereas following the economically driven mandates of the World Trade Organization will accelerate the exodus from the countryside while making agriculture less and less sustainable. Maintaining stable communities by improving the existing system of agriculture instead of replacing it with "modern" systems could also support the social sustainability that is eroded by rapid mass migration.

My first recommendation, therefore, is to improve life in the countryside and refuse to move from peasant production to agribusiness. However, much of the countryside is overpopulated, and there will be, and should be, continuing urbanization. This urbanization

has a better chance of being sustainable, and of being a part of a sustainable China, if the flow of population from rural to urban contexts is slowed. China had a program from the 1990s to encourage migration to the more remote areas, especially the Xinjiang and Tibet (Xizang) provinces, but it has been problematic.

Increased urbanization will take two forms. No doubt much of it will be the expansion of present cities. How that occurs is very important. But because I think the cities of China are already too large, I would encourage aiming primarily to build new cities rather than to enlarge the present ones. I have already indicated that I believe that a larger number of smaller cities will prove more sustainable than a smaller number of larger ones.

In any case, a discussion of sustainable urbanization should consider both how to make present cities less unsustainable and how to build new cities that are, from the beginning, genuinely sustainable.

I am particularly interested in the possibility that China, facing this enormous challenge, will experiment radically with a different type of city. For decades I have believed that the most original and important vision of what cities could be and should be is that of Paolo Soleri. He presents has presented his vision, and specifically his vision for China, elsewhere, so I will not repeat what he has said. If somewhere in China he is given the opportunity to build a small city, I believe this may be a turning point in the quest for a sustainable world.

This is not only because Soleri points in the direction of cities that are energy self-sufficient, producing few poisonous wastes or greenhouse gases. It is also because his cities will take much less land away from agricultural purposes. Further, they will encourage new forms of human community as traditional patterns of community based on the extended family decline. They will make possible new experiments in economic organization that guarantee to all some participation in the economic life of the city. They can reduce the hardships of poverty by making all the facilities of the city available readily to all its inhabitants. And they will make possible new forms of local self-government.

I do not want to be misunderstood. Neither Soleri nor I believe that the architectural form will solve all problems. What is needed is to get the best thinkers about community, economics, and politics to help in planning. Ideally, several experiments should be developed soon to learn from mistakes and provide stimulus to others. Perhaps the genuinely sustainable new cities that would emerge in China would be quite different from any of the designs proposed thus far by Soleri. That would be fine. The enormous value of his work is that it points forward to an entirely different conception of what cities can and should be. This is certainly an area in which China could lead the world into a new and far more promising age.

7.3.8.4. IV

Whatever breakthroughs of this kind occur, China must still deal with the problems of its present, huge and numerous, currently not sustainable, cities. This comment is not a criticism of China. Chinese cities are no less sustainable, I assume, than European and American ones. Bill Rees has led the way in showing that the ecological footprints of cities are enormous and still growing. Modern cities developed originally when most of the world's population still lived in the countryside and could provide the goods needed by the cities. Natural resources such as wood, then coal and then oil were abundant. Pollution was a local rather than a global problem. But the relationship to the environment has now changed. This urban civilization of the petroleum age is now unsustainable.

I have given special attention to the use of oil since the petroleum age is coming to an end. Existing cities cannot abruptly free themselves from dependence on oil. They can however reduce their use of oil both by reducing their need for importing energy and by substituting other forms. Both procedures are needed, but since there are problems with all forms of imported energy, the former procedure is the most important. Technological improvements can greatly reduce the amount of energy needed to generate a particular amount of light or motion. They can also make it possible to capture solar energy, including its passive form, for more and more purposes.

We now have many examples of buildings that require virtually no energy other than the heat from the sun in order to remain comfortable all year long. I am sure that Chinese architects are fully aware of this and are making use of many of the innovations that make it possible. I am also quite sure that much more could be done.

I am impressed, for example, by the work of David Orr at Oberlin College in Ohio. He has erected a building that produces more energy that it consumes and that is designed to require minimum-cost maintenance indefinitely. Amory Lovins has constructed a building at 7000 feet in the Colorado Rockies that houses both his home and extensive office space. It is extremely well insulated and arranged to capture sunlight, and as a result it is heated entirely by passive solar energy.

Similar strategies for solar energy and transportation are needed. The policy in China should be that all new buildings should be self-sufficient in heating and cooling, as well as extremely frugal in their use of imported electricity. San Francisco recently made a city-wide effort to turn the sunlight falling on its buildings into electricity. Examples of this kind can be studied and, when appropriate, emulated.

Transporting people from home to work is another major drain on the energy supplies of a city. Not long ago, much of that transportation was by bicycle. Cities should be sure that they do not allow new developments to make it more difficult to return to bicycles as the major means of transportation. In general everything should be done to discourage the ownership and use of private automobiles. Good public transportation helps. Many European cities exclude private motor transportation from the central city. Locating residences near places of work is helpful. Suburban sprawl of the sort so widespread in the United States should be prevented.

The implementation of all these policies depends on technological developments as well as on political will. In the appropriation of technology, one important policy should be leapfrogging. Alongside all of the destructive aspects of contemporary technologically driven society, there are also genuine advances that enable goals to be accomplished with far less use of natural resources. Cell phones, for example, whatever their problems, may make it possible to have the advantages of the telephone without the huge infrastructures that have been needed for this kind of communication in the past (except for the towers everywhere—maybe they could be combined with solar or wind machines). Buildings that are self-sufficient in energy production are also an example of leapfrogging over intermediate stages.

A massive example of leapfrogging is provided by the arcologies of which I have been speaking. There are trends in the development of urban centers that now move in the direction of arcologies. But there is no need to evolve gradually in that direction through steps that are extremely consumptive of resources. By leapfrogging over these steps, China can take the lead. Between cell phones and arcologies there are many more examples to be considered.

One might consider that certain proposals for urban economies are also a form of leapfrogging. There are excellent ideas that have been proposed and then quashed in the West by those persons of wealth whose interests they would have threatened. These stand a much better chance of serious consideration and implementation in China.

7.3.8.5. V

Whether or not cities are built as arcologies, they are more sustainable if, together with their rural surroundings, they are relatively self-sufficient. One reason I support experimentation with arcologies is that they are more likely to have this character of sustainability, but I will set that point aside for now. To put the matter negatively, the more the healthy survival of a city depends on long supply lines and on decisions made by people at a distance who have no interest in the well being of the city, the more precarious is the future of that city.

This illustrates the fact that, especially in recent decades, we have been constructing a more and more unsustainable world. The world economy has been reordered so that goods are produced thousands of miles from where they are consumed. Instead of planning agriculture so that local people can be fed, huge monocultural plantations produce for export.

The economic commitment to growth has supported this development. It may be that moves of these kinds lead to the most rapid economic growth, although I am not sure that statistics bear this out. But, many of us do not believe that what is called economic growth consistently benefits human beings. This growth is usually measured by Gross Domestic Product, which can, and often does, rise, while the actual living conditions of most people deteriorate. There are several reasons for this.

First, GDP is indifferent to the distribution of the income it measures. The policies employed to increase GDP are often based on the theory that wealth accumulated by the richest trickles down to the poor so that all benefit. These policies lead to the increase of the gap between rich and poor. Such “trickle down” as may take place rarely reaches the poorest segment of society. Furthermore, concentration of wealth is typically accompanied by concentration of power, and much of this wealth and power is in the hands of foreigners who do not care what happens to local people.

Second, the GDP is unaffected by environmental deterioration. Indeed, there is a direct relation between the rise of GDP and the decline of the environment. First, extra costs incurred because of environmental decline are added to GDP. For example, if water must be transported farther and new facilities for its purification are required, the cost of all of this adds to GDP. Second, there is an obvious correlation of increased consumption and reduced resources on the one side and increased pollution on the other. Again, nothing is subtracted from the GDP because of the loss of natural capital.

Third, the policies designed to speed economic growth as measured by GDP almost always prove destructive of human communities. People are separated from the means of production and from one another. The quality of family life declines. But healthy community is essential to sustainability. It is a profound mistake to adopt policies oriented primarily to “economic growth” as that is measured today.

Common sense tells us that real “growth” must be understood in quite different ways. The question is whether the changes in the economy actually benefit the people with special attention to the poorest and most vulnerable. The question is whether the society that develops is sustainable. The goal should instead be that kind of growth that leads to

sustainable communities. One characteristic of sustainable communities is meeting the basic needs of all its members.

This global economy is not sustainable, and the more China buys into it, the less sustainable the economy of China becomes. If new cities are built primarily to produce goods for distant countries, they will be unsustainable and contribute to the unsustainability of the whole society. If they produce primarily to meet their own needs they will be far more sustainable.

The goal of complete self-sufficiency, on the other hand, is undesirable. Trade can and should play an important, although minor, role. It should be such that the people of the city could survive without misery if the trade were ended. In other words, their basic needs should be supplied apart from trade. In that case trade can add to the enjoyment of life without threatening its sustainability.

Trade with the countryside and with neighboring cities should be favored over trade with distant place. Whereas a single city provides a sufficient market to stimulate competition in the production of clothing, sports equipment, household goods, and office supplies, its demand for elevators would not suffice for a healthy market. It may be inefficient for each city to manufacture its own elevators, or if it did so, the market would not support more than a single company. Monopoly has many negative consequences, and has to be controlled carefully by government. But the results for manufacturing of bureaucratic control are often negative. If several cities manufactured elevators, it would be important that the manufacturers competed with one another without the assurance that they would be excessively favored by the city in which they were located.

One advantage of relatively self-sufficient cities is that they could make decisions about wages and working conditions without fear that these would put their businesses at a disadvantage in competition with businesses elsewhere that paid lower wages and had worse working conditions. Goods coming from such places should pay a tax that would at least compensate for this difference. Of course, it is now very difficult to control the movement of goods into and out of a city. With an arcology it would be easier.

7.3.8.6. VI

Let me summarize some of my basic convictions about sustainable urbanization for China.

1. In an uncertain future, a city together with its surrounding countryside will be more sustainable if it is relatively self-sufficient. That means that it is capable of meeting its basic needs. That does not preclude trade with other cities and even more distant places, but the local region should not be dependent on that trade for survival.
2. Both the city and the countryside should be self-sufficient in the production of the energy they need to function.
3. Smaller cities can achieve these goals better than huge ones. Arcologies could do so best of all.
4. Cities together with their countryside should adopt new technologies that leapfrog over wasteful ones still characteristic of much of the West.
5. Cities together with their countryside should experiment with political and economic systems that allow maximum participation in local self-government of the people.

6. To achieve genuine sustainability, cities and their countryside should foster community among their people, such that none are excluded from participation and from having their basic needs met.

The Chinese government, by creating experimental arcologies on a large scale, could lead the rest of civilization to make the transition to self-sufficient cities.

7.3.9. *Possible Forms of Chinese Arcologies* (Being edited)

The first arcologies were designed as heroic geometric structures by Paolo Soleri, suitable for placement on a small footprint on earth or for floating in the ocean or in orbit in space. Terrestrial arcologies should take cues from the landscape, however, to fit within ecological limits or cultural values.

China is a nation of unique landscapes. Given the goals of an arcology to interpenetrate with wilderness and agricultural lands, some Chinese arcologies would fit with cultural modifications of the landscape. For instance, one possible arcology could be designed as a massive hill, covered in flooded terraces. The terraces would be functional, but built over dwelling and commercial areas; the upper wall of each terrace might have windows built in.

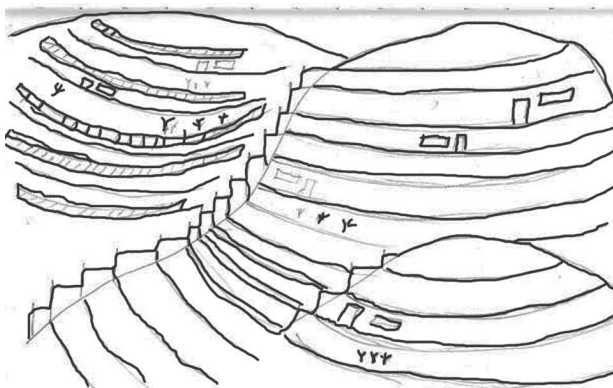


Figure 739-1. Chinese Terrace Arcology

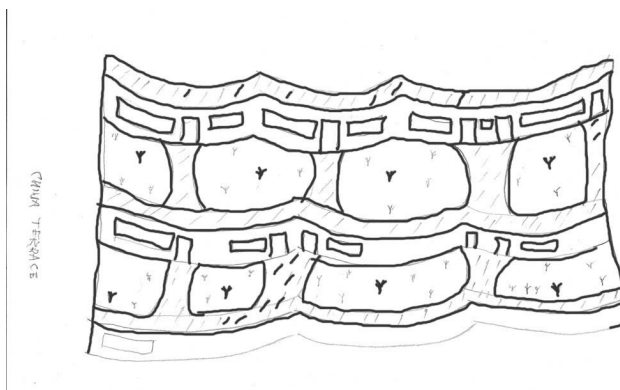


Figure 739-2. Chinese Terrace Arcology (Face Detail)

7.4. Regional Design Factors: Ecological Economics or Koinomics

The formal study of how people use their surroundings is economics (from the Greek words meaning 'law of the house'—house is used as a metaphor for human society and nature). The word has come to mean the management of resources to supply human needs. It is basically concerned with sharing resources to meet physical needs of a people.

Although economics is a social science that studies human behavior, it considers itself a positive science. As a social science, economics addresses human problems. The acknowledged fundamental problem of economics is the contradiction between scarce resources and unlimited human wants. The kinds of resources and the possibilities of using them in production are considered in the scope of economics, as are flows and stocks in homes and businesses, the role of the government, business cycles, monetary details and policy, stabilization and growth, international trade, consumer behavior, production costs, pricing, and resource markets.

7.4.1. Poverty of Humanity & the Earth

In general, poverty is a lack of things that others have, especially necessary things. There are different forms of poverty. For instance, one form is the lack of needs, such as food and things or money. Another is the lack of use of natural or public services that would provide food and shelter. On the other hand, what is the use-value of feet in Los Angeles? The lack of potential is harder to define, but it means that people who suffer that poverty cannot improve him or herself, or change, or develop. Finally, the lack of luxuries has become a form of poverty. The idea of affluence in a global village creates a new modern kind of poverty, the potential poverty of not having what is possible somewhere in New York or Paris. Modernizing needs creates a new dimension of poverty. This adds a new discrimination by a violent cargo cult that seizes traditional cultures.

Industrial society is constantly mobilized for emergencies with, in the battles against noneducation, poverty, diseases, and terrorism. Industrial development has never been nonviolent or respectful to people or nature. Some human poverties are poverties of the local ecosystems. Loss of entitlement to a natural resource base needed for foraging or agriculture is a political poverty. Interference with or destruction of the processes of ecological balance and renewal, the loss of diversity, the loss of capacity for the renewal of ecological systems, are ecological poverties.

7.4.2. Ecological Economic Wealth

Values are based on knowledge, which is measured partly in terms of information. And information can be considered a source of wealth. Some business economies are based entirely on providing information. Information is apparently boundless. Yet it can be manipulated. It is information that defines the use of resources by people. For example, hydrogen is worthless unless technologies exist to transmute it to helium and manage the released energy. What is not limited is our use of information. A sophisticated technology needs fewer resources, according to R.B. Fuller. Ecosystem productivity becomes less important if food can be grown in tanks using solar energy.

The economic argument for valuing plants and animals is based on the fact that

animals and plants are self sustaining factories, that is converters. (Hermann Reinheimer, 1910, thought that all organisms were economic traders anyway. He espoused cooperation rather than competition, however.) Economic value is a function of our state of knowledge; penicillium was just mold before Fleming amplified antibiotics from it; wheat was a natural grass before being hybridized with a weed, goat grass. We should preserve much of nature for its undiscovered wealth, that is yet to be known. The technocratic vision treats all interests as human interests; but even so, this cannot be used to reduce all to instrumental value. Not all human values can be quantified and assigned common dollar values. Even if human values have objective meaning, not all of them will have dollar values; therefore not all natural processes can have dollar values, but all have some kind of values. R.F. Dasmann notes that birds or dolphins have values to observers that do not fit any yardstick. Wildlife has commercial value, e.g., fish can be caught without being produced.

According to Buckminster Fuller, wealth consists of physical energy combined with metaphysical know-how or know-what. In terms of solar energy—real wealth according to Fuller—all humans are potentially rich. This type of wealth should be based on what is valued most: Happiness, clean air and water, good food, technological devices, art, or goods like automobiles, apartments, and clothes.

7.4.2.1. Information and Resources

Any economy must consider the needs of its members, as well as the limitations of its resources. Surprisingly, political and psychological factors have been and may always be more important restraints on food supply than physical limitations. Deprived peoples have difficulty striving for better crops and supplies; planners have difficulty envisioning an agricultural system operating on ecological principles.

The problem of food mirrors lesser problems. There are shortages of land and energy; there is overpopulation; there is degradation of land and people. Any solution must address the whole complex. At least half the population of the earth is suffering from malnutrition, according to Borgstrom. Although some shortages are caused by transportation and logistical difficulties, food production is still falling behind population growth. Food is one of three types of resources: Fastly accruable (i.e., renewable); slowly accruable (basically nonrenewable); or, slowly dispersed (really nonrenewable).

Most of the wealth used by modern economies is nonrenewable. These resources are limited, interrelated and distributed unevenly. Forests are a special problem; although trees can grow to a good size in 30–40 years, forest ecosystems may take 300–600 years to develop and then last for thousands of years. Oil, coal, peat, and some woods are functionally nonrenewable. Geological time periods are required to produce them. Mineral reserves may be understated by a factor of 5 (*Limits to Growth*) or 1,000,000 (Hudson Institute). But, they may be located so far and so deep that it would cost more energy to extract them and move them than they are worth, unless we used a “renewable” energy source—the sun.

Slow accrual and slow dispersal resources should be equally available to all cultures. It is impossible to sustain any quantitative arguments about resources and population pressure on them without a comprehensive overview. Demands on food, fertilizer, energy, and metals are related inseparably. Organic and inorganic assets need to be assessed together. Population carrying capacity cannot be formulated until both resources have been quantified.

We depend on vegetation for far more than food—for newsprint, construction,

furniture, clothing, and packaging. Furthermore, with shortages of minerals, many substitutes are expected to be organic. The measurement of total production of vegetation is difficult and complex. Wild plant communities, that could form experimental controls, have been altered over thousands of years. Original wild communities were efficient and flexible.

The International Biological Programme embarked on a large number of projects to assess the biological productivity of all the main types of terrestrial ecosystems. Efforts based on these materials have been made to compute the actual net primary productivity (NPP) of land vegetation at the present.

7.4.2.2. The Real Wealth of Nations

Samuel Eyre based his own calculations on these and other criteria to calculate the Net Primary Productivity (NPP) of the original wild vegetation of the planet. Eyre, in his book *The Real Wealth of Nations*, calculated the NPP for wild areas of the earth and for wild and domesticated areas of individual nations. National boundaries have different potentials. Australia, Zaire, Canada, and Brazil have the highest potentials. Among the most poorly endowed are the heavily populated European, Eastern Asian and West Indian countries and the dry Middle East and Southwest Asia.

Eyre then calculated the terrestrial production per capita: At the world population of 4 billion, and an above ground NPP of 50 billion tons, we get 13 tons per head. Currently the average person in the United States eats equivalent of one dry-weight ton per year, including waste and meat production. In addition, over half a ton of timber per person is consumed in paper and packages. He considered that an average of 10 metric tons per capita potential NPP was necessary for self-sufficiency (that is, we are approaching the limits of the planet).

Eyre also devised a common denominator to consider organic and inorganic assets together. Population carrying capacity can be formulated only using both. He assigned a nutrition equivalent unit weights of metal, but this calculation depended on a dollar value for food and minerals.

The advantages of primary production as wealth are that the wealth is sustainable, plants are renewable, and minerals can be recycled. The disadvantages are that the net community production (NCP) is not considered, which takes all of the food chain into account, dollars are used instead of fair human work units and the technological production costs of food are not considered. Many countries, such as Surinam, with very high NPP figures, have low NCP figures, and therefore low potential for development.

Until human labor is equalized across cultures, dollar value only reflects the unfairness and inequality of the past—this is not to say that unskilled work is the same as skilled work, but that people performing similar kinds of work should expect equal rewards. Many external costs, such as those by forests for cleaning and holding water, never enter the calculations of modern economics.

The original vegetation cover of the planet was extremely diverse. The potential natural productivity of wild vegetation is 120 billion tons of dry organic matter per year. But not all is available for human exploitation. The proportion of NPP above ground would only be 80 billion tons. These are all rough approximations. This is the theoretical amount that would be produced by wild vegetation with no major environmental changes.

Much of this is not usable. For example, in the production of forests, 65% of above ground production is not used by most lumbering operations. Possibly, over all ecosystems,

the representative average of unusable material is only 50%. Taking most of the material is not desirable anyway because mineral nutrients are locked up in plants. Complete extraction of plants would result in removal of from one to two thirds of potassium in the whole ecosystem. Although there is plenty locked in rock particles, this is released very slowly.

But the land has been “improved” to pastures and crops. Some crop productivity, usually at experimental stations, is capable of producing high NPP, in total dry weights. The most productive of crops can approach the NPP of the original cover, but average crops produce less than half of the natural cover. The highest figure was achieved in Japan, where substantial dressings of fertilizer were applied. In countries where no fertilizer is applied, the annual productivity is unlikely to be more than one quarter of the native vegetation.

In tropical climates, the NPP does not appear to increase in proportion to increased sunlight. The tropical plant also uses up far more energy for its own metabolism. The hotter the environment the higher the metabolic rate; so temperate zones produce higher yields than tropical. Although tropical ecosystems offer less potential for high levels of secondary production, microorganisms (autotrophic and decomposing) and invertebrates could be potential converters to high quality animal food.

In a world no longer regarded as unlimited, it is important to know the annual production of organic material. The potential food producing capacity of the earth is represented by conflicting views. Many ecologists fear that agricultural activities have strained the earth's productive capacity, while supporters of the Green Revolution regard food shortages as simple organizational problems. These extremes cannot be adjudicated until there is some idea of the productive capacity of lands under their original wild vegetation.

In *Productivity of the World's Ecosystems*, Rodin, Bazilevich and Rozov estimate the phytomass of land at 2.4×10^{12} metric tons of dry weight—82% of this is concentrated in forests. Since those figures refer only to a standing weight, it is important to know the rate of production. The total primary production of land is 1.72×10^{11} metric tons per year. Forests produce over 49% of that.

Eyre estimates that the total annual terrestrial NNP has been reduced by 38.5 billion tons since the advent of agriculture. The complete removal of all forests, converted to cultivation and pasture, would lower the NPP to 27.6 billion tons, assuming all savannas, prairies and scrublands remained unaltered. Even in low-use areas, there are effects of human occupation. Interference in woodlands may slow secondary growth. For primary forest recovery, the transition may take thousands or tens of thousands of years. With its two-year pay-back horizon, market economics cannot allow ten-thousand year plans. An economics with vision, with new images, could accommodate long return cycles.

The basis of all wealth at this stage has to be the operation of the planet, which hosts the life forms that create the production. The planet provides the cycles that keep necessary nutrients and elements available. And, the planet has produced the human abilities to generate new forms of wealth from ideas and inventions. The protection of all these forms of wealth requires common rules of conduct on the global stage.

7.4.3. Regional & Global Economics

Humans have been trading items for over 40,000 years, starting with ochre, stone, copper, furs, and continuing with gold, tea, or people, by foot, camel caravans, or sailing ships, across regions. Then, with steam-driven ships taking intercontinental trade, grains and meats from many countries, such as Argentina, Canada, and the US. Then oil. Then shirts and manufacturing, electronics and computers. Because of the advantages of specialization, many nations do that. This creates larger webs of interdependence, which is a crucial characteristic of globalization. It is not the same as trade between self-sufficient nations. Perhaps this can level dominance so that nations come to resemble species in an ecosystem.

Globalization is a supranational trend that has been emerging for the past 500 years, as a result of human explorations of the planet. As a result of differential trade and wealth, however, the range of wealth has spread and social inequality has increased. Globalization accelerated from the 1400s. At first, there was a movement of people and immigrants. Then there was a movement of materials and energy sources, followed by a virtual movement of money and capital. Then there was a specific movement of information.

The first wave of global trade destroyed many of the traditional societies of the Americas and produced incredible suffering. Globalization was destructive on several levels at first, not only diseases, but conquests and exotic exchanges. American crops, grown in harder conditions, grew where native Euro-Asian crops grew less well. This allowed expansion of areas and populations. Exotic crops went everywhere, even manioc into Africa. The coming together of zones was often destructive to native peoples. Not just from trade and competition, but from livestock, exotics, and diseases.

A later wave of globalization destroyed traditional economic systems. European exports, especially in textiles, undermined regional livelihood. These processes enriched the Atlantic shores, but it also widened the inequities within nations. Thurow states that governments did not decide to start global trade and marketing. But, that is what they did through East India and Hudson's Bay and other companies. There is also change to a popular cultures, with clothing, foods, and songs being dominated by a few.

Many of the modern trade agreements are causing suffering and violence. The gross domestic product of the world increases, but what is produced? Who produces it? Eighty percent of the lowest produce only twenty percent of the global output. Globalization is a set of factors that offer advantages to traders or companies, but can weaken individual states (or possibly deterritorialize them).

7.4.4. A Peacetime Economic Shift

With the collapse of Soviet domination in eastern Europe and western Asia, some nations called for a 'peace dividend' that could be used to restore crumbling infrastructures and to restore skewed equities. That dividend was postponed for uncivil adventures against perceived terrorists and perceived weaknesses in oil trade. But, it could still be distributed from the current massive military spending. It could support the transition to an ecological economics.

7.4.4.1. Jobs

Over 60 percent of the human labor force of the planet is working in 'informal' jobs, without wages or benefits. This condition seems to be a permanent result of the way governments and corporations deal with 'cheap' labor. It also leads to the immigration of guest workers, who

send a portion of their wages back to a home economy. This condition will likely contribute to instability. Yet, as part of a transition to an emergency state, the UN and governments could employ the entire labor force to rebuild and relocate the infrastructures of civilization.

The enormity of the military budget suggests that we are willing to dedicate massive resources for one thing we deem important, although that is not sustainable. However, the military could be assigned to the domestic emergencies at home, for making transitions in energy and agriculture. We need mobilization as fast as what happened in WWII. When the auto industry was drafted to make planes and ships. When strategic goods, from sugar to gasoline, were rationed. That emergency restructuring was done in months. Why not try for 6 months for global mobilization, now? Restructuring could be done profitably, to increase global security.

The cost could be quite reasonable. Lester Brown and others have calculated the costs of social goals and of restructuring the earth. The social goals came to \$75 billion per year and the restoration goals at \$185 billion per year (compared to a world military budget of \$1.522 trillion). If we added other social goals, such as equalization and reparations, infrastructure repair, or the deconstruction of some cities and industrial area, it might only double it, to \$150 billion. Increasing environmental goals, such as the restoration of farmlands or wilderness might double that estimate to 370 billion. If we added the social costs of transition, including monies for UN to take over police actions, education and health, that might raise social goals to \$220 billion. Setting aside more land for hotspots and common areas might reduce income \$100 billion per year. The grand total is \$690 billion per year.

Compared to \$1.522 trillion per year, \$690 billion is a half-price bargain. The military budgets are not affordable anyway, which is why social and environmental goals have been so neglected. All that is really required is convincing world leaders that we are in an emergency situation, now, before a major catastrophe claims millions of lives and billions of property. Of course, they would have to sacrifice some money and some comfort, but then they could be heroes. And, that is what we need, uniform sacrifices for the benefit of all.

The expenditures, as well as coordination would have to be handled at the international level, by the United Nations, which would have to monitor progress towards the goals. It would need new offices and agencies to pay out the money allocated for it. The UN could also appoint new Boards to oversee each individual goal. This scale would be larger than anything done before, so it is important to have a hierarchy at the top, but let the smallest groups be loose and inventive. Sometimes the most effective directions come in a bottom-up way.

This scale of change, with actions performed at one time in every community might be possible. Everyone has to understand that it is a planet-wide emergency, as immediate as any hurricane or earthquake; it is just more subtle. There will be social and cultural hurdles. Of course, the rich and powerful now will not want to sacrifice the comfort of the status quo, but they will still benefit more than anyone else. It is in their interest to still be the richest group in a healthy culture and planet. If we can just educate them to their real interests. If. Some cultures will not want to work with other cultures, if they perceive unequal gains. That is why a diverse body of managers is necessary. No matter what the outcome, this has to be tried, for the whole planet not just self-assigned, special groups of humanity.

7.4.4.2. Tourism

Certainly, it is eye-opening to see how people in other cultures live, and living and eating with them can be an adventure. But, the modern packaged tours seem to be exercises in wretched excess, as people look out the windows of their steel tubes between stops at cloned modern hotels and restaurants. A few souvenirs to go with the slides and these tourists are sophisticated travelers. Our direct experience of the world has become shallow, in spite of faster travel. Travel used to broaden the mind, but now it narrows it. We travel in sealed corridors like boxed goods, comforted by homogenized foods and our own language.

The costs for this kind of tourism are high, especially with the costs of jet fuel, boat fuel, and automobile fuel. Special watered down menus are usually offered, not too spicy, but with volumes of wasted food. Special adventures for the tourists often interfere with wildlife patterns. The hotels create a large footprint on the local ecosystems.

In many places, the tourists interfere with traditional ceremonies or ways of life. Tourism has transformed many cultural ceremonies, with the demand for close photographs and souvenirs. Sometimes native peoples play to the tourists and what they expect.

Tourists have romantic ideas about what other cultures should be like. When the reality disappoints them, they fall back on ideal themed vacations, where the cultures can dress up to tourist expectations. The obvious wealth of most tourists has effects on the visited culture, as those people witness tourists eating the best foods while wearing expensive clothing and carrying expensive gear.

Environmental tourism still interferes with the environment, although there is an effort to educate tourists about ecology. Tourists can crowd or interfere with wildlife, which can become addicted to handouts of food. Is ecotourism a mechanism to provide solutions to the problems of the poor of many countries? Or does it make it worse? Especially if it decreases in volume. Surprisingly, tourist dollars can exceed the value of takings, fish for instance, making tourism income greater than food or resource for many communities. Tourist dollars can make payments for the protection of biodiversity hotspots. If the import of tourism is measured by dollars, then it is greater than the value of local resources or the income from crop production or technological invention. It might be better to make it as ecological and ethical as possible, a curious meld of education, entertainment and preservation of traditional forms. Working tourism can bring income to special projects, and as citizen-scientists the tourists can collect data and make observations to contribute to the projects.

We have not evaluated the costs and benefits of all tourism. Should we abolish tourism entirely? Perhaps we could limit the impact of tourists on dry, delicate ecosystems, or other places, by limiting the number of tourists. Perhaps, after calculating the number of tourists who could visit other cultures and places, we could start a lottery for travelers. This would make the event more valuable to the tourists; maybe they would perceive the people and places as unique and valuable in themselves. Tourism can be a vital part of education and the economy, but its potential for the destruction of ecosystems and cultures has to be limited by good and fair rules.

7.5. [Empty Topic]

(Being edited)

7.6. Regional Design Solutions: Charting Ecologically Responsible Corporations

The metaphor for a corporation used to be a simple mechanical model for turning resources into products. To be successful, a corporation had to grow and turn a profit continually. Unfortunately, the assumptions of the model were also simple and failed to consider human needs and natural cycles, causing great suffering and great disruption.

To be really successful, corporations need to adapt a more comprehensive model, one that reflects stability, cooperation, justice, and respect for nature. With an ecological model, the ecological responsibilities of corporations, to themselves, to nature, and to human communities, are described.

7.6.1. Corporate Organisms

A corporation is defined legally as an individual person, although one that is defined by law and exists only in contemplation of the law, hence it is artificial, invisible, and intangible. A corporation is not the stockholders or officers; it has its own entirely separate and distinct existence. This kind of artificial person was the invention of commercial interests; the first corporations in Britain were granted charters by special acts of parliament to provide services for the state. Most corporations have characteristic legal features: Individuality, permanence, limited powers, continuing succession, action in the corporate name, limited liability of members, transferability of member's interests, and representative management. Charters have become easier to get, until now corporations can be formed under general law. Corporations have been adapted to meet most modern business and social needs. Real persons can do anything not prohibited by law; corporate actions are derived wholly from law and limited to the charter, although charters have become very comprehensive statements that allow a great variety of activities.

In the publication *Integrating the Enterprise* by Digital Equipment Corporation, it is stated that "Digital is a living organism," tending toward a state of dynamic equilibrium by adapting to circumstances as fast and economically as possible. This is a natural-enough metaphor, and it leads to interesting deductions.

Like an organism, each business is born, grows to a certain size, then matures and dies—perhaps a natural span is hundreds of years, like the Oxford University Press, for instance, or perhaps only a year like so many new businesses. Biologically, maturity marks the end of physical growth in humans, but not necessarily the end of emotional, intellectual, and social development. Like an organism, the corporation, unconsciously through its officers and managers, starts to act to preserve itself before completing its formative objectives, such as maximizing profit. Like an organism, a corporation lives in place and alters that place to some extent by living, although some of the larger ones risk destroying the mixed community of humans, animals, and plants (and all their associations) on which they depend. Every organism must fit in its community and environment. It must be integrated and limited—self-consciously so in the case of humans and corporations.

Corporations are unique organisms. Corporations are more than just groups of people without structure. Corporations are described by analogy with individuals. But, each has unique characteristics: The corporation has a right to property and free speech, but not a right to worship or vote. They can be longer lived than their human components.

7.6.1.1. *Problems with Corporate Organisms*

The old analogy of the corporation as a machine leads to bad assumptions: that everything is a resource; that resources are unlimited; that production must continue endlessly; that the corporation has to keep growing to survive; that the purpose of the state was to legitimize exploitation; that the purpose of humanity was to multiply, produce, and consume; and that the purpose of the universe was to supply human and corporate needs. The machine analogy also leads to false economic beliefs: that mass production is most efficient; that obsolescence is necessary for successful growth; that people's needs and wants are fulfilled by advertised products; and, that quality does not matter very much.

Some companies have started to work around these beliefs. Kodak and Head, for instance, have succeeded with custom production, high-quality, long-lived products that people did need. Other corporations are suffering problems as the results of bad assumptions and false beliefs. These problems include: overgrowth, with an increase in complexity and costs (many of them social); economic and ecological instability; social burdens (from pressures on family from relocation and powerlessness); misdirected effort on ill-conceived products; slack employee attitudes and performances (sickness, accidents, turnover, layoffs).

In the effort to control their problems, corporations have sought more control. The corporation tries to avoid being vulnerable to change and uncertainty, fluctuation, and market conditions by relying on planning and control. Corporations try to ensure stability by taking over the supplies of materials, controlling their subcontractors and the buyers of their products, controlling the work force with pay and incentives (as well as by cultivating identification), and managing demand by sales influence and advertising. Many corporations try to be flexible about resources, using what costs the least, say, cheap energy to replace expensive labor. Corporations, especially multinational ones, seek raw materials everywhere, in any nation, under any ocean. Corporations become international, mining, assembling, and selling in three different continents. Where developing countries were once regarded as sources of raw materials, they are now used as bases for manufacturing, and they are becoming growing markets.

This control is possible because corporations have acquired such great power. Large multinational corporations have great power to control national economies and ignore environmental laws, partly because of their historical promise of providing social services to national states. Unfortunately, as private good became identified with public good, corporations became less concerned with social service and more concerned with greater profit through greater technology. Greater technology lets the power to change overwhelm the power to see the consequences. So, social amenities, such as clean air and fresh water, are violated legally—after all, no right of contract or fair use of property has been breached. Corporations exercise enormous influence over our lives, probably more than governments or churches. Furthermore, the size of some companies means that their influence is felt like shock waves through societies and environments. Multinational corporations are a force in the business world and a major influence on world affairs. Size and complexity give them special power, not only financial but political. Power is supposed to evaporate in a purely competitive economy, but capitalist economies are not purely competitive; power accrues to corporations.

Usually the goals of a company are generously, nobly, and broadly stated as intentions to support the best interests of owners, managers, shareholders, employees, the public, and, lately,

the earth. Many corporations pride themselves on their generosity and personnel standards and on their good corporate citizenship, although the public concept of good is being extended beyond traditional bounds as citizens become aware of the interactions of business, politics, and the environment. Even corporations that claim to make clean products in safe ways often seem to depend on “dirty corporations” for power and packaging, as well as for paper and materials.

Business as usual, with its inertial model of growth, could end in catastrophe for humanity and its environments. Industrial cultures, with their characteristics of simplification, naïveté, homogeneity, and incompleteness, turn wild landscapes into flatscapes, where variety disappears and significance is ignored for the comfortable standards of meaningless continuity. Rapid growth might precipitate a catastrophe sooner, while modest efforts at environmental protection and increased efficiency may only postpone catastrophe.

An organic model offers the best alternative, with its emphasis on energy efficiency and alternative sources, its major commitment to environmental protection and the internalization of environmental costs, and its change from growth to stable, sustained development. Such a model would provide organic assumptions and beliefs: that resources are limited, that human value is only part of ecosystem values, that humans are more than consumers and producers, and that the quality of life is more important than quantity of possessions.

Like organisms, corporations may have an optimal size and a home place; organisms that occur out of place are often called weeds, and organisms that grow too large monsters. Perhaps corporations should be limited in size and tied to one place to avoid having them become as weeds or monsters.

Healthy organisms, even humans, are educated to take their place in a culture that limits their impact on the environment, proscribes their actions towards one another and towards others outside the culture, and trains them to reproduce themselves and renew the culture. Most corporations act like improperly socialized individuals who have not been taught how to take a proper place in society and how to be responsible for their actions; instead, corporations hide behind their legally limited liability.

Any organism, like robins to fermenting berries, can be addicted to certain things in certain circumstances. Corporations have become addicted to cheap energy and easy defense money. It is possible to create circumstances that limit or cure the addictions (for robins, the berries fall to the ground and get covered with snow).

7.6.1.2. *Ecosystem as Metaphor*

Perhaps the metaphor itself is not adequate. Even organisms take a large part of their identity from their context, from the surrounding environment. It might be more productive, since corporations actually contain organisms, mostly human, to consider the corporation as an ecosystem. Ecosystems occur in a large diversity of sizes in nature, from a rotting log to one covering most of a watershed.

7.6.1.2.1. *Definition.* An ecosystem is defined as a biotic community and its nonliving environment functioning together. An ecosystem is also a self-organizing, chaotic system with emergent properties. Ecosystems develop in time. That is, a community develops by a reasonably orderly, directional process that involves changes in structure that results from community modification of the physical environment. Although the physical environment imposes limits and determines pattern and rate of change, the community controls the

succession. The result is a relatively stable configuration characterized by a high biomass (or information content).

7.6.1.2.2. *Characteristics—Energy.* The “strategy” of ecosystem development is increased control of (or homeostasis or homeorhesis with) the physical environment—to protect itself from perturbations. There is a fundamental shift in energy flows, as increasing amounts are used for maintenance. The structure of a community changes: organic matter increase, inorganic nutrients are used internally (instead of being extrabiotic), biochemical and species diversities become high, and pattern diversity becomes well organized.

As more and more energy is used for maintenance, the net community production approaches zero. Agriculture keeps an ecosystem immature in order to harvest the larger yield in immature systems. The mature system becomes more efficient, as it supports a larger biomass with the same amount of energy. The food chains become more weblike (dominated by detritus chains as opposed to linear grazing). Mineral cycles become closed and the nutrient exchange between organisms and the environment slows.

The life history of organisms undergoes change as well. Organisms tend to be larger (perhaps as a result of shift from inorganic to organic nutrients), with longer, more complex life cycles and narrower niche specialization. Population growth slows, with emphasis on the quality of life of organisms. Internal symbiosis becomes more developed, conserving nutrients and resisting perturbations.

7.6.1.3. *Corporations as Ecosystems*

Corporations have been developing for hundreds of years. There have already been shifts in the meaning of corporations and in the forms of organization and style: From a stable product line to continuing innovation process, from a product based definition (shoes) to a process (information), from a single pyramid of organization to constellations of satellite concerns, from the static to the flexible, from product line management to networks and innovations (the management of change), and from stable forms to temporary. Mature systems have a greater ability to trap nutrients for cycling. Corporations have settled in an artificially maintained pioneer state, feeding on the extra productivity.

7.6.1.3.1. *Energy Use.* If corporations follow similar patterns over time as ecosystems, we would expect their “food chains” to become more complex, with most of the energy flow following detritus pathways. Optimizing material and energy use, reusing ‘wastes’ as resources (food webs between companies, where wastes are products, not side-effects), and closing loops by recycling. Reciprocal adaptations between plants and animals, or between producers and consumers, leads to mechanisms that reduce grazing and increase feedback.

7.6.1.3.2. *Low Productivity, High Stability.* A mature ecosystem produces many things, most all of which are used by the system; wastes are broken down into component chemicals by microbes, while other resources, like nitrogen, are fixed to roots by other microbes. The tightening of the biogeochemical cycles is an important trend. Corporations sometimes parallel the aging of an ecosystem, from a pioneer state to a mature state.

7.6.1.3.3. *Life History, Symbiosis.* The longer lived the corporation, the less clear the divisions between private and public and economic and environmental concerns. Short-term individual concerns meld into long-range corporate and social concerns. The short-term pressures may seem immediate and irresistible, but the long-term goals cannot be ignored for long. We may need electric power or paper now, but the cost cannot be the destruction of

the source of those needs. We need the social and environmental health and stability first and always. Partnership between unrelated species, say mycorrhizae and trees, becomes notable. Corporations would team up with other companies and social and environmental groups (the pattern could be industrial symbiosis). Pollution is the most limiting factor; possibly we could predict new corps arising to deal with pollution.

7.6.1.3.4. *Differences.* Although ecosystems can be long-lived—thousands of years for tropical rainforests—corporations can disband at any time. Furthermore, unlike ecosystems, corporations still seem to be bound inflexibly by the rule of two-year payback. This means that decisions are based on short-term return and not on long-term durability.

Furthermore, although large organisms are the case for mature ecosystems, the scale of many corporations is too large; the patterns are unsustainable—large institutions lose touch with their constituents, become self-absorbed and less responsible.

The differences between ecosystems and corporations allow for the possibility of changes. Human communities can redefine corporations and limit their impacts. They can change the charter of corporations for the benefit of the community. Corporate responsibility is more complex than a simple linear cost/benefit analysis. Using the metaphors of corporations as organisms and ecosystems, it is possible to outline a new set of responsibilities for corporations and a series of behaviors that human individuals and communities can do to integrate corporate behavior into the communities.

7.6.2. *Ecological Responsibilities of Corporate Organisms*

The public responsibilities of corporations, according to Harvard management, are to grow and prosper (thereby providing customer satisfaction, employment, taxes, and contributions to the economy) and to control their hazards. According to Milton Friedman, the only social responsibility of a corporation is to make money, by striving after profit as an efficient agent of production, although he admits that the corporation should conform to the rules and norms of society.

Profit making is a necessary part of a for-profit business, but not the sole reason for business. The best business serves public goods as well as private interests. (This is similar to Ruth Benedict's original anthropological meaning of synergy as it applied to individuals. In secure, nonaggressive societies, an individual serves her own advantage as well as that of the group with the same act. The institution ensures mutual advantage; the acts are mutually reinforcing. High synergy institutions transcend the polarities of selfishness and altruism. Virtue pays because the rewards for selfishness coincide with benefit for the society. The social structure of low synergy cultures ensures opposition and counteraction; the advantage of one individual is a victory over another, as in a zero-sum game.) This is necessary for employees, since they have to feel like their work is meaningful and contributing to the public good. The path of production should therefore serve public good as well as profit. Environmental and social problems should get as much attention, because their part of the process, as sales, finance, and production.

Economic recession may bring a re-examination of values, not only by individuals who may have less material wealth, but also by corporations that have emphasized growth. The public may insist that corporations consider social performance as well as strictly economic performance. The single economic purpose may only be the focus in a social ecological environment. Economic actions, such as where to build, who to relocate, hire, or dismiss,

will be subjected to greater public scrutiny. Corporations will have to adapt to changes in standards. Business cannot assert primary self-interest at a cost to the public or environment. Corporations need to keep track of their environmental impacts. Many of the problems that corporations face are connected to the problems of the environment and society.

Every corporation depends on the stability of the environment and on the stability of social institutions. The environment provides air, water, and land, and provides renewing (both physical and psychological). Institutions, from sanitation, police, schools, churches, and community centers, provide a supporting network. As these institutions wobble or fail, corporations may have to subsidize or replace them to survive. Schooling for example, is often inadequate to provide literate, numerate, ecologically, or imaginatively workers. Police may not be able to provide secure conditions on corporate grounds for female workers. Public transportation to plants from town may not be available in enough volume.

A corporation has traditionally been seen as a morally neutral body, but even if it has only to conform to the nominal rules of society, it is already a moral agent. Corporations are no more neutral than other organisms. Etymologically, the word moral means simply “living together.” Sometimes even routine business (nonmoral and nonenvironmental) matters become deeper ethical conundrums about justice. Many areas of moral concern already are recognized: Worker safety, affirmative action, advertising truth, foreign investments, and harm to the consumer, public, and environment. Corporate responsibility occurs wherever the interests or rights of a person, society, or ecosystem are significantly affected by the actions of the corporation.

Responsibility can be understood in terms of costs and benefits, that is, through operations and their consequences rather than abstract behavior. Every action entails a gain and a cost (or profit and loss). Profits and losses are distributed privately, socially, or environmentally. Unfortunately, the modern system privatizes the gain and externalizes the loss (to the “commons,” considered as a pool of “unowned resources,” where in traditional societies, it was surrounded by rules for use). As long as this is possible, it is profitable to charge the cost to the environment. Externalizing costs works fine in an uncrowded world, where the costs are negligible and can be absorbed by natural processes. Resources were traditionally seen as free for the getting; air and water were seen as free sinks. Modern economies, embracing the notion that “nature is capital,” draw on the accumulated “capital” of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth. Decisions regarding resources are made on short-term economic grounds and lead to material shortages and environmental degradation.

Similarly, labor was seen as minimum value. For example, the idea that “labor is a resource” implies that, like any common resource defined by industrial society, labor is cheap and can be used up. The real costs of free goods and externalities have had to be accounted for, yet—this often influences the selection of corporate priorities and growth. Furthermore, the production and distribution system for most corporations is linear (straight throughput) and not circular (complete recycling), although this is logical economically, given our frontier resource-use accounting. Major changes are occurring, though. The scale of civilization now makes externalization unfeasible. The costs of pollution and waste are being internalized; other inputs, such as labor and capital, are becoming more expensive. Corporations will have to internalize or be forced to internalize. With the internalization of costs (since the losses as well

as benefits will accrue privately), the system will benefit from intrinsic responsibility.

Corporations need to work cooperatively to make sure the costs and benefits are extended equally throughout the system. They could start by sponsoring the rational use of rare resources through taxation. Influence the government to determine priorities for wilderness areas or special landscapes. Beautiful, fragile, unique, or endangered ecosystems and species must be protected at the expense of commercial activity.

Corporations have at least three large, ecological responsibilities: To be Economically Healthy, to Preserve the Health of Natural Communities, and to Support the Health of Human Communities.

7.6.2.1 To be Economically Healthy

The first responsibility of a corporation is the maintain its own health, to mature organically, limiting its size and impact to the locality.

7.6.2.1.1. Create a department with ecological authority to envision long-range plans and impacts. Corporations need to react more quickly, to monitor their ecological and social environments for emerging patterns that determine their future. They need to anticipate and participate in the social and natural framework. A new department, with global, anticipatory functions could provide direction and continuity. Such a department could be justified in the same manner as military forces. Military expenditure is a nonproductive cost; its benefits are general and long-range, that is, it must discourage war in the next decade as well as in this one. Its scope of advice would include educational services as well as advertising, capital acquisitions as well as new products, plant engineering as well as security.

7.6.2.1.2. Plan all foreseeable consequences of a product. Advanced technology permits the power to change to overwhelm the ability to foresee the consequences of change. Avoiding the opposite actions of intentions (the enantiodromia recognized by the Greeks as the operation of tragedy) is extremely difficult. Good intentions are not enough: Labor-saving devices may contribute to unemployment and social problems; foreign aid may result in starvation for more millions as local agriculture cannot compete; the environmental management of some species for sustainable yield causes population collapses.

7.6.2.1.3. Determine the optimum corporate size. Limit the size of the corporation. After a point, growth results in inefficiency and nonadaptability. Development, on the other hand, can continue for hundreds or thousands of years. A smaller size could mean more flexibility and faster response to local conditions. Recognize material limits. The global economy is probably too large already to be supported by the natural systems of the planet. What is the upper limit to the economy of scale? Accept limits to growth based on materials and on nonrenewable or dangerous sources of energy. This should not limit development based on advancing technology and knowledge.

7.6.2.1.4. Adjust corporate strategies to changing values. Smaller social and cultural groups have different and diverging values, so corporations are going to have to adjust to a diversity of values instead of to a monolithic standard. Now, the structure of power is disintegrating (with information replacing things as wealth). The knowledge-driven economy is more decentralized and customized. This moves us towards customization of production and away from mass production. Change the shape of the corporation to a framework coordinating separate divisions sharing information. Each could react more quickly to market conditions.

7.6.2.1.5. Work to delineate a new information model of production in which the

stages of a process (capital, materials, workers, design, advertising, selling) are simultaneous and synthesized. The conception of the product is extended from design (even customer contributions and design of working conditions) to aftercare, including ecologically safe retirement and disposal (recycling). The notions of efficiency and productivity are changing. Innovation and computer technology shortens product life cycles. Production diversity is increasing. Convert the information model to an understanding model. Information is just data without appropriate structure. Provide a structure and material base for understanding through communication, education, and training.

7.6.2.1.6. Enter partnerships with the employees. Address the optimum productivity of employees. For instance, government studies show that half-time employees are more efficient than full-time ones. So adjust the work force to fewer, more flexible hours (thus avoiding layoffs during the transition). Increase worker participation. What is extent of worker participation in management of workplace? New forms of ownership could mobilize workers in a more efficient and democratic economy. Productivity is declining, so is job satisfaction. Efficiency and productivity are often less important than use and appropriateness. Better pay and shorter work weeks have not compensated for lack of worker control. Offer more control. Streamline the organizational structure. Organizing workers hierarchically is costly. The best path for organization is lateral modularity, not bureaucratic hierarchy. The levels of management could be reduced drastically.

7.6.2.1.7. Promote the principle of least effort, allowing the company to consume less, recycle, use longer, and avoid waste. Corporations could develop renewable energy sources. Reduce office costs through energy conservation plan. Use renewable energy sources. Corporations need to maximize recycling. Energy and materials can be used and reused, flowing through the system. Ship by the best transportation, probably rail. Cars are ecologically unacceptable forms of transport, yet companies intrinsically recognize them with large, free parking lots. Discourage commuting; encourage telecommuting or even alternate forms of transportation (bicycling, buses, and trains). Minimize wastes, for instance, by using permanent packaging. (Milk bottles and cola bottles can be reused forty or more times.) Conduct a complete series of audits, including an energy audit for every building, an environmental audit to determine negative impacts, from acid wastes or product disposal, and a problem audit, including inherited problems. Produce a comprehensive annual impact statement.

7.6.2.2 To Preserve the Health of Natural Communities

The second responsibility is to maintain the health of the natural communities—because environmental health is the basis for community health, and community health is the basis for economic health and worker health. The quality of life depends on the quality of the environment. If the environment is degraded to raise the quality of life, the effect will be very limited and never be self-sustaining. Fitting economic costs and needs to the limits of ecosystems and monitoring the economic process would reduce wastes and pressures on natural processes. The coupling of agricultural productivity to a solar budget, and the conscious restoration of degraded systems, would contribute to the health of ecosystems. Sufficient wilderness would allow the self-maintenance of global cycles. With the increase in security, wealth, and self-esteem, human populations could be dependent on ecosystem productivities and still be diverse and unique.

7.6.2.2.1. Be accountable for ecological impacts. Corporations will be held more accountable for their technological impact. New technology will be more closely regulated. Corporations could anticipate this by favoring open appraisal of new technologies. By studying the potential consequences, physical, social, and ecological, as far as possible into the future, of its innovations in information technology, a corporation can gain credibility. Otherwise, it can wait and be forced by public and governmental pressure.

7.6.2.2.2. Avoid interference with natural processes. Technological processes must be brought into balance with the cycles of the earth. They must not damage or degrade natural cycles. Avoid unnecessary harm. It may be appropriate to use trees or to compete with black bears for tree use, but it is never wise to destroy the ecosystem of trees and bears. Laws on pollution and noxious wastes have been notoriously lax and sometimes wrong-headed. Minimal acceptable tolerances are legal, yet people often prefer zero amounts of many substances. Minimal compliance with them is virtuous in comparison with many companies, but it would be better to lead to higher standards. Work toward setting zero-level goals. Do not dump exotic or dangerous wastes. Do not discharge quantities of 'safe' wastes.

7.6.2.2.3. Integrate loops and material flows; internalize cycles. This will minimize waste and the associated costs.

7.6.2.2.4. Corporations maintain building and plants in thousands of locations, each requiring support. Convert to ecological grounds practices. Forgo economic development of key ecosystems, which are not available for human use. Consider adjusting economic pace to natural rates; do not cut trees, for instance faster than they grow. Consider minimizing use of ecosystem productivity to the net ecosystem productivity, rather than the gross productivity, especially as regards fisheries.

7.6.2.2.5. Promote ecological design, which starts with questions. Is the product low-cost, aesthetically pleasing, and ecologically wise? Where does it fit in society? Ecological design, both responsible and socially responsible, must be radical, that is, rooted in a community in place. Membership in a place, in fact, leads to community. Corporations must become responsible members of the community. It would encourage an ecological approach to systems and processes in the whole environment, where the product, with its plant, engineers, and advertisers, is a link in a long biomorphic phylogenetic chain reaching from knotted ropes to surgical microchip memory implants. Ecological design has important characteristics for responsible technology: The products are designed by interdisciplinary teams considering all parameters and consequences; ecological sciences offer creative insights into design through a search for underlying organic principles; the product must be related to the particular environment, the tool is a link between human and environment.

7.6.2.3 To Support the Health of Human Communities

It is hard to protect communities when the way most business is done tends to disrupt community life. Because of its size, power, and intentions (for profit), the corporation should take higher risks than the surrounding communities. This will ensure the safety of products and wastes.

7.6.2.3.1. Support the community. Work place isn't just collection of individuals. It is a number of groups. Group interaction can change attitudes. A working community can build mutual responsibility. Show proper behavior; learn community etiquette.

7.6.2.3.2. Design the corporate structure and size for the community. Limit unnecessary

movement or disruption. Plan the shape, size, and products of the corporation to fit the local community. Encourage self-reliance in communities. Communities can be self-reliant by producing enough food and shelter, by limiting their population to what can be produced, by using local products and raw materials (soil, minerals, plants), by using general and not specialized machines, by having multipurpose factories, by networking with other communities, and by doing without things that are not needed (bombs, food additives).

7.6.2.3.3. Behave ethically. An ecological corporation could use corporate buying power to promote acceptable technologies and discourage unacceptable practices. Deal less with nuclear weapons contractors and more with solar energy companies. Deal less with one-shot paper companies and more with recycling paper companies. Boycott paper companies involved in Rainforest destruction or old-growth forest destruction. Avoid banks that invest in anything that brings a high return (from third-world debt to Amazonian destruction and South African discrimination). Favor peace-oriented companies as business partners. And refuse to participate in work that is socially destructive.

7.6.2.3.4. Participate in the economic and social functioning of the community. Economic development and social progress are necessary for the welfare of humanity, but must be conducted with environmental knowledge. The goal of economics and politics is to provide suitable and comfortable human habitations and meaningful activities. Human settlements must be planned and constructed within environmental constraints and according to ecological priorities. Work to preserve the structure of the natural and social communities. Corporations can encourage decentralization and restore schools, clinics, and shops to local communities. Offer cooperative control with the community. Change the pattern of ownership to reflect employee and community participation.

7.6.2.3.5. Promote ecological education in a total context and interdependency. Encourage cultural traditions to stop letting social and spiritual needs be subverted by economic ends. Help lead the young into their adult responsibilities through training and participation (perhaps apprenticeship programs). Educate for appropriate ways to achieve wealth and well-being. Teach appreciation of services rendered by nature through flows and cycling. Point out the unexpectedness of consequences of even simple corporate interventions and innovations (positive feedback, biological concentration of poisons, and synergetic effects of simple new chemicals like CFCs).

Emphasize that a fixed set of ecological parameters in an ecosystem can not be maintained sustainably, because the system is dynamic and changing. For example, where do computers fit in schools? Children do not need computers to develop the powers of thought, but they do need an ecological curriculum where animals display greater powers of mind than computers or machines. The important technological advantages of a computer, word-processing, database searches, complex connections, and rapid computation, are not really needed before high school, unlike myths, languages, and physical activities.

7.6.2.3.6. Implement community responsibility. In education, integrating business with humanities; the responsibility for the welfare of the citizens belongs in the community, as does education, safety, and the whole infrastructure. In management development programs and management as source of influence by setting goals, modifying structures, and introducing criteria for measuring progress. By the Board of Directors, the architects of responsibility and stewards of all resources. By the government, in its legislative, judicial, and regulatory functions, providing rules and permitting freedom.

7.6.3. *Summary: Changing the Model*

The corporation, regardless of its legal definition, is a long-lived, collective, impersonal body. Yet, it has more physical, legal and moral power than any one individual. Its investment is long-term in actuality. Many stockholders keep their investments for decades or a life-time. They are not concerned about only one dividend. Like the corporate organism, they want the long-term outlook to be positive; they want to know that their investment is stable and that the quality of life it encourages or supports is continuous.

The complexity of environmental problems should not permit escape of responsibility. The context of corporate responsibility falls within the spectrum from individual responsibility to social responsibility (the designation of property or trading conventions—capitalism or communism). Perhaps that responsibility could be enforced if the entire earth were incorporated and concerned with maximizing its own values: healthy beings in living contexts. Certainly not having 'free' services and resources would force corporations to internalize all costs of production.

In any case, there are strategies that a corporation could pursue to become ecologically minded. Instead of treating decisions as trade-offs, an ecological corporation could aim at a congruence of moral, economic, and ecological objectives. Responsibility could be manifested in organizational structure, manufacturing, and marketing practices, without departing from economic decision making.

Such a corporation could bring corporate research and development capacity to bear on the transition to a sustainable society. Where technologies play a role in the transition, companies can assume social responsibilities equal to their size and wealth. By commanding their vast resources, corporations can ease the transition to a sustainable society (which would actually meet their needs for stability). The model of corporate life needs to change, from dependence on continuous growth (of profits and waste), to being based on stability, sustainability, cooperation, justice, and respect for nature.

7.6.3.1. Designing the Business Model

Corporations could be subsumed under an ecological business model that emphasized the diversity of institutions, such that nonprofits and trusts could compete with profit-making institutions. So much of business is an "underground" reciprocal form that the strengths of those forms have to be considered and factored into the entire business model. These forms might be far more useful and beneficial on a smaller scale of operation.

(Being edited)

7.6.3.2. Designing the Economic Model

The overall model of the economy itself has to exhibit concern for the survival of the members of a society as well as the social and ecological structures of which they are members. The model has to be able to respond to crises by changing its function to repair the breaks or wobbles rather than simply increasing consumption. The model has to be self-examining, to identify destructive economic principles, standards and trends and then analyze the forces that form them and drive them. For instance, is the momentum of the dominant economy causing it to be slow to respond to negative trends? Or is it our value system, much of which is based on the metaphor of machines?

We need to change the operating rules—the principles, standards and practices—to allow profit only after natural systems and human needs have been restored to health and protected. Profit is a recent idea that arose from a system concerned with raising capital for exploration and trade. It has become a trap that has been made a critical factor of modern economics, which is riding a sudden exponential expansion based on fossil fuel use, resource dumping, the continuation of extreme inequities—and complete indifference to environmental costs and human suffering. Profit is being driven to growth along with the conversion of resources and fuels to commodities.

Yet, it does not have to be. An ecological economic model shows how human welfare can be increased without growth or profit, using rules that limit drawdown or overshoot, or any of the other catastrophic trends that are deepening. It would slow resource depletion while increasing productivity and efficiency. It would reconnect processes into cycles of reuse and lower waste streams causing pollution and dead end sinks. More than just the purchase of basic goods, the economy can provide a spectrum of services, while protecting the sources of energy, materials, and labor. It can make the strong connections to ecosystem and community health, to the availability of good jobs and security of homes and work places. With strong connections to education and healthcare, with limits to salary differences, the ecological model should provide an ethical responsible approach that could lower poverty rates, unemployment rates, and all forms of sickness. By understanding the limits of ecological and political systems, by respecting the properties of healthy ecosystems, place and cultures, ecological economics can still provide for the needs and luxuries of most all of humanity (allowing self-sufficient cultures to remain mostly outside of a new economic system).

Of course, a good government could oversee the shift in economic models and coordinate the responses of other governments. The government could intervene if necessary to set the standards and goals that an ecological economics could implement ethically and efficiently. Common lands need to be regulated for the health of the lands first. Public goods, in the form of clean air and water, biodiversity and monumental places, need regulation for use and protection. A government can offer incentives as well as regulations and laws. Incentives can range from tax shifts to and higher wages for less desirable (or more dangerous) jobs. Government can strengthen national economies, which are the basis for self-sufficiency and self-reliance, and control the global economies to make them more committed for their social and ecological responsibilities. This may mean controlling and regulating global corporations so that they cannot take advantage of some resources and citizens to continue an unsustainable hypergrowth to make obscene profits.

7.7. Regional Design Challenge: An Ecological Design for Reforesting Ireland

We propose to redesign Ireland with a comprehensive regional ecological design process based on the biohistory of its ecosystems, the cultural values of the people, and knowledge of the limits for sustainable development. Creating this regional design requires common sense, as well as knowledge of ecological design, critical thought experiments and eutopian strategies. This approach makes the ecological and cultural limits explicit and sets equitable goals within the limits. As a synthetic framework, it provides for the health of the ecological system, as well as for the health of its human inhabitants.

This regional ecological design considers the whole system and designs communities for an optimal fit within the limits of the system. Communities should be designed for an optimal fit within the limits of the system. This kind of planning is a conscious adaptation of the benefits of technology to the traditional idea of physical and cultural limits.

7.7.1. Context & History

The design uses five general design steps. The first is to identify the place within its natural boundaries. Ireland is a uniquely identifiable island ecosystem, with recognizable boundaries and a unique history and character. It is part of a larger regional context, with neighboring landmasses, as well as oceanic and wind patterns. All systems on the island should be inventoried and monitored. Second, an optimum amount of wilderness to preserve the natural cycles indefinitely should be calculated. If the current area is less than the calculations, as it most likely is in Ireland, the difference should be restored and set aside as a reserve. Third, the remaining area would be zoned for appropriate use, including conservation, preservation, and artificial areas, with historical, cultural, and functional importance. The infrastructure, including agriculture, energy generation, and urban areas, could be reworked to be more appropriate and efficient. Fourth, we need to identify the resources available for human use, including raw materials and the biological productivity of the areas (this productivity could be used to calculate an optimum population). Then, we need to plan the long-term use of resources, identifying appropriate and best uses. And, fifth, we need to apply cultural modes—in style, values, and technology—to suggest limits on technology and population. This would preserve cultural values. Encouraging popular participation in an open design would allow people to invest in the design.

As part of the formulation of a design, it is crucial to examine the natural and cultural histories of Ireland. We need to understand interactions in the ecosystem, as it existed before humanity, as it was lightly settled, and as it is now, dominated by humanity and coevolving with culture.

7.7.1.1. Identifying the Regional Context

Plate tectonics shaped Ireland over millions of years (tectonics refers to the rearrangements of large plates, part of the crust of the planet, over hundreds of millions of years, driven by the uprising of molten magma from deep inside to the surface, as well as subduction of old rock below the crust). Over 450 million years ago northwest Ireland belonged to the Laurentian landmass (now mainly represented in North America), while the rest of Ireland belonged to another plate. The two parts finally merged about 400 million years ago when the separating

ocean closed and the two plates collided. The impact of those collisions is visible in mountains in the north of the island. The plate with Ireland moved north, reaching the equator approximately 300 million years ago. At that time, the Atlantic reopened and started widening, due to volcanic action. About sixty million years ago sea-flooring spreading created a period of magma-spreading and volcanic activity that affected Ireland, as well as western Scotland, Iceland and Greenland.

Because of this complex geological history, the rock cycle in Ireland shows many types, from the very old metamorphic rocks in Galway to the intrusive igneous rocks in Donegal and the sedimentary rocks in southwest Ireland in County Fermanagh. The most widely distributed of the last is Carboniferous limestones, which has underground drainage, but is also overlain by glacial drift.

In the last million years, a series of glaciations covered most of Western Europe, and most of Ireland, where the most widespread created a dome over southern Ireland. The creation of a multitude of low hills, known as drumlins, may have contributed not only to the psychological character of the Irish, but may have made it difficult for the English to control parts of Ireland, such as Ulster. The influence of the ice caps extends from the rising coastlines to the carbonite mounds offshore (likened to coral reefs in the tropics).



Figure 7711-1. Location of Ireland

7.7.1.1.1. Climate & Soils

Sometime before 70,000 years ago, glaciers started forming on Ireland. They expanded and contracted until about 15,000 years BP, when the ice began to melt. The climate warmed considerably and some plant life started to colonize the island about 14,000 years ago, except for the northeastern part of the island, which was still covered with ice. The effect of the warming was accentuated by the topography, a low-lying interior plain ringed with mountains, which directed the drainage inland, rather than directly to the sea. Shallow lakes dominated the midlands. Meadows formed stayed open for several thousand years, until junipers could use the poor soils. Animals, including the Irish Elk, Giant Deer and Reindeer, crossed land bridges from Scotland and England, which were connected with the rest of Europe.

The Younger Dryas event, about 12,000 years ago, caused temperatures to drop and glaciers recovered some areas for about 1300 years. A loss of food caused the extinction of Irish Elk and the extirpation of Reindeer. As the climate again warmed, juniper spread again, and birch appeared. Pine continued the process of forestation, moving several meters per year. Willows and birches arrived as wind-blown seeds. Elm and oak took several hundred years

longer, although their seeds may have been carried by crows and pigeons. New animals crossed the land bridges as well, including Elk (Red deer), wild boar, red squirrels, pine martens, wolves, and fox. Eagles, other birds of prey, and game birds arrived. Fish, such as salmon and trout, started to inhabit streams and rivers. After 8500 years BP, the sea level rose and severed the land bridges with England, cutting off most plant and animal migrations. Because England was still a peninsula of Europe, migrations continued there, giving it a greater variety of plants and animals than Ireland. As sea levels rose from melting ice, that bridge was also submerged. As the immense weight of glacial ice melted away, the land rebounded.

Glaciation had a tremendous impact on the environment. Cirques and glacial lakes created water supplies (and the possibilities of hydro-electric power and tourism in glaciated regions). Deposits of boulder clay and old glacial lakebeds created fertile land for farming in some areas; other areas have badly drained, boggy land. Abundant rainfall and runoff filled the lakes with water and mud. Water plants lived and died, forming a peat layer on the bogs. Sphagnum moss raised the bogs and blocked channels of water flow, causing soil saturation and more bogs. This expansion of bogs limited and reversed the growth of forests.

The Gulf Stream brought warmer air and the climate became temperate maritime. Most precipitation occurs in the winter months, except near the coasts. June and July can be sunny. Prevailing winds are from the southwest, and most precipitation falls in the west.

7.7.1.1.2. Animals & Plants

Trout, salmon and Arctic char made their own way from the ocean into newly forming rivers. Freshwater eel, lampreys, and the rare pollen are native now. A few species were introduced by people after the 12th century, such as pike, roach and dace.

Eventually over a 1,000 plant species became native to Ireland. The quick isolation of Ireland limited the mammal species to 28, compared with 55 in Britain. Moles are absent, as well as burrowing common shrews and field voles, which should have been able to make it across the bridge. Brown bear and wolf were early predators; fox, badger and wildcat followed in the Neolithic. The pine marten followed them. The Irish stoat, Irish otter and Irish mountain hare may have been there already. Other animals were introduced in historical times: The rabbit by the Normans, the grey squirrel by the British from America, and the hedgehog possibly by the French; the bank vole and the American mink were escapees from ships or farms.

Ireland's woodlands are the eastern part of the temperate mesophytic deciduous broadleaved forests that extend across Europe to the Ural Mountains. There are at least three forest formations in Ireland, including acidophilous oak forests, mixed oak-ash-hazel forests and mixed alder-oak-ash forests with willows. These woodlands are similar in species composition and distribution to woodlands in Britain and the continental mainland. Due to the mild, moist climate and the different species composition, especially the absence of numerous species, Irish forests are distinctive and unique at a regional and global level.

7.7.1.1.3. Forest Patterns

The pattern of forests had been established between 7,000 and 5,000 years Before the Present (BP). The climatic optimum of the Holocene promoted mires in the lowlands and at high altitudes above the treeline, which may have been dominated by Scots Pine, with some sub-alpine juniper or birch scrub. The pine forests represent an extension of the boreal coniferous

forests of Europe. Boreal deciduous birch woodlands continue through northern Norway and Lapland along the Arctic seaboard. Alder concentrations are patchy because of its habitat requirements and reproductive ecology. It has very specific habitat requirements, which are limited by climate and hydrology.

By this time, possibly 65 percent of the land area of Ireland had natural forest cover (surprisingly less than Europe at 73 percent but well above the planet average). Original forest as a percent of land area refers to the estimate of the percent of land that would have been covered by closed forest about 8,000 years ago assuming current climatic conditions, before large-scale disturbance by human society began. Figures are based on a map of estimated forest cover developed by the World Conservation Monitoring Centre (WCMC). About half of this may have had a relatively open canopy (from 10-20 percent coverage, a tree height of 5 meters, and with a continuous grass layer underneath) and most of the rest was partly closed (25-50 percent). There were some scrublands and grasslands. Because of the climate, there were essentially no drylands (dryland falls within various aridity zones, with a low aridity index, the ratio of average precipitation to average transpiration), deserts or areas of sparse vegetation, or extents of covered by ice.

7.7.1.1.4. Zones

Ireland has been subdivided into a series of physical regions largely formed by the effects of glaciation: The Antrim plateau, the Drumlin belt, the western Caledonian province, the Mourne uplands, the central plain, the southern hill and vale province, the south-eastern Caledonian province, and the Munster ridge and valley province. In the North-Western Caledonian Province, the Ice Age stripped the whole region of soil, and today even the valleys have a lack of soil. The region is thus agriculturally poor, with settlement being limited to the coasts and the upland areas generally being left to small lakes and bogs. Agriculture is possible in these sheltered Glens, but the top of the Antrim Plateau remains largely uninhabited. The drumlins are poor agriculturally, and the hollows between them tend to become water-logged (although the lower rainfall in the east means that this is more of a problem in the west). In the Western Caledonian Province almost all the soil was scraped away in the ice age, and the region now consists of barren rock, bog and small lakes. There is almost no human settlement in the interior. The Central Plain is a large, low-lying region dominated by the Shannon basin underlaid by limestone rocks and covered in glacial drift, resulting in some good fertile agricultural land? The Southern Hill and Vale Province is really an extension of the Central Plain. Here, the lowland relief has been interrupted by the remnants of ancient shale. The south-eastern Caledonian Province consists of a granite mass which includes the Wicklow Mountains contains blanket bog which is suitable for extensive sheep-rearing but is sparsely populated. In the Munster Ridge and Valley Province differential erosion has produced parallel ridges of sandstone mountains with fertile limestone floors between. In Kerry and Cork, glaciation accentuated this topography.

7.7.1.2. Patterns of Plants & Animals Mixed with Artificial & Cultural Areas

An ecological history would trace the development and succession of ecosystems from the postglacial to the modern agricultural and urban grids. A survey would identify areas to preserve and restore, as well as identify common areas to be used for human and ultrahuman exploitation, and those artificial areas used for exclusively human purposes.

7.7.1.2.1. Human History of Ireland

After the last ice age, Ireland was covered by ice until relatively recently (10000 BP and then partially until 6000 BP). Ireland's vegetation developed, but it never reached the same levels of diversity that developed in the rest of Europe. Forests developed and covered a large area of the island. The shallow lakes created by the movements of ice filled in and became raised peat bogs. Many kinds of animals used the forests, including red deer, Irish elk, rabbits, squirrels, and hedgehogs. Birds were abundant, especially geese, although many classes of fish and amphibians were not represented—there were no turtles or, famously, snakes. Other animals, including humans, were able to 'invade.'

The first Mesolithic hunters and gatherers (foragers) may have crossed from Scotland in wooden boats around 9500 BP, although fluctuating sea levels may have allowed traffic over a land bridge connecting western Scotland. These foragers may have concentrated by shores and waterways, which would have limited their impacts to those areas and not on the developing interior forests. After the last of the ice (and the end of the Mesolithic era around 6000 BP) foragers started using coiled pottery for storage. Men of the community were able to hunt large deer and elk, or fish, while women were able to gather nuts, fruits, berries, and herbs from the forest. These societies were traditional hunters and gatherers. By as early as 5000 BP, the ideas of farming spread from Mesopotamia and Eastern Europe. These Neolithic farmers enlarged and prepared their fields by girdling or cutting down trees with stone axes. Removing the forest canopy allowed light to reach low, grassy crops, like wheat. Often, when the nutrients in the soil were exhausted the farmers cleared new fields.

Additional invasions brought domesticated animals, including dogs, sheep, and cattle. New technology, in the form of iron plows and harnesses for animal-drawn plows accelerated deforestation until the 1600s, when British merchants removed the remaining trees for building and shipping, rendering the island treeless, but still green with grasses. The new ways of life with agriculture emphasized work and family size to produce large surpluses for growth and trade.

There have been two human cultural patterns in Ireland: An archaic one that offered tribal egalitarianism and limited impact, and a technological one based on feudalism, republican democracy and industrial consumption. The first cannot compete against the second, but it has not been completely eliminated either. The monoculture of coke and cars tends to overwhelm the subtle adaptations of foragers, for instance. A coherent culture provides a secure platform for exploration and open-mindedness; it provides criteria to judge the 'special effects' like television. A conscious culture, with elements of foragers and early farming traditions, with appropriate technology and knowledge, could improve and guide the culture of the market place; television, as does telephone and radio, unites people through information, but a common culture is indispensable for uniting their hearts.

There are numerous advantages of way of life of Celtic foragers: Fewer working hours (about 4 per day); more leisure to talk, sleep, engage in rituals; a diverse and healthy diet; deliberate underproduction, below the maximum levels; deliberate control of population growth below maximum levels; and deliberate under use of resources, resulting in small ratio of people to resources. Subsistence economics means simply that surpluses are not accumulated. This might make them more vulnerable to food shortages, although the ratio reduces the possibility; furthermore, industrial cultures have far higher incidences of starvation. Ironically,

industrial culture is approaching a form of subsistence now, in the sense of a source or minimum of necessities—we cannot leave after we have eroded the soil this time. Perhaps we will be less tempted to exploit the land for short-term profit, since we have to remain after the profit leaves. It may be that Celtic foragers require 10 times the space as rural settlers; and, it may be that these settlers require 10 times the space as their urban counterparts. Or, it may be that people would prefer to have more discretionary time and less work time, as was possible in archaic societies.

Athelstan Spilhaus suggests that a good index of the quality of life is the number of choices a society provides for its individuals. Western culture has valued the pioneer life of the individual—independent, self-sufficient, free to choose different life styles—but with more people, the choices are being subtracted. The more we value open spaces, the fewer people the area can support and still have the open spaces.

The cultural landscape changed slowly until the 1900s, when many bogs were drained and more forests cut. Overgrazing and erosion on uplands, and the fencing of commons, changed the vegetation and the water cycles. Small forests were planted for aesthetic reasons on large estates. The building boom required more rock, gravel and sand. As more energy has been needed, the peat-fired power stations have been replaced by coal and oil facilities, which are being replaced by wind farms. The recent demand for recreation has resulted in hundreds of golf courses, each occupying up to 60 hectares of land. Large cities, with their water and energy demands, and new buildings, homes waste disposal areas are having massive impacts on the lands. Combined with global patterns of change, such as atmospheric heating, water regimes, some shorelines, and conditions for vegetation, including domestic crops, are expected to change.

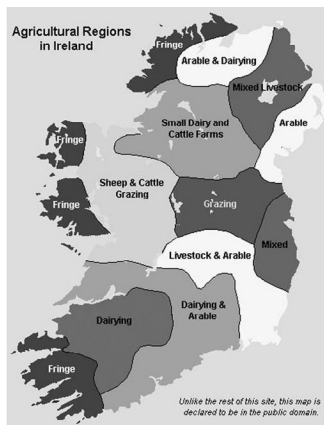


Figure 77131-1. Agricultural Conversion of Ireland

7.7.1.3.2. Forest History of Ireland (with Humans)

The small remaining native woodlands or old-growth forests represent small ‘hotspots’ of biodiversity, with small habitats for a diverse range of fauna and flora. The native woodlands have contributed disproportionately to Irish history and culture, in numerous references to native trees, place names and song. For instance, the ash tree is synonymous with the national sport of hurling and continues to be part of sports culture. Recently, the People’s Millennium Forests Project recognizes how important forests are to Irish historical and cultural heritage.

Although virtually all of the original Irish forests have been destroyed, remnants of

woods from the Middle Ages still exist. Some ancient woodlands regenerated from the practice of coppicing (allowing the trees to sprout back from the trunk). Population pressure and the constant creation of farmland were responsible for most of the loss, although natural bog expansion continued. In fact, the clearing of forests may have accelerated the process (based on evidence of stumps in normal soil under bog).

In the Mesolithic, elm dominated many forests, but by the Neolithic the remaining woods were composed of oak and hazel, on land too infertile or too steep to be useful for agriculture. Even these small remnants were replaced by conifer plantations in the 1800s, as part of the modernization of forestry on the German model. England and the United States had also followed this scientific fad of destroying ancient forests, although by the 1900s, The English Forestry Commission, and later, the US Ecoforestry Institute, were working to reverse the effects of this massive replanting. These new studies, also recommended by the Forests Project in Ireland, ties together different methods and different lines of evidence, from written records and pollen analysis to archaeology and ecological experimentation. The challenge still remains to understand and account for the changes that require longer than a human lifetime.

7.7.1.3.4. Technology & Urban History

Just as important as any calculation of the population in an area is the rate of resource use by that population. Grasslands were the basis of early civilizations, and few regions have been altered as thoroughly or as devastated by human occupation, by overcultivation and overgrazing. Using too many resources, such as water and timber, too fast can make deserts.

We are digging up metric tons of minerals per hectare. We are draining the aquifer for our irrigation. We are mining the soil for everything it has and letting the rest erode. We are using 10 to 30 times as many resources, e.g., 94 million Kcal and 2.63 million liters of water per person per year, as foragers did 500 years earlier. Are we 10 to 30 times as happy? Indigenous peoples did not use resources at an accelerating rate. They were limited by their technology, but more importantly by their wants, as taught in myths and stories. Our high rates are clearly unsustainable. The difference is in our technology and values.

Technology can be used to expand or contract resources. Technologies have the capability to minimize the use of resources, but they also have negative effects. Breeding, fertilizer, pesticides, and modern equipment have certainly increased agricultural production, but the negative impacts of genetic loss, soil degradation, erosion, and pollution decrease actual and potential productivity. When all factors are combined, and total energy cost is compared with energy production, the result is disappointing and does not compare well with traditional methods, using draft animals and human labor.

In another instance, technology has greatly increased the kind and quality of materials used for buildings and machines, especially aluminum and other light metals and silicon constructs. Yet, the scale of technology produces pollution that reduces the productivity of natural and agricultural systems. Unbridled, unconscious technology has given us benefits, but only at the cost of irreplaceable stocks of energy and environmental degradation. Instead of expecting technology to triple or quadruple our wealth, it is more likely that it has barely had a temporary positive effect. Making technology appropriate, responsive, and conscious may go a ways to increasing its positive impact. Two technological processes are especially important, substitution and recycling.

Substitution is one way to avoid shortages of resources. For instance, petroleum products

have substituted for rubber from trees for many uses, including tires; aluminum, relatively abundant, is substituted for copper, even though its electrical properties are less desirable. Plastics, also from petroleum, are used to substitute for wood, leather, and metal in many industries. Some substitutions may temporarily ease pressures on biological systems, but they depend on the supplies of petroleum, a practically nonrenewable resource. Therefore, in considering substitution, we should concentrate on materials that are plentiful and local rather than scarce or remote. Basalt is a good example. Perhaps wheat chaff is also. There are not substitutes for everything, so there must be a minimum of irreplaceable stocks.

New technology has been a primary force for change for decades; but some technologies, like computing or genetic engineering, may lead to opposite effects from the intended ones. The use of new tools may have unexpected effects. For instance, mass-produced computers may lead to individual autonomy, as well as invasion of privacy. New energy technologies could have the same effect. Small-scale water power plants could lead to decentralized living; or energy-saving devices could result in more energy being used.

7.7.1.3.5. Settlements & Cities

The history of settlements in Ireland followed a similar pattern to those in Mesopotamia and Europe. The first permanent settlements, such as Dublin or Limerick, seemed to have been developed by the Vikings as trade ports. Settlements became larger as agricultural surpluses needed to be stored and protected, allowing many new specialties to arise relating to that. Many of the cities were walled for protection and included large buildings for government and worship. Normans built walled cities, such as Kilkenney. English settlers and traders also build planned towns and walled cities, such as Ulster and Munster.

Derry, one of the longest continuously occupied places in Ireland, became the first planned city. Beginning in 1613, walls were built around it, followed by a new cathedral twenty years later. Formerly a monastery occupied the site, which was named after an oak grove on the hill. As Irish cities became subject to British trade laws, many cities such as Cork or Galway, became impoverished. Several 'utopian' settlements and model villages, such as Rahaline or Kiltrush, were founded in Ireland in the 1800s.

As industry developed, some towns and communities became protectors of the environment, basing their beliefs and actions on local heritage as resistance to the overweening technologization and industrialization embraced by industries and the nation as a whole. Ireland now has six major cities, Cork, Dublin, Galway, Kilkenney, Limerick, and Waterford.

7.7.2. *Sketching a Design for Ireland*

In place of a comprehensive design, this thought experiment is offered to describe an optimum human presence within ecosystem restraints; it is a deductive, synthetic, conceptual model based on data generated from research on biological productivity, the rates of resource use, and cultural valuation. It also considers minimum wilderness preservation, air and water quality, genetic minima, nonrenewable resources, appropriate technological innovation, the importance of cultural frameworks, adventure, research, beauty, uniqueness, and other intangible experiences.

A deductive approach is necessary because accurate measurements of productivities in most ecosystems are lacking and exactness in values is misleading. A synthetic approach is necessary to integrate quantitative and qualitative data. In combining measures of qualitative

and quantitative, it is simpler to set aside the first and then to calculate the second. The model must be conceptual because of the inherent fuzziness of the systems.

This model design is in harmony with strategies for sustainable ecosystems, the conservation of biological diversity, and aspects of global change. This model design attempts to work out plans and policies for long-term environmental stability by paying attention to the architecture of physical and social institutions, that is, to buildings as well as politics. The goal of planning is to enhance life—all life, not just human life—so the model is not restricted to one species at one time.

As a design process includes the planning of ecosystems, this means a fourth and fifth level of design—notice that numbers one through three are properties of traditional applications of design: (5) Regions, landscapes, and watersheds and airsheds, (4) The community, for instance forest, city, or corporation, (3) systems, such as ecosystems, traffic, or industrial areas, (2) products, as habitats, houses, roads, or plant sites, and (1) components, such as trees, fungus, bats, tools, rooms, cars, or land. Many problems occur below level three—more are to be expected at the new levels four and five.

All levels of design need to be addressed, from the conceptual to the political, and are involved in all stages of the process. This involves new challenges for ecological design, which has to address all five levels simultaneously: (5) Relate a project to its regional context (fifth level of design); this is the level of regional cycles relating to precipitation and waste recycling. (4) Relate a project to its ecosystem context (fourth level of design); be concerned as much with cultural survival, justice, and wilderness preservation as with efficiency and aesthetics. (3) Consider the whole perspective (third level ecocentric, perhaps)—the proper vision is of the whole community in which we dwell—and apply ecological concepts, such as networks and carrying capacity. (2) Make designs that are anticipatory, flexible, pluralistic, polyvalent, and polytechnic (second level); make open guidelines for long-term decisions. Essentially, work backwards from values and goals, and from the bottom up and inside out, drawing designs from the genius of place. (1) Finally (first level), participate in place, care for all inhabitants, and assume responsibility for the designs. One of the shortcomings of design has been the lack of consideration of the higher levels, which can result in specific problems with safety or recycling.

Ecological designs can be applied in eight stages. These stages should be typical of all designs:

- First, Decide to design; Use a design management matrix, review the situation; Evaluate ecological history of the site, observing patterns of movement; Account for interconnectedness, population change, land use, building and development, boundaries, limits, and life; Conduct ecological and functional analyses.
- Then Inventory, record all of the resources, from physical resources to cultural resources. Survey the area and create base maps, from geological to zoological maps.
- Next, evaluate the interactions in terms of impacts, needs, goals, and limits. Assess the whole system. Delineate and balance components.
- Create a series of plans, from the site plans to value plans. Integrate with biosystem services. Kinds of integration: horizontal, Vertical, temporal. Consider aesthetic-perception factors.
- Start to design, which is a community process requiring the participation of all people, including the elderly, handicapped, and poor, as well those ultrahuman beings who cannot

voice their concerns. Synthesize simulations and models (conceptual, capability, and suitability). Make another series of plans, from landscape plans to policy plans, within a master design.

- Implement the design together. Use appropriate measures and techniques, emphasizing native species over an adequate time period to ensure the stable processes of transformation. Create new connections, Reduce unwanted effects, such as road effects or heat island effects. Integrate into context. Optimize passive mode integrate water, biomass, materials flows. Conserve water and energy
- Maintain and manage design. Provide services for continuity and management. Monitor and improve constantly. Monitor, Reassess.
- Prepare for undesign and disintegration.

Ecological design must work within the components, structure, and function of ecosystems. Unless it does, it will not be long-lasting or satisfactory. Because ecological design has to work with wild ecosystems, whose aspects are often ambiguous, fuzzy, changing, and general, design has to be able to work with these aspects. Furthermore, the design has to work within the constraints of the ecosystem.

7.7.2.1. Setting Ecosystem Goals

Before any goals are set, there has to be a surveying and monitoring plan. The ecological survey would identify biogeochemical cycles and limits. It would survey all minerals and energy sources on the island. Plants and animals would also be surveyed and then monitored for presence and health.

Ireland has 70286 square kilometers of land. Urban land is less than half of one percent of the area (and about half of the area in natural forests). Just over 2 percent of forests are protected. Currently, there is seven times the area of plantations as natural forest. Most of the plantations are pine, for economic reasons.

Forests should be 50-80 percent coverage. Agricultural coverage should be reduced to 8-10 percent outside of cities. City coverage could remain at 0.5 percent, but the agricultural space within would need to increase.

7.7.2.2. Setting cultural goals

Culture changes as it develops, but we need to specifically address the properties of a culture to realign it with new knowledge, as well as with many other cultures and ecosystems in a global framework. This approach would try to make the metaphors and goals of a culture conscious to improve the weaknesses of traditional culture as well as develop its strengths.

7.7.2.2.1. Technology Goals

Ireland embraced higher technology, especially automotive and digital technology, that resulted in an economic boom beginning in the 1980s. Now, cars, computers, Apple iPhones, and other items are manufactured there. There have been attempts to attract foreign investment in life science technology. Ireland's economy has evolved greatly, becoming more diverse and sophisticated than ever, by integrating itself into the global economy. By the beginning of the 1990s Ireland had transformed itself into a modern industrial economy and generated substantial income that benefited the entire nation. Although dependence on agriculture still

remains high, the industrial economy is producing goods as sophisticated as any from other nations.

Still, the technology has been used without goals or planning. How much technology is needed? Which technologies should be avoided or rejected? Some of the technologies are leading to increases in pollution and physical harm.

7.7.2.2.2. Setting a Population Goal

Is 8 million people in Ireland too many? Is 5 million? How many more people could live in Ireland sustainably? 4 million? 1 million? Is this number above or below some maximum carrying capacity? There is a maximum carrying capacity for this region, as well as an optimum. The carrying capacity is the population sustainable on a long-term basis of renewable and nonrenewable resources. For humans, this capacity must include domesticates, as human equivalents, since many domesticates compete for protein consumption. Domestic animals can extend the carrying capacity somewhat, since many of them consume agricultural wastes or use lands marginal for agriculture, but they are not as efficient as wild populations. Technology can expand the carrying capacity to some extent, with higher yield crops and resource substitution, but also it reduces the capacity with unforeseen effects, from the use of pesticides, for example. War and social disorder would reduce the ultimate capacity. Furthermore, the capacity decreases as the per capita use of energy and resources increases. Carrying capacity calculations often just consider food energy, but all needs—clothing, shelter, transportation, information generation, and aesthetic satisfaction—must be included.

A number of assumptions are necessary to calculate an optimum. Calculating a population based on plant productivity is relatively simple. Ireland could support probably a maximum of 8 million people if every system was dedicated to human consumption. However, considering the need for resources and the ubiquitous Law of the Minimum, the maximum goes down rapidly. Economists have claimed that the minimum does not apply in a growing system; alas, the modern system has been growing through transformation and conversion and not real growth.

The current high levels of population, at a high range of standards, can only be maintained through the constant takeover of natural habitats for arable land, or through the drawdown of fossil fuels, or by economically cheating the poor and powerless. Since the quantity of wild lands and fossil fuels is quite limited, either human populations must adjust to renewable resources or technology must provide substitutes, to avoid an eventual crash.

Eugene Odum suggested using land area as a measure of human carrying capacity. The minimum per capita acreage requirements, for a temperate area like the Georgia in the USA as a model for a quality environment, is just over two hectares (5 acres). The natural areas are based on minimum space needs for watersheds, as estimated by land use surveys. Food-producing land includes acreage for domestic livestock. Using Odum's technique for Ireland, assuming that wilderness area has been considered in the calculation of natural areas, and converting for the differences in productivity of ecosystems (about the same as Georgia), the population calculation comes to 3.4 million people. This figure, however, does not include trade land, that productivity needed to trade for necessities, such as rare metals.

The human population of Ireland can be related to land area, productivity, technology, and culture in one algebraic expression. An optimum population (P) is calculated by adding the total annual agricultural productivity (in Kcal) to the total annual resources (in Kcal) of

might approach some minimum. The likelihood of this possibility is low. The early hunters and gatherers did not approach it at 50,000. The minimum number for genetic health, for the entire species, could be only 5,000 individuals. For a guarantee of fertility, or for a minimum for social contact, the population minimum might be 50,000.

Ultimately, our cities depend on agriculture, and agriculture depends on wilderness—for recycling, pest control, genetic diversity, soil-making, and water purification, among other things. Our cities depend on cultures for their vitality, and cultures depend on wilderness for their context and imagery. Therefore, we must preserve wilderness areas and cultural knowledge first.

Ireland has adequate resources to feed and care for its current population—at a reasonable level. The rates of use of energy and some minerals are far too high. Our demands and values are not related closely enough to the particular beauties and limits of our home ecosystem. We have to fit our goals within the limits.

Reducing the population can be done with incentives and behavioral change. It would not require legal restrictions, conception control, or abortion. Reducing the population with incentives and agreements could make a significant difference in 20 years (about 1 generation).

7.7.3. Implementing Goals Through Practices

Based on the ideas of adequate wilderness and forests, on an idea of an optimum population, and on cultural values for luxury and trade, goals need to be made explicit as part of any design or plan.

7.7.3.1. Reducing Population

The Irish population is approximately 6.2 million in 2010, including both the Republic of Ireland and Northern Ireland: comprising 4.459 million in the first and another 1.75 million the second. Although this is a significant increase, it is lower than historical figures, which may have reached over 8 million by the 1860s. The potato famine and subsequent emigration lead to a growth rate of minus 21 percent and the population dropped to just over 3 million. The rate was slow for many decades. Now, the Republic has a very high rate for a developed nation. Since 2002, the population has been growing at over 8 percent. This leads to a doubling time of about 9 years.

The current population, as well as the history of expansion and contraction, is a function of biological limits, historical changes, and cultural and religious values. For instance, the Catholic Church used to exercise an enormous amount of power, and still has some influence on sociopolitical issues in Ireland. Irish bishops no longer advise and influence the Irish people to the same extent. Partly this is due to a number of church scandals and controversies that have reduced its effectiveness and credibility. Partly, it has to do with the changes of interests of a new generation. Some youth organizations, for instance, are pushing for more legalized human embryonic stem cell research. Even with strict rules against divorce, chemical birth control, and abortion by the Church, the population could be reduced to a reasonable goal without violating religious beliefs and without great suffering or death. That would take discipline, but not more than farming or industrial work takes.

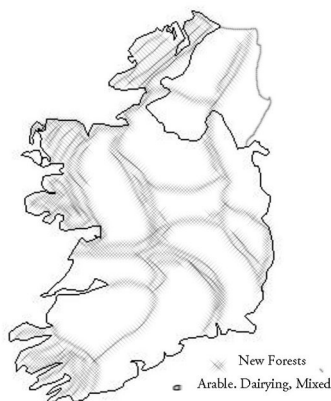


Figure 7732-1. Proposed Restored Forest Areas (shaded) in Ireland

7.7.3.2. Restoring Forests

Currently, only 1 percent of the land area is covered by native forests. Over 90 percent is covered by cropland and cropland/natural mosaic, which includes mixed forests and coniferous plantations. Currently, no forests or plantations are certified for sustainable practices by the Forest Stewardship Council. Acquiring certification would ensure that minimum standards are identified and met.

A country's future wealth might be gauged by its tree cover, according to the Richard St. Barbe Baker. Ireland is one of the least wooded lands in Europe. Will its wealth decline in 200 years? Baker calculates that the minimum forest cover for safety is a third of a country's land area, more than the current cover in Ireland. Furthermore, Baker states that about 22% of a farm in shelterbelts could double the yield of the farm. Baker divides agricultural land into seven grades, and forest into seven grades; the last three grades of fields overlap with first three of forest; the lower grades of forest land could be used for agriculture, especially natural farming, permaculture, treenut culture, or organic farming.

Ireland now has a Native Woodland Scheme whose primary objective is to promote both the conservation and enhancement of forest biodiversity in forests. The projects intend to reinstate the native woodland type, characteristics and attributes deemed most suitable for their particular site conditions. Timber production is encouraged, where it is ecologically appropriate, for quality hardwood and high-quality timber. Education and training are also considered important.

But, how much of the forest should be used? What did Irish forests look like? Was the pre-Neolithic vegetation forest? What part did fire play in Irish prehistoric and historic vegetation? Why did coppicing decline early in Ireland? Why does Ireland have so few ancient trees?

The Forest Service is the forest authority in Ireland and is responsible for overall forest policy, legislation, administering grant aid, forest research, and production of forest statistics. The Forest Industry and Planning System (FIPS) held by the Forest Service records the location and broad 'crop' types of all forests. There is a proposed Forest Service inventory to assess the status and trends of Ireland's native woodlands to encourage the expansion of native woodlands and biodiversity through the application of appropriate silviculture. Continuous cover silviculture, natural regeneration and other approaches that enhance biodiversity are

specifically encouraged, as are operations that minimize site and habitat disturbance. A research project (Bioforest) will investigate biodiversity in plantation forestry and augment research.

Management experience is intended to be combined with scientific, indigenous and local information for the expressed purpose of improving practices. This would include a network of Monitoring Sites where different management approaches in various woodland types could be assessed, as well as professional conferences, training courses, workshops, and manuals and guidelines. Management has to address threats to forests. Invasive exotic species, such as rhododendron and laurel, are major threats to native forests. They must be controlled or eliminated so that they do not prevent natural regeneration. Although fire is not a major issue in Ireland, none of the forests are fire dependent for reproduction, fires must also be controlled.

7.7.3.3. Limiting Agriculture Integrating Cities

Agriculture covers such a large part of Ireland. Can the area be reduced without negative impacts on people? How important is it to restore forests? Can some of the forests be tree crops, such as nuts?

Using arcologies, is it possible for the cities themselves to produce a significant amount of food? Maybe not using just rooftops and balconies. Maybe converting some buildings to greenhouses or vertical fields.

That may be possible, but it might not be the best way to do it. Agricultural fields do not need to be totally converted to forests. There is a place for a natural farming using a significant part of natural grasslands. But, some of the grasslands should be restored also, so that the entire matrix of the nation is based on a natural matrix.

7.7.3.4. Discussion of Politics and Management of a Design

The government of a community is a framework to maintain the people. For the original archaic peoples, tribal teachers were adequate. The adequacy seems less in representational republics. Specific political goals have to include: Expressing the original purposes of government, taking and yielding appropriate powers, and increasing the participation of constituents. Politics has to be adequate to limit the overall impact of human activities, as well as protect traditional and desired ways of life. Politics also has to be strong enough to pay the costs of the nation, whole leveling extreme differences in wealth, so that too much does not reside in too few hands or everyone is not equal at a low level—either extreme could result in no improvement or innovation.

Ireland's Parliamentary system of government should prove to be flexible and strong enough to control a national design. Ireland planned several new towns in the 1960s to accommodate a growing population and new industrialization, so there is precedent for large-scale design.

What it will change with this national ecological design? It may not eliminate unhappiness, but it might reduce it by empowering people to care for their places and communities. It may not eliminate violence, but perhaps it will reduce competition to the best kinds of garden plantings or restoration techniques.

Will the design process increase employment? Just inventorying and monitoring the nation at every level would result in full employment. Coordination and concentration of new forms of trade, for instance, alternative energy generation, mass transportation

designs, software, or literary productions, would add many opportunities for other kinds of employment.

Why would this design work? Because the island has adjusted to being under ice or invaded by exotic species. Because people and cultures have over 5,000 years of practical experience adapting and making changes on the island, and because humans are immensely adaptable—if they can adjust to poverty and suffering, they can adjust to a few good changes. This design is based on traditional cultural values and on known ecological limits and properties. It is not a complete reinvention of human and natural societies, it is simply a readjustment. We may not know enough to create this kind of eutopian design, but we can still act as if we were wise, as if doing the right thing makes a difference. And, we will have worked together to help others, to improve things and to make good places.

7.7.4. Summary: Goals & Recommendations

A number of concrete recommendations can be made to address the goals of Ireland: (1) educational campaigns for public awareness of the uniqueness of Ireland and of the effects modern lifestyles have on it, (2) the promotion of equity in opportunities and rewards for all people, (3) the offer of tax incentives to private and public corporations to redesign their paths in the community, (4) the gradual increase in preservation of wild and restored forests, perhaps up to 20 percent by 2012, to protect ecosystems and resources, and (5) a geographical and environmental database for the intelligent management of the land.

There should be a proper mix of handicraft labor, intermediate technology, and heavy industry. The root problem is how to live with technology in a mature manner. We need an ecological awareness at all levels; a humane, existential ecology, where humans are part of the system and aware of it. But that may not be enough; we may have to legislate limits or induce adherence with economic incentives, especially if awareness and reasoning are not enough.

The goal of planning is community success and personal happiness, based on self-reliance in food and shelter, self-sufficiency in agriculture, and self-limitation in size and desires. If human patterns were based on mature ecosystems, a balanced Irish civilization would be far more complex. Human values would allow for the welfare of humans, animals, plants, and land. We have to be wise enough to be disciplined, to leave wilderness for other beings, and yet to make good places for ourselves. Designing must include every dimension of human life. This design is such a framework. It is incomplete, but open to improvement and suggestion. It could coordinate the many other proposals to improve transportation and agriculture. Anyone could add to it or transform it.

7.8. *Managing Multiscalar Interacting Technologies*

At one time, new technologies were adopted because herding animals and cultivating crops were more reliable ways of producing food than hunting and gathering. This may have been a choice between moving and staying in one place, between finding food in different places and increasing the food of one place. These waves of innovation started with digging sticks and horse harnesses, and continued to iron and water power go through steam powered cotton to electricity and the combustion engine to petrochemicals and aviation, digital networks and biotechnology. We have to entertain the possibilities and directions of further human physical and cultural evolution. As humans continue to create extensions of their bodies through technology, using surgical or genetic enhancements, their patterns and behaviors change. Human cultural evolution has already resulted in more complex forms of culture, with technological modifications. If humans finally become domesticated, then sexual selection will become controlled and perhaps artificial. Evolution can be considered in Merleau-Ponty's term as a 'pattern mixed-upness' of styles of living, as beings radiate through time and place, unfolding into new, complex patterns. Evolution is less a hierarchical ladder or an up-escalator than the history of forms fitting and refitting changing environments. Human needs and goods get mixed up with the needs and goods of other beings. The mixture rapidly becomes complex.

We already use computers for dazzling communications. We are starting to embed chips in our bodies and brains, to repair diseases or enhance memories. Perhaps smaller computers will be internalized, for better modeling and communication, or perhaps for dealing with the complexity of global design. Biotechnology and nanotechnology seem to be qualitatively different from external tools, such as knives or tractors. With nanotechnology, we think it might be possible to create a distributed energy plan with alternative energy networks. This would be a radical solution harnessing quantum foam and manipulating atoms. Nanotechnology is the emerging science of manipulating molecules at the atomic scale. One need only move a few atoms around to create wood or energy. Nanobiology is expected to push a convergence of biology and technology.

Several writers and futurists have predicted teleportation in 20-30 years. Of course, this would create a real problem with what to do with the excess matter and energy at each end. There are also predictions of space tourism to the Moon or Mars, designer genes for improved health, manipulating matter for smart products, using hydrogen engines for transportation, cybernetic health enhancement for humans, downloading drugs, and domestic robots.

Some computers may radically increase our ability to understand the complexity of ecological systems as well as the shape of the future. There might be an infinite number of multiple universes or mere worlds that we may be able to visit physically or virtually. The interactive realities of gaming may become more immersive. Robots may become more common. Artificial life is projected to arise from new electronic beings, perhaps emerging from robots doing web searches or digitally engineered characters in games. If a network mind forms and gains self-awareness, we may need new forms of communication or influence (control?). Can we contact it or translate its communications if it operates at the quantum level?

Will these technologies use less resources or more? Maybe more in short-term development. Combined with biomimicry, the argument is less energy, less materials, and less waste. By controlling matter on a scale smaller than 1 micrometer, waste may not be a factor. It

is likely, however, that these technologies, independently or as hybrid systems, will create new problems and threats.

7.8.1. *Threats of Technologies and Scales*

Many of our current emergencies are a crisis of our image of the world as a machine and nature as a passive environment. This leads to excessive consumption and blind faith in technology and luck. We have had dramatic global changes, such as the ozone layer disappearances and increases in annual wildfires. But, we prefer to pursue comfort rather than adjust to the real actions of a dynamic and dangerous planet. We have made an enormous investment in technologies designed with little regard for the environment, related to our goal of growth at any cost. Our growth, pollution and terraforming has put us in a trap.

Advances in technology allowed cities to scale up. But, now the infrastructure investment is high and some parts of cities get abandoned. Where is the organic limit to cities? Aluminum and steel are replaced with composites. This is transformative of the overall socioeconomic production process. The introduction of silicon and the fabrication of the microprocessor that is now the center of information technologies. The telegraph transformed technology as well so it is not just computers in the last twenty years, although communications technology makes a difference to the political structure.

7.8.1.1. Dependence

Dependence is a problem with any technology. As we depend on a tool, we sometimes lose the ability to work without that tool, whether knives or writing. We are dependent when we cannot go back to living without it. For instance, now that cash registers in fast food restaurants have pictures of foods on the keys, it might be hard to return to numbers with decimal points.

7.8.1.2. Stagnation

Stagnation becomes a problem when we cannot think of alternative forms of technology. For instance, with transportation and energy, we have been stuck in a rut of burning. Most energy is generated by variants of the steam turbine, which relies on burning something, not much different from dung and wood, just centralized. Transport is primitive burning also, for automobiles or trains. Where is mag-lev? But is that supported by burning? For the flight of aircraft, the gas turbine of jets was developed in the 1930s and although it has been improved, it has not been replaced.

7.8.1.3. Heroic Scale

The unconnected actions of almost seven billion people are really a scale change that can result in environmental disasters. Of course there are other factors, including extinctions and poverty. The scale of industrial output is massive.

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Feedbacks continually emerge as products of evolution at the local level, and they can have a large scale and global influence at the global level. One question is why regulatory feedbacks predominate at the global scale intend to make habitable conditions on the planet and maintain them. Perhaps because the role of life and influencing feedbacks means that when life is wrong it disappears when species make mistakes they disappear. So far, no mistakes have made the matrix collapse.

7.8.1.4. Collapse

External disturbances such as asteroid impacts or basalt eruptions could have triggered significant transitions to collapse of the system or to less stable states. However, most transitions appear to have been generated internally with evolutionary innovation playing a large role. There are many questions relating to transitions or collapse: To what extent is the Earth system self-regulating? How does the system develop? What is the contribution of life to maintaining habitable conditions for other life? Why does regulatory feedback predominate at the global scale?

One thing to consider in talking about collapse and timescales is the presence of multiple stable states. We know that cultural systems can bounce to a lower state and yet survive for a long time in that particular state. We also know that change is neither continuous nor gradual, but is chaotic. Change is better described as episodic with periods of slow accumulation of natural capital that are punctuated by sudden releases and reorganizations. Redmond and the other suggests that scaling up from small to large is not a simple process of aggregation. Stabilizing forces are important in maintaining diversity, flexibility and opportunity. Stabilizing forces are also important in maintaining productivity, fixed capital and social memory. Political management that only applies fixed rules for achieving constant yields, independent of scale and changing contracts, can lead to systems that lose resilience.

Joseph Tainter notes that one factor in addressing these issues is the change of scale that occurs when local people become embedded in larger systems at national and international levels. This is now called globalization, but that term merely denotes a recent phase of the development of the past 500 years. When the periphery is incorporated into a larger economy, it experiences a change in scale of its economic and political relations. However, the information pool remains local. This disjuncture of scale can undermine the sustainability of local populations. For instance, the introduction of roads after World War II initiated many changes in villages in remote parts of Europe.

Tainter concludes that the lesson is that, unless these and other local people become knowledgeable about the full range of factors that affect them, they will continue to be vulnerable to distant processes and others who profit from their ignorance. One approach would be for systems theory, either alone or in conjunction with other research, to develop a body of knowledge of such fundamental importance that it would be incorporated along with other mainstream social sciences. Tainter concludes that world systems create disjuncture and scaling between the flow of materials and the flow of information. This disjuncture must be remedied. People must become cognizant of the factors that does affect them at all scales. Tainter wonders if his proposal is utopian and unrealistic, but suggests that globalization demands the attempt. One certainty is that failing, local places will slide into collapse, from poverty, dependency and ecological deterioration.

7.8.1.5. Trends

Trends, however, can be predicted. To do trends well, we need an ecological perspective to look at the interacting factors. Some trends are long-term, such as climate change and urbanization; others are short-term, such as biotechnology and nuclear energy. Cascading problems each trigger the next problem. Trends can also be deflected or reversed, with changes in behavior.

Human beings have no complete guidelines to interacting with other species in an ecological context. Cultural ethics are usually restricted to some members in a local ecosystem; such ethics are assembled inductively, from experiences from living in specific places. Many ultrahuman cultures have standards (or codes) of behavior to regulate interactions. In birds and simple mammals, these rules may be very rigid and predictable. With increasing brain complexity, however, learning takes a larger role. Human learning can find meaning in absurd patterns of change.

7.8.2. *Extreme Technology & Scale*

Scientists have worked on reasoning holograms and on cloned sheep (although the first one did not live to a normal life span). Scientists might continue to clone humans. They might design specialty bodies for working in a vacuum, for eating cellulose or even for converting solar energy directly into calories. More complex bodies could perceive other wavelengths. Would those bodies replace the evolved organic bodies we use to dream and make art? What characteristics would be lost or added or improved? Of course, it might be possible to create new bodies with new brains that have self-awareness and consciousness. Technology and design could take great leaps, but they would need to be enhanced to deal with the unanticipated consequences of such radical changes.

Extreme technology could remotely combine new bodies with faster than light signals (possibly through quantum entanglement or wormholes). Communication would literally take a quantum leap. External storage would be unnecessary, since it could be done at the atomic or molecular level inside the body, although its permanence, as in the life of the universe, might be problematic. Nevertheless genes, memes, and wenes could be accessed and modified temporarily or for the long-term.

7.8.2.1. Extremes

The technological fixes, from the modern industrial response of geoengineering, are problematic themselves. Geoengineering is the deliberate manipulation of global metabolism to correct or adjust human interferences. This approach would orbit mirrors to deflect sunlight, launch sulfate particles into the atmosphere, or fertilize the ocean with iron. It would consider burying CO₂ gas or solids in the ocean or land. They are simple symptomatic responses that ignore the system. If the problem is simple, pollution or fossil fuels, then it neglects the complex issues of human conversion and scale. It ignores the proper relation of humanity to the planet. Technofixes are based on an inappropriate logic, linear and cause-effect instead of nonlinearity and multiple effects.

Americans and Russians made proposals in the 1950s and 1960s to control the weather and modify the environment. Mikhail Budyko's proposal for artificial volcanoes in 1977. How do we remove the 100 ppm excess CO₂? Atmospheric scrubbing on a heroic scale? Planting more trees on continental scales, and restoring more forests to Pleistocene levels?

7.8.2.2. Limits of Extreme Technologies

Although several national space programs have been able to keep people on ships and space stations for limited amounts of time, with canned oxygen, scientists in Arizona spent \$200 million to prove that we did not have the technology to keep eight people in oxygen for more than a week, using a balanced ecosystem approach. So far, our best technologies cannot substitute for natural processes, especially in terms of detoxifying wastes.

Friedman suggests that the limits of systemic growth can be understood as the threshold of exhaustion of the system. A limit would be related to technological and economic factors, as well as to contradictory tendencies within the system. One bad assumption of computer intelligence and manufacturing is that people and machines perform optimally at all times. Another is that we have anticipated all the consequences of new technologies.

7.8.2.3. Scales of Technologies

On the other hand, we experience problems with scale. We have a human scale, based on our body and images, but this scale does not seem to be favored by the universe. Scale is problematic with smaller technology. What works well at one level may not adjust well when scaled up. Scale changes the interaction. If the technology is too large, there are too many interactions to monitor or understand. Scale also changes the relation to the individual.

The problem of using metaphors between scales is that there are too many emergent properties that do not appear in the smaller, and better known, scale. What can translate as a metaphor between scales? Foam can be found at the smallest sizes imaginable smaller than subatomic particles, and at the largest scales imaginable of the entire universe. But, its predictive value might not be adequate. Seafoam, which is white, refracts a large fraction of sunlight than water. The interaction of light and foam has an effect on temperature and climate.

The problem of scaling is central to linking local case studies to global processes, as we know. And, as we know, ecological variability tends to increase as the scales become smaller in our understanding of the factors on variability is modified by the scale of observation. What's that mean? Global cycles of local exchanges link scales. But the larger the scale the longer the lag time before any changes show.

Really large scales, bioregional or global, are not considered often at all. At large scales, other factors have to be considered. Many cosmic tendencies, such as disorder (entropy) and order (ektropy), as well as change, creativity and temporality, are relevant to these scales. But, managers tend to emphasize only those tendencies that seem positive, such as creativity, diversity, and order, and not those with negative connotations, such as entropy, death, and uniformity. The universe comes with the whole package, and we risk serious error by choosing only the tendencies we want.

7.8.2.4. Global Constraint

There are many implications to global scale problems. These global scale problems include losing forests, losing land, losing fresh water, losing Marine fisheries, releasing toxic pollutants, losing biodiversity, and over fertilizing with nitrogen. These global scale problems are constantly interacting with one another that typically worsen the situation, for example the loss of forests can be attributed to biodiversity loss, climate change, and desertification. Climate change, acid rain, ozone depletion, and water reductions, in turn can adversely affect

forests. Climate change affects everything. It is likely to worsen desertification and lead to additional flooding, reduced freshwater, and adversely affect biodiversity. One problem with global ecological design of forests, for example, is the time and physical scale. Forests need hundreds or thousands of years to mature.

Growing research on urban ecology discovered the phenomenon of the urban heat island, as an example of anthropogenic effects on local weather. The ecological constraints have now become global, related to the number, growth and size of cities, which change the scale significantly. Also there seems to be a distinction between whether the network is global and whether it there is a global culture. The network may be global, but culture has no uniformity (as opposed to some fads and trends). There are several kinds of networks with different spatial scales. These networks include information, prestige goods, political, military, and bulk goods networks. Information forms the largest network because of its ease of transfer. Some of the networks are slower due to the sizes of various buffers.

Some of the networks can be adapted to natural systems. James Lovelock notes that the notion of adaptation is tautological. He claims that this is because on a planetary scale life and the environment is coupled so tightly that it cannot be thought of as adaptation. However, life and the environment are mutually constrained constructions.

7.8.2.5. Connection

Global cycles of local exchanges link scales. But the larger the scale the longer the lag time before any changes show in interactions. All interactions are ecological interactions, from the modification of mammals in Australia to the transformation of grasslands. These are all dynamic interactions between human societies and their environments, from the perspective of long-term patterns and processes. The interactions become tightly coupled. Ecologists call the excessive integration of a system hypercoherence. According to Holling a too-highly connected systems is an accident going to happen. Rigidity increases vulnerability to change. The number and strength of the connections is a problem if disruptions occur. Essentially because the different processes were so overly interconnected and that all the flexibility disappeared from the system. A reduction in flexibility is not the only effect of interactions.

Globalization suppresses many diversities. But, diversities are essential for human stability, capacity and resilience.

7.8.2.6. Other Complexity problems

Even progress is not even. In the short run it has incredible dips and highs as we go from accomplishment to disaster. William McNeill suggests that escalating vulnerability is the price of growing local and short-term mastery, especially when the scale is increased to the global. Joseph Tainter argues that societies choose to increase their complexity to solve immediate problems, their social and political dynamics, but that leads to increased vulnerability in terms of returns on investments of energy in the complexity itself. Human complexity, like ecosystem complexity, requires demands for more energy. Globalization is a titanic effort to put us all in the same boat, more complex and advanced, but vulnerable to human error and natural catastrophes.

7.8.3. *Designing Hybrid Systems & Mixed Communities*

Given the limits of the Precautionary Principle, as well as other principles and standards, it seems possible to create living cells that could create machines. It seems possible to produce nanotools that could scrub or repair living cells. In fact, it might possible to create entire communities of machines and living beings on a very small scale that would have a vast number of interconnections to wild ecosystems. It is quite likely that these systems might be more fragile than natural systems, collapsing or dying out in months or years. And, it is quite possible that the remaining waste might not be completely biodegradable. Ecosystems already get mixed with plastics and pollutants. Given the possible dangers, however, these possible changes and applications need to be kept isolated for extensive testing. In fact, the proposals need to be critically reviewed by panels of ecologists, engineers, and other scientists and literate reviewers. This kind of explosively reproductive technology has to be planned out and engineered through complex thought experiments, especially before it becomes part of the mix. Thought experiments let us describe interactions, such that if one thing and another interact, a third happens.

Human and wild communities are already mixed. Humans use tools, so that means that technology and nature are also mixed (many mammals are observed to use tools). Humans have always collected food from mixed systems, without landscape conversion. A maturing agriculture might recapture some of this strategy. Mixed crops are easier to grow, we know that. Mixing is part of the process of ecosystems, as animals and plants try to fit and excel. Hybridization occurs in species, especially grasses and bacteria. Hybridization may be a solution to the survival of some species, but it is a problem with human biological classifications. Biological and legal issues have already raised by documentation of instances of hybridization. For instance in red wolves and coyotes, using molecular markers. Zones of habitats become hybrid. Large-scale changes in habitats, such as from land clearing, may result in hybrid zones between closely related species (Ontario Canada might be such a hybrid zone).

Cultural development also changes through a process of hybridization. Industrial culture becomes a hybrid as it tries to satisfy the needs and wants of a growing population, especially for space and food. We have hybrid political systems, such as democratic socialism (Britain). Religion is becoming aware of human-machine hybrids, as well as the concept of universal gods and a living planet.

We need to have mixed communities. This is what evolution and wildness do—provide the turbulence and chaos that every system needs to be mixed and renewed. Nature, the formal matrix for wildness and chaos, pursues a strategy of overproduction and waste. This is not the wise, motherly Nature of our dreams, this is a wild creator, profligate with energy and forms of information through low-efficiency and the waste of cells, seeds, and sperm, and with the escalating warfare of plants and animals. The sheer magnitude of energy and diversity allows tremendous margins of error, that Evan Eisenberg suggests is the envy of human artists. Error pushes the whole process, allowing possibilities and diversities. Flawless transmission would have stayed at bacteria level. Freeman Dyson suggests that the reign of genes, like that of the Hapsburgs is “despotism tempered by sloppiness.” The harmony and stability of nature are perceived by human minds as they make them abstract.

7.8.3.1. Potential Damages & Alternatives

Some business organizations, people using some technologies, can threaten to destroy the mixed communities of humans, animals and plants, and their flows and patterns. We have to have goals and define new niches in mature hybrid ecosystems. We may not need much technology. Symbiosis can be a model for cooperative designs.

7.8.3.2. Surprise

An unimaginable part of our recent predicament, especially for readers who have lived through two doublings, is the scale of change in the past 80 years, the dramatic expansion of the human population, and our economic and political systems. Based on cheap abundant energy, in unique and high concentrations, machine power increased, then the factory system increased efficiencies and productivities. Buoyed by capitalism and nationalism, justified by beliefs in a mechanical, progressive nature, we have come to worship of growth. Through positive feedback and ignorance (or greed), growth became automatic and uncritical. Human numbers increased 6-fold in 200 years, but the size of the economy increased 10 times faster than population (over 60-fold), and energy has blossomed 80-fold. The concentration of wealth allowed more dramatic effects from rampant SUVs and private air travel. The past 80 years has created more change than the previous 500 generations. These changes have pushed us beyond our traditional cultural experiences.

The dangers from this are immense: Slow catastrophes, such as extinctions and conversions (ecosystem loss); sudden surprises, such as dead zones in the ocean or holes in the ozone layer as a result of overfertilizing (or overenergizing or overpoisoning); human ignorance of change and uncertainty; and slow, inadequate responses to very long-term changes (as opposed to short or 9-year limits).

The novelty and complexity of interactions of innovations can lead to thresholds that are tipping points, triggering punctuations in natural functions with consequences that may surprise humans. The current global environmental condition has no comparable analogs to any other previous time. One source of surprises seems to be the interaction of climate and environmental change combined with economic development and human and animal health. As tropical forests are converted to farmland people encounter diseases without having evolved resistance. One conclusion is that we have to intensify our search for discontinuities and surprises that we may not be able to predict, although we can learn to be aware of their importance and more sensitive to early warning signs.

7.8.3.3. Mixing Natural Systems

Agriculture causes greatest disturbances to ecosystems. Damage to ecosystems can heal faster if small and surrounded by the original matrix.

7.8.3.4. Mixing Cultural Systems

Jeffrey Sachs notes that all successful economies are mixed economies that rely on both the public sector and the private sector for economic development. Eliminating poverty at the global scale is a global responsibility that will have global benefits. This is something that no single nation can do by itself. It has to be done, as we think globally, and as we create a global network to apply all this at once.

Jane Jacobs advocated dense, mixed-use neighborhoods and frequently cited New

York City's Greenwich Village as an example of a vibrant urban community. Advances in technology allowed cities to scale up. But now the infrastructure investment is high and some parts of cities get abandoned. Where is the organic limit to cities? Urban ecologies view cities as heterogenous, dynamic landscapes, as complex ecological systems that provide services and links. It may be more efficient per capita, but it is overwhelming in scale, especially energy use.

7.8.3.5. Mixing Technologies

We feel it necessary and important to embrace new technology. That is one lesson on human value. The revolution in learning demonstrates another lesson, that technology matters less than the changes it triggers in substance, content and focus of schooling. Environmentalists consider that sustainability is a sufficient basis for technological design. This may not be so. It may be necessary, but not sufficient. Perhaps some kinds of large-scale thought, such as Messianic thinking, have influenced our disposition to large-scale technological fixes, as well as the idea of redemption and the practice of irresponsibility.

Our growth, pollution and terraforming has put us in a trap and only design and engineering, combined with severe conservation and changes in rich lifestyles, can get us out of. Urbanization can help. So can technology. The new technologies promise help but also will create larger problems. These are nuclear power, biotechnology, geoengineering, and information technology, which might be effectively multiplied by convergence, and either enhance or wreck human performance and a global perspective for rethinking science.

The first thing any technology has to do is reverse the bad effects of the previous unconscious technology. Market forces could encourage cleaner technologies as well as clean-up technologies. This new industry should be very promising. Obviously, this would be a response to dirty technologies. Regional design has to consider the percentage of the region covered by asphalt or concrete. Global design has to consider for the whole planet. This is necessary to balance local or regional areas that are overbuilt or too intense. Local design does not have to worry about such balance.

As part of restoration on a large scale we have to consider whether it would be viable to green North Africa would that require me met at technologies promote rain and build soil?. Oh. Would moving icebergs to water the coasts of South America or Australia be of importance? What about micromachines and the use of nanotechnological devices? Should we use ocean ranching and farming for food? Is life and extension even important given the suffering and equity we have now?

For climate change, one technological option might be large-scale planetary geo-engineering, which requires equally large oversight. Energy use is so large that it requires a government. Extreme technologies are so large that they require a global government. The scale is so large, as is speed and scope. Most meaningful actions have to be at the largest scale possible. But to be good at global, we have to think at the level of the solar system.

We always think that technological problems are easier to solve social problems. They are not, partly because they become social, and need fixing. We will have to redo the worldview and values so that they do not emphasize competition consumerism and inequality. The emergencies are a crisis of our image of the world as a machine and nature as a passive environment. Excessive consumption and blind faith in technology and luck. We have had dramatic global warning, such as the ozone layer disappearances and increases in annual wildfires. But, we prefer to pursue comfort rather than adjust to the real actions of a dynamic

and dangerous planet. We have metaphors to support the idea of mixed systems, including a process perspective, field concept, self-organization, and co-constrained construction. These metaphors form the basis of a new image for humanity, where we are an integral part of food chains and part of an organic cycle of birth and death. Human nature does not find meaning in an absurd world, but discovers its structure by interacting with the surrounding order.

7.8.4. Managing Mixed Systems with Design

We have learned from Charles Darwin and others that nature chooses the 'fit,' those who adapt to a specific environment. But, that nature was more stable and predictable. We are learning that the 'flexible,' those who can adapt to several or changing environments, may survive better under changing conditions. And, now that nature and culture are coevolving, it may be the 'creative,' who can change the conditions slightly and limit the changes wisely, who may survive even better! For instance, the North American species that were adapted to forests, died out 12,000 years ago. Flexible Generalists like humans did not.

We have to let the dream of control fade, now, in order to creatively adapt to and interpenetrate the uncontrollable uncertainty of a new climate. If we make mistakes, they can be repaired if small enough. For restoration, we can experiment, improvise and innovate at a small-scale. Mohandas Gandhi and E.F. Schumacher argued for appropriate technology, but we also have to behave appropriately with other forms and scales. That is we need to keep an appropriate level of complexity. Why be too complex in our civilization and social structures? We need to arrive at a goal of an appropriate population size. Materials can be a problem, especially plastics or others not integrated or recognized, that resemble real food or resources. How do new substances reconfigure the fabric of material interactions? By killing off the unsophisticated? How do coexisting materials embody concepts of style and meaning? Can design intervention shape future biogeochemical cycles?

Regional design has to consider the percentage of the region covered by asphalt or concrete. Global design has to consider for the whole planet. This is necessary to balance local or regional areas that are overbuilt or too intense. Local design does not have to worry about such balance. Technology has to fit ecological and social knowledge. Sonar technology meant that big actors could catch more fish. But there is little feedback on the state of the fish population, until it crashes. Thus people invest more in vessels and technology up to the crash, after which they can write off their investment as a loss. This is a tragedy of the commons.

On the global scale, we can build an observation network for global change and found local institutions to assess the change. Very much like the thought experiment earlier, the observational network can function like a macroscope, spanning different scales. The macrosopes themselves, rather than being physical instruments, might be a combination of conception and awareness. That would allow us to view the interconnections of major systems of a complex planet. The macroscope system of observation and reporting would complement existing systems of environmental and economic accounting, by allowing both local and global perspectives of the planet. This is a prerequisite for coordinating global intents and actions.

In any discussion about solutions, we have to consider personal solutions, technological solutions and social solutions. Stopping technology all together might lead to disaster, unless we combined it with radical reductions and conservation, which may be considered in any mix of strategies. But, we can also assess our current technologies and combine them with other approaches to create a truly mixed design on regional and global levels.

7.9. *Regional Ecological Design Planning & Monitoring*

Our regional communities are proud to attract more people and larger industries, but do so thoughtlessly, without regard for the limits of population size or the rate of energy use, without sufficient consideration of the effects on the quality of our lives or on the quality of the environment. Although we make plans for people and their activities, the plans are usually reactions to growth and change. The formal development from planning results in a complex of problems, from pollution to ugliness.

We have always tried to exceed the physical and biological limits of places rather than recognize them and be guided by them. This framework suggests an approach to comprehensive planning based on the biohistory of an ecosystem, the cultural values of the people, and knowledge of the limits for sustainable development. This approach makes the limits explicit and set sustainable goals within those limits. As a synthetic framework, this approach provides for the health of the ecological system, as well as for the health of its human inhabitants.

7.9.1. *Regional Surveys & Inventories Monitoring*

Ecological planning and design has to reflect our understanding and use of the planet and its regional and local systems. Each activity needs to be fed back into the process to update it. Implementing the process should result in improvements to it. The process could be applied in stages.

- Stage 1: Inventory the system
- Stage 2: Analyze the system
- Stage 3: Establish Zones for Protection and Use
- Stage 4: Create Specific Plans and Designs
- Stage 5: Put the Design on the Ground
- Stage 6: Monitor Activities
- Stage 7: Evaluate and Refine Manage Plans

7.9.1.1. *Stage 1: Inventory*

We need to collect knowledge about ecosystems, from local people who know something of the recent history, or from tribal elders, who may have cultural knowledge, or from other sources, such as written reports (from Lewis-Clark or early surveyors), maps, and aerial photographs. This requires research and researchers might want to make narrative reports on findings.

The next part of the inventory is a walk-through, which gives you a rough idea of the state of the system. For example, in the walk-through of a forest, you will look for geological characteristics, wildlife, sensitive plants, number of stems, snags, large downs (or downed woody debris, nurse logs), reproduction, and fire potential. The walk-through may be informal (follow trails) or formal (create and follow a grid, marking distance by chains). If you do not have arials or maps, this is a good time to make your own map; be sure to establish easy to find reference points. You will record this information on forms.

An ecosystem inventory is the primary source of data for planning. The cost of complete data is considerable, the more complete the more considerable, but you must have data to

make any intelligent decision about a system. A partial inventory is better than none.

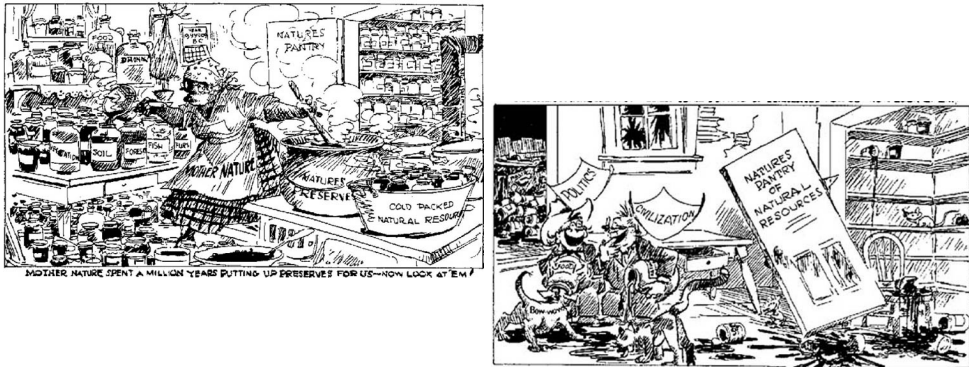


Figure 7811-1. Nature's stocks: Inventorying the Pantry (from J. N. Darling, 1940s). This is reminiscent of a statement by the philosopher, G. W. Leibniz (1683): “man’s knowledge of nature seems to me like a shop, well-stocked with goods of all kinds but lacking any order or inventory.” —or perhaps understanding of value.

7.9.1.1.1. Techniques for Inventorying (and Monitoring)

One of the roles of a tribal shaman was to sense and know the health of prey animals and plants. If they were too few, then taboos or restrictions were imposed on the people and they had to find other food. This kind of traditional ecological knowledge is still important, although we now have sophisticated techniques for observing systems of plants and animals.

The first images of the earth from the sky were captured in balloons and airplanes. Aerial photographs are still used for many local property ownership maps. The U. S. Forest Service has used remote sensing since the 1930s to manage diverse and ecologically complex landscapes. High-altitude photography has been used since the 1940s, and satellite data (film and magnetic tape) has been available since the 1960s. As the technology has become more efficient and cost-effective, the amount of data and the uses for the data have increased.

Satellite remote sensing is a preferred tool; satellite data for compiling estimates for area surveys is a less expensive substitute for more expensive aerial photo surveys, which were a less expensive substitute for on-ground surveys. Most of this data comes from a Landsat satellite, from the U. S. space program, since the early 1980s (other recent satellites include SPOT). Landsat provides data from a wide spectrum. The data has to be analyzed and mapped to the landscape using a program such as VICAR/IBIS. Furthermore, the field data must be correlated to the Landsat spectral analysis.

7.9.1.1.1.1. *Geographic Information Systems.* Analysis can be done with a computer-based Geographic Information System (GIS). The objective of this discussion of GIS is to present the technology. Each discipline has its own language. GIS is a composite discipline formed from a combination of geography, cartography, computer science, topology, image processing, information theory, and all of the “content” applications—civil engineering, biology, natural resource management, environmental sciences, and dozens of others in which it is used. What this means, among other things, is that the language of GIS is a composite of terms originating in other fields.

Classification results in a GIS vegetation data plane that contains species, canopy cover,

habitat types, and quantitative information such as timber volumes. Vegetation classes are used for many applications, including mapping old-growth timber, mapping wildlife habitat, and designating fire classes. In 1988, the U. S. Forest Service initiated a national strategy for implementing GIS technology to manage resource information. Notice the ever-present assumption, that everything is a resource to be managed—in fact, people's values can distort GIS maps as easily as any maps or word models; furthermore, conclusions drawn from GIS maps can also be inaccurate, regardless of the accuracy of the data.

GIS is an information-processing tool to manipulate resource data to support organizational decision-making. In a sense, any computer system that can incorporate, analyze, and display data is a form of GIS. The system is a combination of human skills (also known jocularly as 'jellyware') with appropriate computer hardware and software (the programs that tell the hardware what to count). Data is fed into a database in layers, which can represent different aspects of the geography, such as topography or vegetation types (these layers strongly resemble the "layer-cake" model that Ian McHarg used in his book, *Design with Nature*); various operations, such as attribute searches or connectivity analyses, can be performed on these layers either singly or in any combination to address specific problems. The results of the operations include tables, graphics, or map-like products.

Before satellite data analyzed by GISs, ecologists did not have tools that could address the scale of landscapes. Regional and global data was hard and expensive to collect. The International Geosphere Biosphere Program (IGBP) coordinated by the U.N. uses GISs for global and regional issues, such as deforestation or desertification. The large images from satellites are exceptional for identifying landscape patterns, especially those related to the scale of species behavior, such as home range or breeding dispersion. Pattern can also be measured at the level of patch size and spatial relationships (that is, inter-patch distance), which is critical for relating the size of a habitat to the species in it—for instance to test or to apply theories, such as the theory of island biogeography.

The data derived from satellite imagery and from field studies can be used to model the landscape at various levels. Some of these tools will be used for specific problems in the classification of forest ecosystems and harvesting schedules.

At some time you, as an informed citizen or consultant, will be exposed to GIS based analyses and decisions. This arises particularly with respect to the plans of public land management agencies, but also with respect to proposals from nongovernmental sources. Neither cartographic beauty in map production nor technical sophistication in spatial analysis bear any necessary relationship to the accuracy of the information or the validity of the conclusions presented. In fact, the conclusions may have preceded the GIS analysis, which was then undertaken for the purpose of supporting them (often the way with science). The mere assertion that the conclusions are supported by the analysis does not prove they are.

7.9.1.1.1.2. *Land Surveying.* Most natural boundaries can be identified by sight. Legal boundaries, however, are composed of imaginary lines through the landscape. In the USA, two major systems for subdividing land are used: (1) the irregular metes and bounds method used by George Washington and throughout the original 13 colonies, and (2) the rectangular surveys attributed to Thomas Jefferson, adopted by Congress in 1785, and applied to most of the public lands in the country.

Metes and bounds survey lines follow ridges, streams, and roads, although they can

follow lines of a specified angle (*bearing*) and distance from one established corner to the next corner. Modern surveyors using the first method must depend on old-field notes or titles for guidance. Ecosystem surveys can be made with only a general knowledge of boundaries furnished by the owner. Boundary lines, such as roads and fences, that have long been accepted by owners on both sides, become legal boundaries only if neither party objects. Often owners must agree arbitrarily on a boundary line.

The rectangular survey system is laid out into square areas (with specific exceptions due to the curvature of the earth), the largest of which is a *township* of 36 square miles (23,040 acres), containing 36 sections of 1 square mile each (640 acres). Sections are divided into four quarter sections; quarter sections are divided into 40-acre tracts one-fourth of a mile square. Forties were not surveyed out in the early surveys, but their lines have been run out as land became subdivided.

The system in laying out public lands includes guide lines (meridians) running north and south, which are crossed by base lines (parallels) running east and west. Between the meridian lines, the north-south boundary lines of townships are called township lines; between the parallels, east-west boundary lines are called range lines. Townships are described with reference to the initial point where the base line crosses the principal meridian. Because the north-south meridian lines converge at the poles, they are not parallel (as are the base lines) and thus require corrections in laying out the townships. This is accomplished by reducing the areas of outside forties of the 11 sections on the north and west boundaries of each township.

Boundaries of private land are marked at section corners (and some times at quarter corners) by iron or concrete posts capped with a brass marker indicating their specific location. The earliest surveys were marked with wooden posts, piles of rocks or blazed trees—either witness trees facing corners or bearing trees showing direction to an established corner.

To create a local map, the first step is to obtain base maps for the general area of the property. These maps provide orientation. You can obtain maps of the county showing subdivisions from records in your local county court house. In map making on private or public lands, the primary concern is with sections and forties within sections.

7.9.1.1.1.3. *Cruising*. Once the zones are established, each zone should be refined, in its margins and content, with field data. Using forest characteristics and the principles of ecoforestry, you should be able to set the objectives for each zone (a list or table will do).

Establish permanent plots and cruise them. Field data is collected in an orderly way, along routes in the forest determined from maps and air photos, and adjusted as necessary in the forest. Field data collected includes soil, water, plant, animal, timber, terrain (landforms), and other information that is important to understand and use forests in ways that do not impair their functioning. At this time, you should establish a series of permanent plots with photograph points. You should take the first series of ground-level photographs.

7.9.1.1.2. Conceptual Tools

Conceptual tools are necessary to frame, relate and support the physical tools and techniques that we use to inventory and monitor the planet. Two conceptual tools are ecological design and island biogeography.

Ecological Design is concerned mostly with fitting human activities within the framework of the planet. It can try to minimize the impact of human activities on the global

anatomy of the planet, and to minimize the impact of the planet on human constructs. Global ecological design is a human process that considers the emergent and unique factors of the planet. We have to change the framework so that we can shape new approaches. At the biophysical level, global design has to address many more systems as well as the new emergent properties of the globe. (Section 2.6.2.1.) Emergence of a whole system that allows diversity and evolution in frame of place. At the level of ecocultural play, global design considers the sum of cultures and evolution acting on planetary patterns, allowing for failure and development. In terms of ecological economics, global design has to consider economics as the basic exchange of energy and elements at all levels. And, at the level of global design, values are expanded from human and species to those useful for the planet.

This design addresses a global scale. Many global rhythms are influenced by the tilt of the earth and its orbit around the sun, as well as its movements in the plane of the planets and through interstellar dust lanes. Dramatic conversions of forests can create tensions in the mature temperate or tropical forest landscape, as well as with global chemical cycles and rainfall patterns. In global ecological design, many human landscapes can balance wild landscapes in nested levels. Principles of global ecological design either emerge at the planetary level or become more important at that level, such as the Principle of Wholeness, which states that a whole emerges from the interactions of parts and that whole is more than the total number of parts. These principles also result in a further qualification of standards and behaviors, especially limited actions, such as protecting diversity (Section 2.6.7).

7.9.1.2. *Stage 2: Analyze the Landscape*

Once you have determined the pattern, character and condition of the landscape and particular sites, you can indicate them on your map (graphically with patterns or color). The character describes the pattern of habitat types (species of plants and animals), as well as patterns of age and reproduction. The condition indicates how human activities have changed, damaged or improved the state of an ecosystem, as well as the landscape pattern. For instance, the No Name Creek watershed, which is part of the larger Flanagan Creek watershed, which is part of the Palouse River watershed, which drains into the Columbia Basin, much of the forest surrounding Altazor Forest (See Section 4.6.2 in *Redesigning the Planet: Local Systems*) has been cleared for fields; virtually all of the rest of it has been cut using a variety of methods.

7.9.1.3. *Stage 3: Establish Zones for Protection and Use*

The primary concern of an ecological plan is to protect the framework of the ecosystem for all organisms during human use. That means that the habitat of key species has to be preserved. Grandparent trees have to be protected in old-growth areas. Ecologically sensitive areas—steep or broken slopes, shallow soils, xeriscapes (really dry areas)—have to be used lightly, if at all. All riparian ecosystems (rivers, creeks, streams, lakes, ponds, wetlands—all water courses) have to sustain minimal human interference. Animal and plant corridors, especially cross-valley corridors that cross ridges between valleys, need to be maintained for critical movements; remember, many animals, such as bear and deer, require different habitat for eating, mating, and sleeping. The result is an interconnected network of protected ecosystems extending throughout the forest.

Once the protected landscape network is established, the remaining forest areas are zoned for uses to provide for human and ambihuman needs. Forest use zones include culture,

recreation-tourism, conservation, fish and wildlife, wilderness, trapping, timber, firewood, and alternative products. None of the uses in these zones should damage the forest.

We have to do the same for regional and global patterns.

7.9.1.4. *Stage 4: Create Specific Plans & Designs*

Field data can either be summarized in one grand ecological plan or in individual plans. If in individual plans, as many of the following as possible should be completed: Landscape plan, Watershed inventory, Soil report, Road plan, Zone plans, Harvesting or Use plans, and a Restoration plan (if necessary). The plan(s) provides an overall picture of the parts of the forest landscape and stands, and how they are functionally interconnected.

If in a grand plan, then more questions have to be asked. Conservation biology recognizes the need for planning at a landscape level. Conservation biology also attempts to answer vital questions about forests.

- Considering that as little as 10% of forests survived in isolated refugia during the ice age, is it reasonable to conclude that today's forests are supersaturated as some industrial foresters claim?
- Given current trends, what rates of forest loss will occur in the next decade? Will the curve be linear or exponential?
- Will the extinction spasm of millions of insects and fungi have a greater effect on forests than other extinctions (such as Pleistocene megavertebrates)?
- Will a major (90-98%) loss of forests in developing countries (especially in the Amazon) be more risky than it was for Europe and North America, considering how relatively slow the changes were in North America and very slow in Europe?
- Can conservation biology provide tested strategies for conserving biodiversity at various scales of space and time?

To answer these questions and others, as well as try to meet its goals, conservation biology must start major taxonomic pushes to classify and inventory species in every kind of ecosystem, using residents, biologists, computers, axial tomography, and nuclear magnetic resonance to collect and scan specimens. It also has to start to plan for future biotas, that may be less beneficial for humanity. Many of these will be restored or assembled from exotics, reintroduced natives, or engineered species. To address problems of inbreeding depression and loss of variability in small populations, molecular markers should be used in a framework of conservation genetics. Biotechnology might also be applied to problems with exotic species that cause damage to the integrity of ecosystems. Cryogenic techniques could be used to suspend material from rare or endangered species. On a large scale, science has to plan for changes in the evolutionary process as a result of massive human technological and social impacts, e.g., slower rates of speciation due to confinement of wild populations. On a national level, people have to build interest in diversity projects, such as salmon or old growth. And, on that level, people have to concentrate on several highly visible successes.

Based on this picture, the protected landscape network and activity zones may be revised. Then, detailed plans for on-the-ground activities are prepared for each zone. Using forest characteristics, the principles of ecoforestry, and objectives, you should be able to set standards for each zone, e.g., number of intrusions, number of snags left or created, or canopy coverage. The standards are established to set limits and provide direction for activities so that the forest is protected at all scales in the short and long terms.

Because the designs take place within a human culture, people also have to analyze the activities to prepare a cultural and financial plan. The whole idea of valuation in ecology is to have enough knowledge (or guesswork about the possible value) about the system to create an intelligent plan that can guide its preservation and use. As Herb Hammond has noted, however, guessing at a value and then requiring a major percentage of it to be exploited has no real basis in an ecological inventory and assessment.

Rather than remeasure the entire forest every year, foresters prefer to measure a number of permanent circular plots, keeping track of ingrowth and cutting. The CFI system does not replace regular inventories. Once you know what you want to do, and where, in the forest, as well as how, you need to find out how much these activities will cost and how much revenue you can expect from the goods and services.

This analysis ensures that your activities will be profitable without degrading the forest. If timber cutting or leasing is determined to be unable to generate adequate revenue to cover costs, then this activity can be abandoned before people are tempted to “cut corners” and degrade the forest in order to achieve short-term economic success. Your economic goals should include covering costs, ensuring that sufficient revenues are generated to cover future costs, such as equipment replacement, improving forest health and aesthetics, and guaranteeing that workers are paid fairly for their services. Many of these activities may not be considered profitable under conventional timber management.

Part of the analysis is investigating markets or places to sell your products or services. A business plan provides a practical blueprint against which you can check your day-to-day, or month-to-month financial picture; it compares the costs of activities with the revenues received from them. Based on the plan, you should also consider borrowing money for short or long term.

7.9.1.5. Stage 5: Put the Design on the Ground

The knowledge and planning can now be applied in the ecosystem, region or planet. Within the limits of principles and standards, you can begin laying out the human infrastructure (trails, landings, buildings) and performing the activities that are beneficial or profitable. As you work you should be adding feedback to the plans; for instance if a granite outcropping makes a road in one place prohibitively expensive, you might need to reroute or reconsider.

7.9.1.6. Stage 6: Monitor Activities

In order to understand the effects of your activities, as well as the natural changes in the forest, you must start monitoring a number of vital things. Monitoring ensures that standards of ecoforestry are followed for the duration of the activity. Monitoring also allows the standards for the activities to be revised to increase the protection of forest functioning and to increase your efficiency.

7.9.1.6.1. Establishing a Context for Ecosystem Monitoring

Richard Hart recommends laying the foundation for a new approach to assessment and monitoring, with a scientific approach at its core to account for the act of observing and recording the entire ecosystem. This approach is based on important observations. The actual substance of which the forest environment is made consists of *patterns* rather than things or individual species. The environment is generated by a patterning of an ecological ebb and

flow of energy, substances, individuals, and species across a suitable landscape. Successful adaptation to this complex system requires an enormous number of minute local adaptations by a large number of individual organisms from a large number of species. The distinction between growing and declining patterns is not arbitrary, and can be arrived at objectively. And the environment is constituted of a large set of events that are objectively definable by specific outcomes. The procedural consequences of these facts involve practical changes in the relationship:

- Between the region and its species over space and time
- Between the region and the collective ability of species to respond flexibly to situations beyond their normal patterning in the processes of adaptation and repair
- In the flow of energy through the environment and its biotic community
- And, in the ecosystem's collective patterning of shared needs and governance which can be defined as its health.

“Taken as a whole, the process of observing patterns in these relationships leads directly to a fundamentally different way of perceiving ecosystem management,” states Hart. We need to review our perception of how species link with one another. We have names for species but we not for their dynamic relationships. We have labels for bundles of relationships, such as aquatic macroinvertebrates, yet, as an example, we do not have a label for the relationship between a caddis fly and dipper. They both have similar needs, but they also have very dissimilar ones when they enter each other's environments. They each follow distinct patterns that overlap to meet their needs, and fulfill the function of their relationship. Traditional labels such as predator/prey need to be expanded upon to more accurately portray the full intricacy of natural relationships. In addition, for each direct species to species relationship, additional bundles or sequences of indirect interconnected relationships spiral outwards logarithmically into the ecosystem and the biosphere as a whole. Indigenous peoples have names for many of these relationships, usually in verb form, such as pollinating, germinating, shading, or camouflaging. They understand and respect the importance and intelligence of species connectedness.

7.9.1.6.2. Relationships are generated by rules of adaptation

It is obvious that relationships are fundamental. What is not obvious is that these relationships are generated by rules of interaction. Each species is ultimately a product of the rules inherent in the gene system; interaction of those rules creates and sustains its life. The generative rules are relatively simple in comparison to the complexity of the end product. This is accepted as a part of bioscience, but for most people it may not be emotionally real. The idea that there can be a set of rules which ultimately generates the environment can be difficult to comprehend, because the rules themselves are not physically apparent. As a result, the idea of systems of rules actually generating structure is not widely shared. The point is that the structure of ecosystems at all levels is not random, but is strictly adaptive, according to straightforward principles.

In this generative sense, rules actually create the species in an established order during the course of embryonic development. Over the course of many generations adaptation occurs and the generative rules are “revised” by evolutionary processes to fit changing circumstances. Hart emphasizes this, “It is by observing the interaction of the set of rules that one can begin to generate the kinds of monitoring pertinent to the ecosystem's well being.” Monitoring

the connections is important because it brings the inquiry back to the ultimate intent of ecosystem management—the attempt to discover and describe the structural correspondence between a species and its environment. A healthy species not only fits its environment well but also defines or clarifies the collective life it adapts to. We perceive this clarity to be the richness and wholeness of ecosystem structure. An unhealthy or absent species confuses the collective life, and we perceive this as static, fragmented or degenerating environment. There is a correspondence between the holistic behavior of a species and how it can be seen to relate to other elements of the ecosystem.

The distinction between wholesome and defective structure is a matter of fact, not value. Other species, such as pathogens, take defective structures back down to basic components, to be reinvested at another level of suitable structure. This process of reinvestment is vulnerable to (unnatural) disturbances when its patterning does not possess adequate information for a balanced response. The ecosystem will proceed to construct and repair according to its established patterns, no matter how disrupted or fragmented it has become. After disturbances to which the ecosystem is not adapted, it may take a considerable amount of time to re-establish the living community, even when there are sufficient resources available. The free functioning of a forest ecosystem (within the bounds of natural disturbance regimes), is not only the key to its current structure, but is also the source of holistic patterning over time.

The forest ecosystem is a large-scale pattern of millions of minute events. The environment requires an enormous amount of minuscule local adaptations between the earth and its users. The essential intent of ecosystem management is to initiate and maintain a fabric of events that weave through the common connecting points for all species events within the forest in a ‘neutral’ or beneficial fashion. The ultimate goal is to collect the information that details the establishment and maintenance of “comfort zones”: the climate, nutrient and mobility suitable for species viability.

Monitoring shows how the ecosystem is changing and at what rates. It shows what areas of the system are critical for its functioning and ecological integrity. It may give an indication of how to rank values in the forest. It shows how use of the forest can be balanced and how the use can be zoned according to degrees of protection and use

7.9.1.6.3. Monitoring

“Monitor” means to observe for a special purpose or to regulate (a machine or process), from Webster’s New Collegiate Dictionary. I.F. Spellerberg defines monitoring as the “systematic measurement of variables and processes over time for a specific reason,” such as ensuring that standards are met. In the last topic we were concerned with measuring the area and content of forests; this week, we will address the measurement of the parameters that define patterns that indicate health or change in a forest.

There are many groups at international and national levels measuring the environment in general. The US Geological survey monitors hydrological cycles; the National Oceanic and Atmospheric Organization studies climate. The United Nations, the Environmental Protection Agency, and The Nature Conservancy, among others, have established long-term ecological monitoring programs. The National Science Foundation administers a long-term program with a network of representative ecosystems, including forest ecosystems. Two of the research sites are the Harvard Forest (temperate deciduous forest) and the H. J. Andrews Experimental Forest at Oregon State University, where topics include: Successional processes, forest-stream

interactions, population dynamics of stands, effects of nitrogen fixers on soil, disturbance in landscapes, and patterns of log decomposition. Started in 1989, this program collects data on long-term trends in ecosystems, that is, patterns of primary productivity, organic matter accumulation, inorganic inputs and movements through soils and water, disturbances, and populations in trophic structures.

There are different levels of monitoring, including environmental, biological, and ecological. Environmental monitoring is an umbrella for many activities, including climatic variables and geological processes; for example, the systematic recording of soil and air temperatures, humidity, air pressure are measured by meteorological organizations to predict long-term climatic change.

Biological monitoring, according to J. Cairns, is the regular, systematic use of organisms to determine environmental quality; that is, the state of the environment can be analyzed by how individuals react to pollutants. British Columbia, for instance, uses target species of small mammals to intensively monitor the impacts of herbicides (which are used to try to control early succession) in the Coastal Western Hemlock Biogeoclimatic Zone on Vancouver Island and the mainland; they put live-traps or pellets along transects to get counts of mostly mice and shrews. Biological monitoring has numerous subcategories, such as the biochemical, microbiological, epidemiological, and biotelemetry. Pollution affects the productivity of trees. Lead (from gasoline) in tissues can slow plant growth. Particulate matter (smoke, ash) impairs stomata in plants. Sulfur dioxide (from blast furnaces) causes tissue degeneration and interferes with enzymes in plants. Lichens are good indicators of sulfur dioxide pollution because different species vary in their tolerance; fruticose lichens are very sensitive, while crustose seem to be most tolerant. Acidification (from evaporation of wastes) comes from many sources and depresses microbial activity and decomposition.

Ecological monitoring is the observation of communities to understand long-term ecological processes, such as succession and maturity. We will concentrate on environmental monitoring to chart changes in a forest, but we should always be aware of the other two.

Before monitoring can begin the objectives and data collection methods have to be nailed down. The purpose of the monitoring program has to be stated; the objectives have to be identified, e.g., the health of the forest. Health will probably be your first objective, followed by production or aesthetics. Health can be “defined” by a set of indicators of health, such as species, or patterns of health, such as stability or productivity. None of the indices that are measured are really adequate to define the health of the forest because they cannot account for the complexity, richness, and cycling that goes on in the forest. For that reason health indices are data that need to be resolved on the ground in person by someone who knows the history of the forest and has a feel for it.

The basic medical definition of health used to be freedom from disease. Part of a new definition is resilience to stress—of course, there is good stress (eu-stress) as well as bad stress. Ecosystems respond to stresses in different ways, but usually through a decrease in the indices mentioned. Some of the stresses and their generally negative effects can be categorized.

7.9.1.6.4. Goals & Objectives

Monitoring is needed to provide a general characterization of the general “physiology” of the system, including the ecology, biology, and hydrology, and to suggest a set of primary indicators that can be inventoried, understood and monitored over time. Monitoring can

provide guidelines for The processes are easy to learn and relatively inexpensive. But we should not be deluded into thinking we are gathering cheap information.

The information needs to be credible, and gathered strategically and carefully. It needs to be entered into a data management system that is both relational and spatial. We are not looking for easy “cures,” nor are we presuming to reduce nature into numbers. We are looking for and gauging relationships and their patterns—including our own. Gauging is a way as determining the capacity, volume, or contents of the patterns. This is not for the purpose of making value judgments, an activity common to many forms of life, but for observing how and if the ecosystem is responding to its own needs, and what resources it has available.

What makes something valuable is not in its own properties alone, but also in its relation to the ecosystem as a whole. The “usefulness” of a thing or species does not rest solely in its appearance as an individual entity, but rather in its existence in a web of relationships. How it “is” essentially involves a complex series of relationships between the various events that are going on inside and outside its boundaries over large and small spatial and temporal scales. To understand the physiology of the forest requires that all view-points be considered together (top-down, bottom-up, across the landscape, etc.). The health of forest ecosystems essentially determines our health—physically, socially, economically, and spiritually.

As a result of their monitoring woodlands in Britain, G.F. Peterken and C. Backmeroff propose a set of useful rules for ecosystem monitoring:

1. Any variable or process which can be readily measured and dated may be valuable in detecting changes in ecosystems.
2. Long-term monitoring must be supported by administrative continuity otherwise the program may simply be overlooked or forgotten.
3. Facilities are required to ensure (i) survival of records and duplicate copies or records, (ii) markers locating the transect or quadrat and (iii) that the program is known to exist.
4. Repetitive recording is obviously necessary and although it may not be necessary at regular intervals, further records should be taken after or prior to any formative events.
5. The monitoring locality should be inspected regularly (annually for a woodland) even if information is not collected.
6. Although objectives of the monitoring need to be defined, recording aims should be open-ended. The basic systematic record should be supplemented with casual adjuncts which have a habit of being valuable at a later date. This is because we do not know how the data could be applied in the future.
7. Simple variables and processes well recorded are more valuable than poorly recorded complex variables and processes. It's better to record something rather than nothing.
8. Representative records and replicates should be established if possible but even an unrepresentative sample may be valuable in the future analysis.
9. Regular analysis and preparation of reports, even at early stages in the monitoring help to improve the methods for data collection and help to refine the objective. These reports also serve as a reminder of the program.

Two approaches to monitoring can be distinguished that are vastly different in scale, precision, and cost. The first is relying on scientific apparatus, which is accurate but often requires you to know the problem in advance; physical and chemical analysis are expensive and technology and labor-intensive. Identifying the indicator species may be difficult. The second is mapping

biological indicators, which is a quick inexpensive survey in the field. Basically, this means walking or crawling (as Gary Snyder recommended once) through the ecosystem with your senses open.

Each approach has advantages. Scientific instruments are not only capable of detail down to a nuclear level, but, in the case of satellite imagery, great scope at hourly intervals. Infrared detectors (and others at other wavelengths) on satellites can differentiate stress-affected trees from healthy ones.

The sun produces a unique spectrum (every star does because the composition and size of each star is unique) of electromagnetic radiation, mostly in ultraviolet, visual, and infrared wavelengths, that is intercepted by the earth as it revolves and rotates. Some of this radiation is intercepted by the leaves of trees, which reflect a percentage back to space, where they are detected by special films or scanners on satellites.

Remote sensing can detect some forms of damage immediately over inaccessible stands over large areas. Although not all forms of stress can be detected by remote sensing, there is still a lot of the spectrum (ultraviolet) that has not been investigated. On the other hand, on-the-ground monitoring is probably more labor-intensive and more expensive. The two styles of monitoring forests are supplementary; satellites can pick up dramatic changes, which can then be investigated on the ground. Satellites are not a replacement for ground work, however. Remote sensing and field work are complementary.

7.9.1.6.5. Key Indicators for Monitoring

The following descriptions of each indicator outline the specific attributes which can be measured, as well as an explanation of why they contribute to our understanding of forest health. It is anticipated that as our understanding of ecological processes increases the number and type of indicators may change.

7.9.1.6.5.1. *Physical/Chemical.* The structural integrity of ecosystems is vital to their continuance. Mechanical and chemical disturbances affect major changes in the structure and function of natural communities. The goal is to gain an objective appraisal of the patterns and processes, including the causes, that lead to enhancement or impoverishment. Compaction is a serious problem, which can result from landslides or from heavy vehicles. The availability of water, air, and nutrients to plant roots decreases as soil porosity decreases. Reduced soil-water recharge potential can result in reduced productivity and viable nutrient-producing soil microbe populations. Reduction in root mass and elongation adversely affects the ability of the roots to supply nutrients and water. Monitoring both the degree and spatial distribution of compaction can assess soil physical conditions and long-term productivity.

Changes in landscape morphology also need to be monitored. Slope stability monitoring provides information regarding potential migration of material into watercourses, as well as effects on landscape structure, changes in overland flow of materials and nutrients and changes in habitat conditions suitable or unsuitable to resident species. Soil erosion causes changes in physical properties of soil, such as structure, texture, bulk density, infiltration rate, depth for favorable root development, and available water-holding capacity.

Changes in stream chemistry, stream morphology, and the atmosphere are also important. Photochemical oxidant pollution damage is related to the decline in plant productivity, and it seems to be interacting with such naturally occurring stresses as drought, insects, disease, fire, and windstorm.

7.9.1.6.5.2. *Biological/Ecological*. The objective is to comprehensively assess viable habitat. Species, in general, continually migrate to habitat suitable to their prosperity. These events can be observed and recorded within the landscape structure.

So, we need to monitor habitat viability. The best way to monitor habitat conditions conducive to species prosperity is to select indicators that are sufficiently sensitive to give warning of impending change, distributed over a broad geographical area, capable of providing a continuous assessment over a wide range of stress, relatively independent of sample size, easy and cost-effective to measure, collect, assay, or calculate, that differentiate between natural cycles or trends and those induced by humans, and are relevant to ecologically significant phenomena.

In addition to measuring plant associations and their components, as well as seral stage, we need information regarding the effect of species displacement and habitat alterations. This would also provide an indication of habitat availability.

7.9.16.5.3. *Organic Deposition* in soil levels or in standing, down, and submerged large woody material (LWM): Measurements of standing, down and submerged LWM, and present state of decay, provides information related to microhabitats, organic soil material, habitat capability, and species viability. As LWM decomposes, it provides an interface between the living and the dead. Monitoring state of decay will insure a continuum of this resource into the next planning cycle. The litter and duff layers are part of a process that produces soil organics. Soil organics are important to soil moisture-holding capacity, nutrient supply, physical aggregation of the soil and reduction of erosion rates. The natural process of decay results in a reduction in the level of soil organic matter—an effect that can be countered only by the frequent addition of fresh residues to the soil. Monitoring of litter and duff thickness is an indicator of soil productivity and health.

7.9.1.6.5.4. *Habitat linkages/fragmentation*: Biotic communities have progressively become reduced in area as a direct result of human activity (Spellerberg, 1991). During this process of reduction, the wildlife habitats and natural communities have become progressively more and more fragmented, resulting in remnants of habitats and communities being surrounded by different land uses. Monitoring this indicator will provide information at the province and sub-province levels on the rate, extent and potential effect of fragmentation. In addition to monitoring the rate at which biotic communities are affected and the extent to which they are fragmented, monitoring the levels of success or failure arising from attempts to reduce the impact of fragmentation is also needed. Buffer zones and corridors are two concepts put forward as ways of reducing the isolation effects of reserve areas. Mapping variations in canopy cover may aid in determining the effectiveness of buffer zones and corridors. Also, monitoring populations in remnant communities and the ecological effects of fragmentation could provide basic data for the development of management strategies for different kinds of protected areas, including late successional reserves.

7.9.1.6.5.5. *Historic range and variability of species*: Use of ecologically-based historic occurrence of species via elevation, aspect, habitat and natural variability of species significance/ presence would be used to contrast with present human activities. Descriptions of historic landscape disturbance regimes (e.g., fire magnitude and frequency) and the ecosystem component patterns they maintained (e.g., vegetation composition) provide an initial template for descriptions of ecosystem health. This function would provide a baseline or control to effectively gauge other monitoring items.

7.9.1.6.5.6. *Biodiversity*: Indicators are measurable surrogates for determining disturbance to indigenous biodiversity that we assume to be of value to the public (Noss, 1990). The 15 indicators were selected based on the following criteria developed by Tom Atzet (Atzet, 1993); they are: Relevant meeting identified objectives; Sensitive, quickly detecting change and indicating trends; Available, being inexpensive and easily applied to a known standard; Measurable, being accurately quantifiable with acceptable methods; Defensible, not subject to individual bias; Displaying Coverage, as the variable is well distributed spatially and temporally; Acceptable, its methods are socially accepted and understood; and, Usable, providing feedback for adaptive management.

The indicators of biological diversity can be put under three categories: Physical, biological, and cultural. Physical/chemical indicators include landscape morphology, stream morphology, soil compaction, stream chemistry, and atmospheric effects. The biological/ecological include species habitat viability, habitat linkages or fragmentation, historic range and variability of species, plant associations, large woody material, and soil organics. The cultural include demographics, economics, cultural influences and history, and human values. Indicators may overlap between the three components, emphasizing the linkage among functions within the ecosystem.

7.9.1.6.5.7. *Regional Diversity*. Regions and biomes have many subregions are not adequately addressed by management. For instance, Hart notes that the patterns that support the diversity in decomposed granitic soils are not of the same configuration that support the distinct diversity found in high elevation volcanics or clays, yet similar silvicultural prescriptions, logging systems, and timber volume “yield tables” have often been used for these areas. We must be careful not to presume that what is good for one ecosystem is good for another area within the same administered jurisdiction. We must pursue the credible path that allows decision makers to look at the fabric of intelligence gathered within a biome and let that very site-specific information determine how human activity will affect its well being. This path utilizes monitoring and integrated post-monitoring evaluation to determine the ecological merit of implemented projects and to develop alternatives that are *relatively* environmentally benign. Social and economic activities that complement and enhance, rather than oppose and degrade, ecological processes are to be preferred and encouraged. Hart concludes that the job of monitoring is to ensure that we can answer the question of whether the lofty goals of ‘beneficial’ management are actually being achieved.

Data must be evaluated in an integrated manner that spans biological and physical scales, watersheds, administrative boundaries, as well as functional areas. To understand how ecological processes are connected we need to relate information across disciplines and agencies, and collectively perceive the effect of our actions on the environment. It will be our challenge to find those events within the ecosystem that give us the most succinct information of what those basic needs are.

7.9.1.6.5.8. *Human Dimension*. Traditionally, it has been human values that ultimately determine what, where, and how we monitor management activities. Therefore, it is imperative that cultural values and natural processes be determined and monitored simultaneously. In this way, we can begin to understand which natural processes we use (favor/discourage) in order to benefit our current value system (Martinez, 1993). Monitoring and evaluation of the indicators below provides necessary information in understanding the human dimension as it relates to ecosystem management.

Social and economic data is often compiled by standard political boundaries, not on provinces, sub-provinces, landscapes or project sites. Thus, socioeconomic data is not strictly comparable or usable at the sub-province, landscape or project site levels (Williams, 1993). However, the indicators listed below can be either described or mapped onto geographic information systems (GIS), providing an opportunity for integration with other physical/chemical and biological indicators.

7.9.1.6.5.10. Demographics as an indicator provides information on where people settle, how many there are, and what they do. This has a profound effect on the environment and its sustainable use and management. Information gathered from cultural and informal sources would assist us in making sound decisions that integrate the diversity of the local and national human population.

Data may include; age distribution, in-migration, percent of population using forest resources directly (including recreation visitor days and employment), where people settle—their distribution, and number including rural interface zoning, roads, type of industry, public services, communication lines, and types of community activities.

7.9.1.6.5.11. Culture influences information gathered through various sources, provides information on historic uses of an ecosystem and surrounding landscape, and associated human activity. This data may include ethnographic information and historic use patterns.

Economics provides data on local and regional economic health would help us to predict long range trend and landscape use patterns. Data may include real unit costs and price changes, income tied to forest activities, profitability of forest management, payments to government, percent of wood products recycled or reused, changes in the distribution of employment and income, employment patterns tied to forest activities, rural interface land values, type of commerce, welfare payments into the community, and the economic base.

Human values data may include various land-use patterns such as percent of land base set-aside in protected areas, dispersed and concentrated recreation areas, grazing allotments, mining activities, “hang-outs” used by certain age groups, vegetative/animal usage (game management areas, firewood, timber, special forest products, fishing spots, water withdrawals), and community contacts (retirees, business people, school faculties and staff, college students, community clubs, tribes). Humans are part of the equation. What makes something valuable is not in its own properties but in its relation to the personal preferences of its perceivers. The usefulness of a species does not rest entirely in its appearance, but rather in its existence.

7.9.1.6.6. Limitations of Monitoring

There are a number of problems or limitations with monitoring that must be addressed.

The processes of many forest ecosystems have not been researched, so there is no baseline to compare measurements with (it is difficult to measure change without a baseline).

Anthropogenic (human-caused) disturbances have long-term, synergistic, cumulative effects that are hard to trace. Synergistic actions lead to emergent and unpredictable properties of a system. The complexity of the measurements and the limitations of laboratory facilities or labor may lead to additional expense. The costs of monitoring are relatively high, not just the prices of tools or labor, but the cost of investigating over a large area for a long time will be very high. The costs of satellite monitoring are high. For example, coverage of all forested areas on the planet would require 4200 Landsat scenes and cost over \$4 million (in 1994 dollars) for current data.

7.9.1.7. *Stage 7: Evaluate and Refine Plans*

Planning is only the first part of acquiring human needs from a wild forest. How you interpret and execute the plan is also important. Your skills and knowledge of the forest determines the success or failure of the principles and standards developed in the plan. The results of monitoring need to be evaluated and fed back into the process of planning and acting. You may wish to create a narrative summary of your experience for later use.

In the late 1970s, C. S. Holling described Adaptive Management as a response to natural disturbances at the landscape level. The ability to make strong inferences about values and sensitivity to management activities among locations is limited. It may not be appropriate to generalize about management impacts unless the interactions of the system are identified and related to the intensity of past activity. Adaptive management is based on an understanding of uncertainty, ignorance and the wild processes of change. Without certain knowledge, however, we can make adaptive decisions based on partial knowledge. Any plan can be refined and improved continuously for its duration.

Funding must be identified and allocated as part of the planning process. Funding would provide for monitoring design, field work, data-management (GIS), and evaluation of results over the period dictated by the sampling scheme.

Involvement with the community, other agencies, research, industry and institutions must be included. Everyone has a stake in the maintenance and enhancement of system and regional health. Collectively, we can arrive at a greater degree of understanding of ecosystem management.

7.9.1.8. *Summary: Studies & Values*

With a focus on exploitation of products from ecosystems, many other measurements are ignored, from shrubs and forbs, and their ratios, to soil dynamics, direction of succession, carbon fluctuation, biomass, biodiversity, long-term biological processes, and the role of ecosystems in global cycles. Beyond products, ecosystems provide food, fuel, and fiber. Many products are consumed locally, but others, such as fruits, medicines, rattan, latex, palm oil, cocoa, vanilla, nuts, spices, gum, and ornamentals, are sold on international markets. We are not measuring these products either, and worse, we are not using them wisely once we extract them.

Ecosystems should be measured at larger scales: Watershed, landscape, biome, and global. Although we have discussed some of the technical tools, such as satellite imaging and GIS, we have neglected the conceptual tools, e.g., the Gaia Hypothesis or global ecological design.

Furthermore, we are measuring over a year or two only to establish a growth rate or productivity. We should be measuring over centuries. An ecosystem is a long-term changing being. We cannot use a short-term industrial approach to measure a few parameters and then pretend we know enough about a forest to cut a large percentage of it. Ecosystems are created by slow processes that take hundreds or thousands of years. In their 36-year study of a 450-year old conifer forest in Washington, Franklin and DeBell (1988) projected that it would take the shade-intolerant Douglas fir 750 years to drop out of the forest. Chris Maser points out how long it takes for coarse woody debris to decay (200-460 years). Soil formation takes millennia; rates can range from 50-100 years per centimeter.

The use of paleoecological techniques, such as pollen analysis, can provide information on some of these slow, long-term processes. For example, sediment cores from lakes in Eastern North America showed a steep decline in hemlock pollen about 5000 years before the present, according to Davis. Hemlock remained rare for 1000 years and took another 1000 years to return to its original frequency in eastern forests. Sediments can also be used to document forest fires and the frequency of fires.

Retrospective studies can be used to start or supplement long-term studies. Tree ring widths can also be used to study growth responses to changes (the science is called dendrochronology). For instance, Brubaker and Greene use ring widths to demonstrate that trees that were completely defoliated by tussock moths recovered and attained normal tree ring widths in 2 to 3 years. Trees attacked by spruce budworm were depressed for 5 years before recovering. Tree ring measurements also show that bristlecone pine in California established many trees at treeline up to 1600, when the numbers began to decline (no new trees), until 1900, when regeneration started again (LaMarche. 1973).

An ecosystem is not a regular annual phenomenon—the kind favored by science. Ecological events may be rare, like a volcanic eruption, or long-term episodic, like windstorms. Many events have not even been observed yet. In marginal habitats, for Ponderosa pine for example, reproductive patterns are highly episodic; in one 37-year period in Arizona, reproduction was abundant in only one year. The importance of insect infestations is overestimated without long-term studies of the forests in which they occur. Many other ecological processes, such as temperature or precipitation, are highly variable. Litterfall in old-growth Douglas fir forests has high annual variability. Finding a few gross patterns in a forest of complex processes is fairly easy; finding the subtle patterns is difficult without long-term comprehensive studies.

An inventory is the primary source of data about the ecosystem for planning. The cost of complete data is considerable, the more complete the more considerable, but whoever has an intelligent say about the use of a forest ecosystem, for instance, must have that data. Instead, a partial inventory is often tailored to the expectations of whoever is controlling the forest legally. Our exploitation—and exploitation is okay ecologically (interference is the dangerous interaction)—of a forest is usually limited to a single commodity: wood. And usually one kind of wood, with other kinds left or destroyed in the getting.

Our lust for wood blinds us to the value of trees and the importance of forests. Forests in fact are horrendously undervalued. Ecological services provided by forests, such as watershed protection or carbon sinks, are not valued directly at all. Yet, forests clean air and water. How much does a canister of Pacific NW air sell for in Tokyo? Even timber is hideously misvalued, due to below-cost timber sales, federal subsidization of roads, or inefficient practices. Furthermore, destructive practices prevent many other social benefits from being realized, such as recreation or aesthetic appreciation—or even nuts and medicinal plants. The fact that forests produce so many things that become products on formal and informal markets means that the forest is more valuable than a single measure can show. We should value everything about the forest and measure everything that has value. So much data is lacking that we should be getting any kind of data we can.

Whole regions have been deforested or severely reduced in forest cover. Over 50 percent of the planet was forested at one time—down to about 28 percent now. We could restore at least 20 percent in the next decade, including the most vulnerable regions, such as Ireland,

Italy, Greece, Syria, Lebanon, and the formerly Fertile Crescent.

On the other hand, how much forest cover do we need to keep the atmosphere functioning the way we like it? Carbon dioxide accumulates in the atmosphere at a certain rate annually. Deforestation releases tons of carbon per year (only a third as much as from fossil fuel combustion). Reforestation could remove carbon from the atmosphere. We need about 1.7 billion acres of new forest to store the tons of carbon lost annually (after George Woodwell's estimates).

Estimates of the minimum forested area for the planet are more difficult to arrive at. Houghton et al. (1990) suggest that the minimum should be about what remained in 1990: about 13.1 billion acres, or 40 percent of the land area, although the area remaining that year is not definitely known.

Not enough aspects of a forest are measured. Besides increasing the number of aspects, monitoring needs to address long-term change and human influences. A number of other tools, from topology to metaphor, may prove to be useful in predicting and manipulating forest behavior, if we can figure out how to use them.

7.9.2. Ecological Planning & Limits (Human Population)

A number of proposed plans to heal the earth and improve human communities have been presented in popular books. Many of them are too philosophical and general, suggesting that we could change values without showing how or urging us to alleviate some of the symptoms without addressing the disease.

A plan should consider the whole system. Communities should be designed for an optimal fit within the limits of the system. Ecological planning considers an optimum or satisfactory population within one ecosystem, although it is connected to others by trade for some necessities or luxuries. This kind of planning is a conscious adaptation of the benefits of technology to the traditional idea of physical, as well as cultural, limits. Direct observation and traditional knowledge yield far more "information" about the societies of animals than autopsies and mathematical models. An outline of a comprehensive plan is presented, to deal with some of the implications, as well as question them.

1. Identify our place within its natural boundaries. Most places exist in a uniquely identifiable ecosystem, with recognizable boundaries and a unique history and character.
2. Calculate the optimum amount of wilderness to preserve the natural cycles indefinitely. If the current area is less than our calculations, restore the difference and reserve it.
3. In the remaining area, zone areas for appropriate use, including conservation, preservation, reservation, and artificial areas (with historical, cultural, and functional importance).
4. Identify the resources needed for human use, including raw materials and the productivity of the areas. This productivity can be used to calculate a base line population.
5. Apply cultural modes—in style, values, and technology—to set limits on technology and population. Preserve the cultural values. Renewable resources will sustain a population longer than energy capital like oil or gas.

As part of the formulation of a plan, we have to examine the natural and cultural histories of a place. We need to understand interactions in the ecosystem, as it was with no humans, as it was lightly settled, and as it is now, dominated by humanity.

7.9.2.1. Limits & Planning

Our modern cosmology, with its basis on machine metaphors and the principles of plenitude gets in trouble because it does not understand how basic the concept of limits is to the physical universe, to life, to ecosystems, and to human constructs, such as cities and economics. Limits are important at all levels, starting with the physical.

The limits of the universe, like the speed of light or quantum of a field, put limits on freedom. Events are limited to localities; size limits function; history limits development. Biological order is built on physical and chemical orders. That is why life is limited to such a narrow range of conditions. And that is why the most complex orders are vulnerable to changes in their substrates; energetic radiation can alter and destroy an individual, a small change in climate can destroy crops and civilizations.

7.9.2.2. Limits of Human Populations

A population of the human species, like any biological population, is a group of individuals of one kind that allows the exchange of genetic information in a specific place. A population has unique properties that can be described statistically, such as biotic potential, density, dispersion, birth rate (natality), death rate (mortality), age distribution, growth form, and structure (in terms of isolation or territoriality). A population also has certain other qualities that can be described quantitatively or qualitatively, such as: dynamicism, variability, adaptability, reproductive fitness, and stability (especially persistence, the ability to leave descendants over time).

The population is the unit that evolves in nature, according C.J. Krebs. Populations interact in neutral, positive, or negative ways. Competition, which can be negative or positive, limits the number of species in a niche (this is the competitive exclusion principle, which Garrett Hardin states as: complete competitors cannot coexist). Niches must be different for species. Krebs states that the fundamental niche of a species has an “infinite number of dimensions,” making a complete determination impossible. A niche can limit a population.

Many factors other can limit population: The environment (weather, water, heat), change (or catastrophe), food Supply (with minerals, trace elements), territory, predators, and psychology (the choice of or desire for certain foods or places). These factors also filter a population so that less fit individuals die before reproducing.

The cost of evolution by filtering (or selection) is so heavy that most of the time most populations are not perfectly fit to their changing environment, which they change through living. Evolution never expresses total fitness; it requires destabilization, a risk accompanying all innovation. Self-presentation offers the possibility of new relations or of extinction.

7.9.2.2.1. Population Change & Growth

Variability in resources and weather, as well as dynamics with other populations, cause changes in a population. As a result of these influences and interactions, a population can grow or shrink or die out. It can stay in place or disperse.

Natural growth of a population is related to development and maturity. Population growth occurs when the birthrate exceeds the death rate, or when immigration from other populations exceeds emigration. Under many circumstances growth confers a survival advantage. At some point a population stabilizes.

7.9.2.2.1.1. Human Population History

A population of individuals grows, or overgrows, like a population of cells in a body. And, individuals, like cells, receive signals from the environment that tell them when to die. Unlike cells, however, which rely on chemical signals, these other signals are in the form of food supply, climate, and predators. Some animals try to avoid such signals by moving; some plants try to avoid those signals by growing larger or producing chemical defenses. Human beings have used movement and technology to overcome those signals. We have become very good at converting ecosystems to food systems and using technology to control our environment.

Regarding the success of human population growth, it is possible to relate it to explicit changes in ideas and technology. Agriculture, for instance, sparked an acceleration in population growth. It offered more food in one place. It allowed a sedentary lifestyle, which permitted larger families, especially to increased labor requirements. This increased population density in small areas. And, it triggered a demand for more food to feed more people in a permanent area.

The ideas of storage and urban settlement allowed more people to live together. But, large populations allowed diseases to survive, also, including those that would die if human populations were isolated. Other changes that permitted growth included improvements in sanitation, water and waste flows, and building.

Urban cultures responded to population growth by intensifying resource extraction (which still continues with the green revolution and genetic engineering), by relying on more technology (that can result in overfishing or overharvesting), by integrating support systems, e.g., transportation and banking, by increasing centralization, bureaucracy and stratification, and finally by migrating.

Cities grew and continued trading at larger scales. Early globalization affected populations by introducing diseases from other groups into isolated populations, resulting in catastrophic losses of peoples. This led to changes in immune systems, also more symbiosis between hosts and agents, and much later, to public health changes like sanitation.

7.9.2.2.1.2. Growth of Human Populations

Human populations have been able to overcome many internal and external problems, from stupidity and greed to overconnections and collapse. The growth of the total human population over the past 60,000 years is an obvious gigatrend, but single populations advanced through losses and gains, depending on conflicts, diseases, and droughts, as well as on advances in technology and social structure. In Europe for instance, the Black Death and then Thirty Years War killed 85 million and 110 million people respectively, which caused losses in populations that took centuries to recover. Despite setbacks from diseases and wars, the most explosive growth trends, measured by doubling rates, can be compared to changes in lifestyles, as illustrated in Table 792212-1.

Table 792212-1. Doubling rates Related to Major Lifestyle Changes

<i>Style</i>	<i>Years to double</i>	<i>Population</i>	<i>Date</i>
Foragers	6,760 years	10,000,000	12,000 YBP
Farmers	1,922 years	500,000,000	400 YBP
Urban Workers	200	1,000,000,000	200 YBP
Energy Slaves	33	6,000,000,000	15 YBP

Human population history can be represented graphically with a long j-curve that is exhibiting exponential growth. Most marriages had over 2 surviving children. The population 2000 YBP grew to 250 million. By the time the Industrial Revolution was developing in 1700, the population was 500 million. In 1800 it was 1 billion, and by 1900 1.6 billion. By 1950 it was 2.5 billion. And, it increased to 6.1 billion by the year 2000. Again, the increase has not been uniform. Some nations in Africa and Europe have experienced declines in populations, for various reasons.

By 1960, in many western nations, such as Norway, the rate of increase started to decline. Some theorists related this decline to the increase in wealth and security. Others suggested that education and new methods of contraception were responsible.

7.9.2.2.2. Discussion of Population Futures

The drawdown of resources, in fact the use of a significant percentage of productivity—enough to threaten biological and ecosystemic renewal, has allowed the increase of populations as well as the expanse of luxuries to exceed the limits posed by annual productivities of food and fossil fuels. Paul Ehrlich has related the impact of population to the population size, its affluence and its use of technology (in the IPAT equation). However, many other factors can influence impact, especially our cosmology, that is, our image of nature as a machine capable of indefinite modification and perfection through substitution and repair, contribute to the overall impact. Industrial economics, also based on the machine model, and partial democratic politics, which continues it, have justified the overshoot and the destruction. Paul Shepard concludes that this has become a form of madness.

The demographic transition, which was hypothesized in 1945, suggested that as people got richer and more urbanized they tended to have fewer babies, in fact so few that they would not be able to replace themselves. Over 60 nations, with half the global population, have transitioned and have shrinking populations. The magic number for replacement rates is a birth rate of 2.1 or higher. This should keep the population stable. Some nations, including Bulgaria and Russia, are experiencing population loss, from emigration or from new diseases. Some nations responded to the decline by encouraging more immigration. Others, including the United States and France, are experiencing population growth again. In August 2009, a study in *Nature* magazine revealed that 18 of the wealthiest nations have birthrates that have started climbing after decades of demand. There are two basic factors that influence population change; one is the total fertility, the number of children a woman would expect to have, and the other is the level of the Human Development Index (HDI), developed by the United Nations. This measure combines per capita gross product, education and life expectancy to measure the development of a country. After the end of the decade, the HDI approached the highest possible number in many nations. The authors concluded that increased birthrates suggest that wealthy nations do not need to fear population implosions that could destabilize the nation. That birth rates in the wealthiest nations are rising again, reversing earlier declines, may be the result of heavy immigration, as people with higher birthrates migrate to these countries, instead of being the result of a rebound in native births.

Recognizing higher rates in some developed nations, some scholars are challenging conventional notions about the environmental impact of more people, leading them to embrace what they call counterintuitive solutions such as larger cities. Unfortunately, having

larger cities is not the same as a having a higher population--the two are not equal. Larger cities may indeed reduce the impacts of a stable population, but often both are increasing. José Guzman claims that a world population of 7.8 billion people could inflict greater damage on the environment than one with 10.8 billion. So what? Any larger flow of materials means that the larger population will inflict greater damage. The poor people may inflict less damage on the environment, although a shift in wealth could cause more damage. However, if global human population is stable at a high number, it will still do more damage to the environment. One argument is that with shrinking populations, there are not enough young workers to sustain a vibrant economy or to pay for social welfare programs to support that the poor and elderly. All of these arguments assume that the current economic growth is maintained. Some people also say that low birth rates could create a perpetual economic crisis. This again is true only if we cleave to the industrial economics scenario.

The demographic transitions may assume a stable population. However, a population characterized by low replacement and high immigration, like the United States, can have an increasing overall population.

Stewart Brand warns that a plummeting birth rate could be terrible news for the environment, since the trend could cause social and economic chaos. That may be true with the assumption of the current economic situation with its requirement for growth. Brand also claims that wars will be more likely in the crisis, and there will be more damage to the environment from wars. And, that prediction has to assume the current economic and political trends that see war as the only response to harm or lawlessness.

Another factor is the aging of populations. In developed nations, populations are generally getting older. In less developed nations, populations are getting younger. Another factor is the shifting of populations through immigration and emigration. Consumption levels are of course a problem. Gusman suggests that it is unrealistic to believe that problems such as climate change and habitat loss could be resolved simply with massive family planning programs in poor countries. This is true of course, but what we need to do is solve the suite of problems as a response from total design.

The wealthiest countries account for a large number of new emissions that might contribute to the greenhouse problem. This can be linked to consumption patterns. One factor of aging populations in nations would be the general reduction of emissions, since old older people tend to live in smaller places, travel less and consume less. Not many people argue that cities hold the best chance for a sustainable future. This is what others have been saying for many decades. Large cities, as arcologies, could reduce the footprint of the population on land.

Traditionally, population growth has been a simple issue of the pressure of numbers against resources. However, there are many other factors that contribute to this, such as lifestyles, energy use, waste, and ecosystem conversion. Population is a complex issue, but many pundits try to simplify it by saying that if populations continue grow, the economy will do well. That might be true if resources were infinite and ecosystems were invulnerable, but they are not. Others say that the danger is a confrontation between a pessimism and smugness. Neither extreme is a good approach to addressing the limits on or impacts of populations.

Design of populations through planning has to balance migrations, levels of luxuries, needs, inequities, and many other things. International agreements can balance emigrations and immigrations. Some violence erupts from uncontrolled migrations, but this can be ameliorated with the lessening of institutional inequities and the need to migrate. The United

Nations control of common areas, especially the entire atmosphere and hydrosphere, can set limits for the unbridled expansion of economics and populations. Finally, a shift in human consciousness, that results from new images of the planet and human destiny, could make these changes agreeable and desired.

7.9.3. *A Standard of Measurement: Ghost Acreage & Ecological Footprint*

Georg Borgstrom, in 1961 and 1969, in his book *Too Many*, used a concept of ghost acreage to explain how the Dutch and Hong Kong Chinese could continue to thrive in a limited area using invisible acreage. Eugene Odum used, in 1970, the idea of a required minimum acreage of the environment to get an optimum population for Athens Georgia. That is a way to use an optimal acreage carrying capacity to fit humans to wild productivity and land through design. Dennis Meadows used the idea of overshoot of capacity in 1972. William Catton used ghost acreage and phantom carrying capacity in 1980 to explain overshoot. Then, in the mid-1990s, William Rees and Mathis Wackernagel came up with a better metaphor though, a footprint. Why is that a better metaphor? Because it is a recognizable human measure, and it presents our dominance as an easy to see symbol.

Their footprint is described by age, city size, weather, zip code, sex, home characteristics and travel. The sum of those things is indicative of impact, but not very comprehensive. It could be improved by increasing the dimensions from 2 to 4. That is to say, a footprint has a depth and history. Microclimates 6 inches off the ground can mean good crops or none. The soil has a depth and a history; animals make soil. Area is not as important as carrying capacity. Carrying capacity is dynamic and has to be represented that way. Therefore, there cannot be one specific number, only a range with a rate. Furthermore, wilderness has to be calculated in, for itself and services. Specific patterns and cycles have to be addressed. Energy use is complex and should be broken out. Some of the assumptions are weak or erroneous. For instance, tropical areas do not offer more productivity for consumption. Their model assumes that no harmful chemicals are used or released. It assumes that coverage is native vegetation, not exotics. They admit that the calculation of a footprint can be off by 100-200% and that goals are not considered.

Footprint analysis, however, is being used for shopping centers and cities, and nations and civilization. The metaphor has struck a sympathetic chord and is popular. If it were made more comprehensive, it would be much more accurate. If it gave more attention to wilderness and to energy use, it would be more revealing about our usages. For example, when we burn fossil fuels, we are using energy from ancient sunlight that is caught in molecules. Each gallon of gasoline takes 100 tons of ancient plants. In 1997, we used 422 years of fossilized sunlight. Since the footprint is an area, then we used 422 planets to get energy that year. That is quite a footprint.

We could use a modified footprint to set a carbon budget for the planet. For a world carbon budget, first we would calculate carbon limits; second, we would calculate a world cultural carrying capacity such that the sum of all is 100%; third, each nation would get a percentage of carbon based on the percentage of capacity that is natural and doable—directly related to area and ecological capacity. So, if China has 13% of the capacity, even if it has 25% of the population, then it gets 13% of the carbon credits. The calculation is not based on population, but on an optimal population; and, fourth, we set the goal for total carbon use at a level from 1800 AD or 275 PPM (or maybe at 1400 AD or 8000 BC). The number of carbon

credits should be limited to the maximum carbon use allowed, not to population or power.

The ecological footprint is a measure of the energy and resource throughput of the human economy. It compares human demand for energy and resources with the regenerative capacity of the earth's biosphere for providing these ecological goods and services. Ecological Footprint analysis adds up the area of different land types, such as forests, fishing grounds, crop land, pasture, that are required to support humans' activities. This is done by normalizing the biological productivity of the different land types in a common unit, such as the global hectare or global acre in the United States. One global hectare (gha) is equal to one hectare of land with world average productivity for all land types. The supply of ecosystem service is called 'biocapacity;' the human demand for these services is the 'ecological footprint.' By comparing supply (biocapacity) with demand (footprint), Ecological Footprint analysis provides a metric for indicating unsustainability. Globally, as of 2002, there exist 1.8 gha per capita of biocapacity available to support human activities, and not setting aside any biocapacity for nonhuman species. In 2002, the most recent year for which data are available, the global human economy used 2.2 gha per capita, resulting in an ecological overshoot of about 20 percent. This means that the Earth takes 15 months to regenerate what humans use in 12 months. This condition of global ecological overshoot cannot continue indefinitely. A catastrophic ecological failure may occur if the demands for 'natural capital' are not reduced to a level that the biosphere can provide on an annual basis.

Footprint analysis can be subdivided itself, into local analysis or ghost acreage analysis and trade analysis. Although the footprint is a good metaphor, there seem to be many things left out. Footprints have not only an area, but also a depth, not just a simple size, but a shape. Footprints can be immediately gone or persist for a long time. The footprint adds up all the real and ghost acreage that a country uses, as part of the footprint. That is, the imports are added and the exports are subtracted, although, exports cannot be subtracted from the footprint exactly since they are originally part of it. Wastes are far more critical than resources, as regards ecological cycles. Many uses are not included, so the efficiency calculation may not be accurate. As Rees and Wackernagel admit, the bio-productive areas that are really needed to maintain today's usage of nature's benefits are most probably larger than the ones in the calculation. Ecological analysis would force us to look at the obvious—generating nonmarketable use values occupies the center of every culture because it provides a satisfactory life to its members. And, that is hard to quantify.

Even with its limits, an ecological footprint documents the consumption and waste production of one nation (or community) expressed in biologically productive land and ocean areas necessary to maintain those services. By adding data on the consumption of various resources and on the ability of the earth to provide them, the ecological footprint provides a means to compare consumption and serve as a rough indicator of sustainability.

7.9.4. Create Monitoring of Regional Properties

A Regional Commission could address real regional problems, such as regional warming, which has resulted in grain harvest shortfalls in recent years. The climate in general would receive renewed and detailed examination.

A regional system is the sum of localities and may have unique characteristics of its own, that is, the whole planet (or universe) has characteristics that local frames of reference do not have. An ecosystem is directly connected with regional cycles and other ecosystems. The system

is embedded in larger systems and global cycles, cyclicity. There has to be a good substrate with energy and materials flowing into the system.

The regional problems include: Regional warming; ozone depletion (chemical-caused); disruption of regional cycles; contaminations, like nitrates or mercury. These threats cause ecosystem collapse. Ecosystem breakdown happens as a result of stresses, singly or grouped, that relate to interference patterns in the system, most of which are caused by humans now, although the potential for asteroids or volcanic eruptions remains.

Our actions on the planet are experiments, whether we want them to be or not. Ignorance, denial, or cupidity cannot unmake this experimental course, which may be global and irreversible. This Commission would make the experiment cautious.

7.9.4.1. Atmosphere Monitoring

The biosphere can exert control on the temperature of the surface and the composition of the atmosphere. On the other hand, soil types and the weather can limit vegetation; invasions of vegetation change soil types. An ecosystem is a topographic unit, a volume of land, occupied by organic beings, extended over an area and through time, with connections to larger mineral, chemical, water and air cycles. This means they are geographical units that intersect with atmospheric units. Ecosystems have a vertical structure, that includes the levels of climate from micro to topoclimate and macroclimate, to soils, water structures, and bedrock, as well as a horizontal structure. An ecosystem is a process, or a set of interlinked, differentially-scaled processes that may be diffuse in space but are easily defined in turnover times.

Processes encounter each other in a functioning web of an ecosystem, with tangible and diffuse surfaces. Lynn Margulis qualifies her definition of an ecosystem: The smallest unit capable of recycling the elements of its membership. For example, organic carbon can be expired, fixed, reacted, or transformed. This is done through the physiological activities of the members of the system, through breathing, enzymes, or some other way. Margulis states that elements recycle faster within ecosystems than between them. Forests, for instance, act as sinks for carbon. The rapid release of sinks can affect other atmospheric or terrestrial cycles. The biota of the planet appear to regulate the surface temperature, atmospheric composition, and ocean chemistry, for a start, perhaps like the human body regulates its temperature, blood chemistry, and other vital signs. As it achieves a new balance, with human inputs, the atmosphere may cause problems with agriculture and other human activities. Atmospheric monitoring is tied with water and terrestrial monitoring. Parts of the atmosphere could be designated as reserves.

7.9.4.2. Ocean Monitoring

Life had once been limited to the oceans. The evolution of living forms expanded those limits. Life, over time, has colonized deep oceanic vents, as well as Antarctic gravel fields. Oceans are not as productive as most land-based ecosystems. Worldwide, oceans could only support about twenty two million people, even though its area is over twenty three times that of grasslands. The ocean bottom acts as a sink for phosphorus. The rapid release of sinks can affect other atmospheric or terrestrial cycles. This Commission would protect the integrity of the oceans. It could designate ocean wilderness or conservation areas. Perhaps eighty percent of the ocean surface could be designated as a reserve.

7.9.4.3. Deep Continents Monitoring

Continents are formed by the movement of tectonic plates. As each continent forms, it develops its own combination of topology and water and climate patterns. Australia for instance has become the driest continent now. As continents rise or subside, in addition to their movement and combination, life has to adapt to the changes. The purpose of such monitoring would be to predict long-term changes as a result of continental change.

7.9.4.4. Bioregions Watersheds & Habitats Monitoring

Monitoring bioregions and watersheds involves a larger spatial scale than ecosystems. Regional goals are appropriate for bioregions. Evaluation of data must occur in an integrated manner that spans biological and physical scales, watersheds, administrative boundaries, as well as functional areas. To understand how ecological processes are connected we need to relate information across disciplines and agencies, and collectively perceive the effect of our actions on the environment. This approach follows ecosystem theory (the hypothesis that cycles in nature integrate the physical, chemical, and biological components of ecosystems), and the hierarchical organization of ecosystem functions throughout the landscape. Hierarchy theory can be described as the development and organization of landscape patterns, e.g., vegetation communities, through time and space.

This can be accomplished by incorporating the three primary attributes of biodiversity, as described by Jerry Franklin—composition, structure and function—into four levels of organization—province, subprovince, watershed, and site. Indicators incorporating composition, structure and function at the appropriate levels of organization have been identified for many ecosystems; they range from landscape morphology to human demographics and cultural influences.

For watersheds and habitats one has to consider the impact of any kind of vegetation removal. What is a minimum, optimum or maximum vegetative cover for various watersheds? Science can identify minima or maxima but philosophy and conservation can aim at optima.

7.9.5. *Preparation for Emergencies & Catastrophes*

Any agency that monitors the planet has to also monitor the potential for destructive events and catastrophes. It has to treat them as emergencies when they happen and be prepared to respond to protect human and wild life, as well as their habitats and resources.

The agency has to *Assess Threats (Internal & External)*. The Security council is concerned with any kind of threat to the global order and the orders of nations and nature. Many of these threats are internal, as nations enter into conflicts with other nations. These threats can be handled by delegations or police actions. But, many threats are external to the planet. They come from solar or interstellar space and tend to be physical.

With regards to internal (or planetary) threats, international conflicts may cause problems. Widespread poverty may cause catastrophes. Richer countries will need to recognize that the poverty of others is not in their interest, especially as potential markets. Inequity may never be erased. Perhaps some inequity is good and stimulating, but gross inequity needs to be limited.

Conflicts, territorial or symbolic, are symptoms of insecurity. Many of our wasteful conflicts could be more easily resolved through a neutral international power. Conflicts would still occur. Conflicts over prestige or power, as much as for various crusades as for a true state,

still lead to human and environmental destruction. The Security Council would be charged with the responsibility to avoid massively destructive forms of conflict, such as biological war or nuclear war.

7.9.5.1. Regional Threats

The planet is still a very active planet. Some threats to humanity rise from the normal activities of the planet, such as volcano-building or continental drift.

7.9.5.1.1. Geological Threats

Typical geological threats include earthquakes volcanoes, and mudslides; rare threats may be comets or sunspot activity. While technology may be able to retard some of these threats or counter them early, the best solutions are design. Cities can be moved from floodplains; cities can be required to have quake-resistant buildings.

7.9.5.1.1.1. Climatic Threats

Someone said that civilizations exist through the consent of geology; however, the consent of the 'first empire of climate' might also be needed. Climate is a constant and immediate challenge. Many variables affect climate. One variation, with a long cycle of perhaps 100 million years, is continental drift. When Panama closed continents, it forced the gulf stream north. The earth's orbit around the sun, a 100,000 cycle, also changes climate. This is close to the spacing of ice ages. Other smaller cycles, at 10,000 years or 6,100 years are minor harmonics perhaps. Other activities that influence climate are sunspots, comets, and volcanoes. The most stable periods seem to be the coldest or warmest weathers. For instance, 400,000 years ago, a warm period lasted 25,000 years. If we are in a 10,000-year warm period, it may be almost up. This means that predictions are relevant.

Cooling can lead to disease and depopulation, which can lead to cooling. Farmland is abandoned to trees in times of collapse. Because trees take CO₂ out of the atmosphere, the regrowth of forests after the plagues in 1322-1351 in Europe and China, would have allowed drops in CO₂, which would have allowed climate to cool some.

The years 1997 to 2004 broke most heat and storm records, especially as some of the warmest years on record. We experienced 500-year floods, droughts of the century, and other extremes. Some of these events have been related to greenhouse effects.

7.9.5.1.1.2. Oceanic Threats

Ocean currents affect not only islands and coasts, but they affect the entire climates of continents. For example, the effects of the Pacific El Nino current can be linked to droughts in India and China in the past 150 years that caused three times the deaths of the Black Death, and more than the 60 million who died in WWII.

There does not seem to be a single trigger for El Nino. One trigger has to do with water overflow and then back flow from the western pacific. Others have to do with sunspots, which would reduce radiation, or volcanic eruptions. Many of these atmospheric, oceanic and geophysical triggers may converge. Nineteenth-century famines may be correlated with ENSO events that influenced China, Indonesia, Brazil, and southeast Africa.

The adherence to political colonialization and 'free market' economics, along with climate changes, made the suffering in famines worse. Millions died within the market system

of the golden age of liberal capitalism. Thus, the famines were political and economic failures. Even at the height of the famines in 1877-78 and the 1890, Britain continued to export grain from India to England, which had its own agricultural downturn. The invisible hand did not lift those starving in India or China. There was starvation before the British, especially during El Nino events in 1596 and 1630, but many droughts did not result in such widespread and deep famines. Market economics and politics magnified the effects. The market economy can spread risk, through insurance companies, when crises are local and intermittent, but they may not be able to respond when the crises are regional and ubiquitous. As the risks increase everywhere, fewer things can be done.

Other movements of water, such as tsunamis or floods, can be linked to earth movements, such as landslides or earthquakes.

7.9.5.2. Solar System Threats

Solar energy is not quite constant; over millennia it has been increasing; over the next billion years it will start decreasing. Collisions with asteroids or comets will always be a threat due to the nature of the solar system. The passage of the solar system through dust clouds will effect the climate of the planet and the solar output. A global agency could plan to deal with asteroids and comets.

7.9.5.3. Protection against Interference Events or Disasters

Police would be expected to be prepared for natural disasters, including the extraterrestrial. The police would focus on the prevention of man-made disasters, from watersheds that were compromised to chemical spills. Collisions with asteroids will always be a threat due to the nature of the solar system.

The flexibility of a natural ecosystem to respond to change has been reduced, so either we have to take over control, which could cost quite a lot, or we have to adapt to the diminishment after some climatic episode.

7.9.6. *Designing Regions & Links*

A long-term model might consider that the locations of some cities and cultures should not be renewed if they are destroyed in particularly active zones of rapid geological or climatic change. There are links between climate and disease, between disease and new patterns of poverty. Global climate change, planetary and atmospheric heating, can increase the incidences of some diseases, like malaria in northeastern European states. The drying out of wetlands, which causes smaller stagnant pools, can increase outbreaks of mosquitoes. Ecological models can delineate the links between ecosystem attributes and stresses. They could suggest standards for design of wild system and human system interfaces.

James Lovelock predicted that the planet is managed by one large bacterial ecosystem that manufactures trigger chemicals. The natural cycles of sulfur and iodine take place through biological production of dimethyl sulfide and methyl iodide. Dimethyl sulfide is linked with algae on the ocean surface, clouds and oceanic climate regulation. Climate regulation on land is coupled with growth of trees in tropical, temperate, and boreal regions. Biodiversity is a necessary part of planetary self-regulation. Ecological design, and regional ecological design, could identify these connections and offer designs to keep the larger system healthy and productive.

The design of wild ecosystems is linked to the history and properties of the system. It is also linked to the cultural images of those who want to restore the system. Nature and culture are adaptive systems that change and develop over time. The design has to link the ecological and cultural dimensions to become a self-making and regulating system. These systems are also linked to regional biogeochemical cycles that provide elements, air and water to local systems.

The regional linking of corporations and economies has resulted in a fragile interdependence, which has reduced the functional independence of many nations, which can no longer supply heir basic food and shelter. Separate regions may want to discontinue or reduce links to financial risks, such as the international commodities market. Economic links can be beneficial in small clusters. With the Grameen bank, Muhammad Yunas decided to link people in clusters, so that a borrower had to join a five-person borrowers group. The group then took responsibility for each borrower (perhaps at this level shame is a critical factor in being financially responsible). Scale-linking is one the principles of ecological design; local banks could be linked to regional and global forms. Small units, with short linkages between groups, are simpler and allow faster feedback. The same ecological design principles work in banks, ecosystems or nations.



Figure 7911-1. SynGeo ArchiGraph Office at Altazor Forest 1999

8.0. Designing Good Places

Small groups of people have made good places. Cultures have made good places. Often, the making is a slow mutual adjustment among life forms, environmental constraints, and human cultures. But, many need to participate in the making. And certain problems have to be addressed. The levels of intolerance and conflict that are permitted between groups and nations have to be reduced. This change can occur through actions of other design factors, such as recognized regional commons. A region, or the planet, could be set up as a corporation with ownership of all commons, especially those that provided ecosystem support for wildernesses and cultural areas.

This could happen if there were a framework to keep nations small and independent, to allow cultures to develop without unfair competition or dominance. There are big problems that require big frameworks. But, the frameworks can only be viable if they are run on a local level. There has to be a framework to accomplish regional designs, especially those related to regional things and cycles. The atmosphere for instance. The framework could allow good places to be designed and managed for long periods of time, within the limits of the dynamicism of the planet as well as accidental events in the larger universe.

8.1. *Regional Problems: Intolerance Conflict & War*

We tend to think of problems as unwanted ‘side-effects’ of the wanted main-effects, but all effects are equal, as Buckminster Fuller noted, and must be addressed as equal. Most things identified as problems are embedded in a network. Nothing is simple; there is not one truth, there is not one way, and there is not one goal. Problems could be considered also as challenges that we must respond to continuously, in the process of living, not as puzzles that have to be solved once for all time. It is about consciously choosing to see what can be done, rather than dismissing a conflict as terrible and unsolvable. When challenged by some situation, we react by habit, although this may be disconnected from other habits. Habits protect us from many problems. Addressing a problem often has to do with a power struggle, which becomes part of the problem of the problem. If problems are regarded as challenges that require a social response, then much of the conflict can be avoided.

8.1.1. *Intolerance*

One problem that typifies every culture is intolerance. Intolerance means a lack of toleration or the unwillingness to tolerate or the contrary beliefs of persons or groups. Intolerance seems to be a fact between cultures and between individuals; it can lead to conflict and violence. It used to be understood that intolerance and violence occurred between ‘irrational actors,’ whether individuals or ethnic cultures were involved. Violence could not be explained rationally.

If cultures or individuals were rational actors, then the irrational actions of conflict and violence would have to be explained in some other way. M.D. Toft suggests that ethnic group settlement patterns, socially constructed identities, charismatic leaders, indivisible issue, and state concern with precedence could lead rational actors to escalate a dispute to violence, even when doing so was likely to leave contending groups much worse off.

The problem of intolerance and conflict can be more easily understood with reference to the cosmology of a culture, basically the complete set of ideas about the nature of the universe used by an individual culture. All cosmologies cause destruction and waste; all produce the opposite of the good intended. Once cosmological ideas are adopted, they may remain unquestioned and unquestionable, and they can influence a culture over centuries. The principle of otherness, where others are not true humans, is an example. This principle may have made perfect sense when cultures had to protect their territory, especially when the territory was rich but limited, or when there was a large investment in it, as with agriculture. By representing others as nonhuman or subhuman, they did not have to grant them consideration from the ethics of the culture. Many modern political ideologies and economics have been shaped by the principle of otherness. Cosmologies can influence a culture to ignore, accept or fight other cultures. Intolerance justifies inequity, domination and conflict.

8.1.2. *Kinds of Conflict*

Conflict is sometimes perceived as the only response to intolerance or to other problems. However, conflict can be related to various losses or cultural norms. Understanding these conditions may allow us to resolve some kinds of conflict.

8.1.2.1. Conflict as Loss of Fitness

Fitness is the ability to function under normal environmental conditions. Stress, obesity, illness, toxic chemicals, social conflict, and other kinds of dysfunctions, can reduce fitness. A lifestyle dependent on physical and energy slaves, not to mention a diet riddled with addictions to cheap fats and sugars, decreases our fitness. All of the elements of a true addiction are present in modern lifestyles: We get a short term high, and we suffer long term health problems. Air pollution, sedentary life styles, exposure to stressful city environments makes things worse, even as we acquire more information about the dangers and options. Conflict is an attempt to correct the problem by capturing more food and energy, or acquiring clean air and water, or conquering new land. The stress of conflict however, can lead to a declining cycle less fitness and more conflict.

8.1.2.2. Conflict from Loss of Equity

Although many resources are distributed unequally over the globe, as a result of different kinds of historical geological processes, trade can allow access to those resources. However, as a result of long-term processes of inequity, from keeping people enslaved to cultural hoarding, many people have far less than others. This has resulted in permanent overclasses and underclasses, which are often maintained by physical force, as well as by the force of economic and religious myths. Most people are hungry; few people are fulfilled. Even low average levels of food and fulfillment can be maintained only through theft from other species and from future human generations. Conflict is one attempt to bring about more equity, although it can result in greater disparities and losses.

8.1.2.3. Conflict from Loss of Accord

As a result of the unequal distribution of natural resources, including unincorporated waste and pollution, and the unequal distribution of materials and wealth between people, economic conflicts arise, often becoming violent political conflicts. Accord, by definition,

means agreement or the concurrence of will or action. As an agreement between the parties in a controversy, by which satisfaction for an injury is stipulated, accord allows people to reconcile their injuries and interests. Because many national boundaries were drawn as a result of colonial expansion and contraction, many cultures are artificially combined in large territories or stretched across several traditional territories. This has created the conditions for continuing cultural and political conflict. In addition to the normal conflict between different cultures with different ways and values, usually resolved by trade or distance, this new conflict resembles small permanent wars over large numbers of territories. This kind of hot conflict not only destroys habitats and resources, but it causes immense human suffering. As the rules change, and conflict includes noncombatants, as well as plants and animals, there is less accord between conflicting groups. Accord requires the ability to trust, which requires self-reliance and confidence.

8.1.2.4. Conflict as a Result of Scale

Leopold Kohr identifies the basic conflict between man and mass, citizen and state, large and small communities, as being the result of bigness. Kohr's theory of size states that the cause of most forms of social misery is bigness. We have always tried to exceed the physical and biological limits of places rather than recognize them and be guided by them. Every advanced country is now over-technologized. Past a certain point the quality of life diminishes, not improves, with each advance. Big science serves big technology, which supports and is supported by big government. And there is no science like big science, and no administration like big administration. But this enthusiasm is misdirected. Scientific advances and technological changes result in unforeseen consequences, good and bad. They cannot be controlled or legislated against before the fact. But the investment seems too big to abandon.

8.1.2.4.1. Personal Conflicts

Individual conflicts often resulted from insults or broken promises. In Mesopotamia, people paid fines for hurting others. For instance, severing the bones of another man with a weapon resulted in a fine of one mina of silver. When arguments could not be resolved, there was often open conflict. Resolution of individual conflicts was usually informal within the confines of the community. For Inupiat and other egalitarian cultures, song duels are a ritual pacific form. The disputants publicly insult one another until the audience laughs down the loser. If individual disputes are not resolved, then they are settled by community consensus.

The predominant value in small cultures, and then many larger cultures, was harmony. This minimized conflict that might have resulted from inequality. Confucian concepts of ritual and etiquette helped to regulate social conduct and made people feel good about their station. For example: "Inequality is the nature of things" and "seek no happiness that does not pertain to your lot in life."

8.1.2.4.2. Group Conflicts

Warfare in band societies, such as the Tiwi, seems to be limited to first injury or death. Could it be due to a lack of interpersonal competition for status? Are people taught to be restrained? Sometimes conflicts are resolved by ridicule before getting out of hand. Population density was controlled by the traditional approaches to resources. In archaic societies, cooperation and consensus, as opposed to competition and individual exaltation, permitted planning to

remain informal. Population growth triggered competition and conflict, which lead to positive feedback of the thing that caused the stress.

In Mesopotamia, complex systems were be managed locally by farmers, although there may have been conflict with upstream users. But, cooperation is necessary, especially within and between villages. As a result large-scale water systems were first managed by religious leaders, then later by secular leaders. Usually irrigation is necessary when the rainfall is unpredictable. Wars started from depressions in food production or storage. Mesopotamian cities had councils of elders to make decisions. They would appoint a leader to lead in war or trade. After 2800 BCE, gods changed from natural forces to war gods. Agriculture gave a surplus; that and property increased the excitement of war.

In China, in the Warring States period, the nature of war changed: From an Aristocratic monopoly of soldiers to one with permanent standing armies, professional leaders and peasant soldiers. Conflict was resolved centrally by a chief or king, who held a monopoly on power.

8.1.3. *War*

Does every society have war? The anthropologist Carol Ember surveyed band societies and found that sixty-four percent waged some kind of war. The reasons for war have gone from insults and personal conflicts having to do with bride exchange, broken rituals and personal honor to group and external reasons, such as territory, resources and patriotism.

The nation states are closely related to large-scale violence, usually having to do with trying to consolidate their power (global war). They then have a monopoly on power(monopoly rents) They specialize on political and economic issues (e.g., the Spanish ransacked the planet for gold). They enlarge and consolidate their territoriality, which gives them increased capacity for marshaling resources (maximum global functions with minimum territorial burden).

Wars, like the recent one in Iraq, are based on weak assumptions: That the war can be waged by blasting away any threats, and that it can be contained by using conventional weapons. But, like most actions, it has affects that can get magnified in the larger system. Furthermore, the war breaks out of the barriers that the participants try to create, destroying properties and civilians—there are no longer any safe buildings or noncombatants, and ruining the social and ecological fabrics.

All wars now are ecological wars that destroy the basis of civilization. There are no nonmonotonic effects with war. There are no side-effects. There are only effects and they can all be measured. Perhaps the next war will be to directly destroy the ecological basis of a nation, an extreme scorched earth policy by the aggressors. These wars would be social wars that destroy entire generations and traditional social structures. Perhaps, future wars will have less to do with honor and territory and more to do with crises, such as famine, population, and environmental collapse. Perhaps, wars will have to do with symbols and religion, again, as they have in the past.

8.1.3.1. Advantages & Disadvantages of War

War has advantages and disadvantages. One of the advantages of war is its long tradition, being simpler to understand than rights, the attendant macroeconomics or the workings of enantiodromia. Another advantage is that war is cheaper than ever before, especially to attack. Of course, war is also stimulating and fun, at least for the victorious survivors, who are bonded

by the danger.

It used to be that it cost more to attack than to defend, with preparations and supply lines. Now, It costs more to defend against a bullet than to attack with one. Cheap bullets destabilized the western U.S., but laws and enforcement, also with bullets, restabilized it. Possibly the same thing will happen with cheap cruise missiles. Maybe not, as the cost of attacking will now continue to be less than defending. This means that the world may become more violent and less stable. Can information warfare be cheaper, or less destabilizing? No, because information attacks may be even easier to perform. Unless everyone has the same weapons.

The disadvantages are greater than the sum of all advantages. Ecosystems in disputed and ravaged territories are always disrupted, damaged or destroyed. Human suffering is always made worse than it was before the war. And, war never solves the original problem.

8.1.3.2. Style and Scale of War

Politics is the management of people through equitable distribution of resources, and the management of relations with neighbors or trading partners, using negotiation or force, war if necessary. Wars have changed in style and scale. From disagreements, wars have become a centralized state function. From religious reasons, where Gods lived with people, it has gone to the secularization of state concerns.

The essence of war is to defeat or destroy an enemy. Governments are efficient killing machines. On the average in the nineteenth century, states killed 3.7% of their subjects. In the twentieth century they killed 7.3% of the world population.

War as related to growth. Often the same factors that allow unsustainable growth allow unsustainable war. Growth is promoted for its advantages, usually without recognition of its difference from development.

The historical rhythm between war and peace inevitably leads back to peace. When does peace occur, when it is won? Unlike many forms of war, peace is a process with a less rigid beginning. It can never be won or kept permanently. It does not have the prestige or honor of war, and perhaps this is why so much less times and effort is devoted to peace.

Is there a way to limit war, within the context of peace? Is there another way to humiliate or embarrass an enemy, and let some other kind of balance be found? Is there a way to limit violence to heroes or to leaders, as if either would agree to have their individual expertise be responsible for a whole population.

Notice the sequence (in Table 8132-1). Competition with other species and groups leads to conflicts, which grow in size and sophistication, gradually including noncombatants, crops, land, other species, and ecosystems, until the war is against large groups of human communities and then against nature in its various aspects from microorganisms to invasive plants or imbalances. The sequence also parallels the growth of groups from tribes to Nations and Unions.

8.1.3.3. The Easiness of War

War has become too easy. It seems easier in the immediate or emotional short-term to use institutional violence to solve any dispute. It is exciting, and it allows the combatants to form close bonds, perhaps much closer than those in business or play.

The largest problem with war, however, is its scale. War is waged between nations and

groups of nations against other nations or groups of nations. Even on a local scale, it often involves larger complexes of political links.

Table 8132-1. Styles of War

<i>Kind</i>	<i>Reason</i>	<i>Examples</i>
Personal Conflicts	Insults, broken promises	Palouse, Aborigines
Leaders Conflicts Group conflicts	Social insults, food, territory	Uruk
General's wars	Food, Luxuries	Babylon
Psychological wars	Prestige, Glory Idealism Patriotism	Greece, Macedonia
Professional Soldiers wars (Army wars)	Food, territory, unification	China, Rome
Religious wars Royal wars National wars	Territory / conversion	France, Britain
Economic trade wars	Control of resources in colonies	Britain, France, Portugal, Spain
Chemists war, with poison gases, explosives	Territory expansion	World War I
Physicists war, with radar and nuclear weapons	Territory expansion	WW II
Mathematician's wars, with guided missiles	Resources Potential threats	Iraq Gulf War I
Electronic wars, to kill computers and databases	Destruction, information or economic structure	Iraq II
Ecological wars	Destruction of land base Against Nature	Vietnam, Iraq Pesticides, Medicines

8.1.4. *Summary: Inseparable Behaviors*

Conflict cannot be separated from other things, such as environmental destruction or inequities. Conflicts have been escalating, regardless of who won a cold war, or whether nuclear disarmament is being achieved. The constant conflict of cultures and the loss of life, human and other, is tragic. But, this kind of tragedy results from a failure of cosmology; humans are responsible ultimately, not fate or chance (See Section 8.2.4.). Humans are equals, not subhuman others. Humans are tragic because they are responsible for their actions. They can choose a tragedy of the commons or of dictatorial control—or they can expand or alter their cosmology.

Militarism, conflict, intolerance, crimes, and health problems are symptoms of the instability of cultures. Confusion and misinformation contribute further to the destruction of cultures. If cultures are lost and new forms cannot fit themselves to the patterns and uncertainty of natural systems, then people may not be able to adapt to the continued development of the planet and its ecosystems.

Conflicts, territorial or symbolic, are symptoms of insecurity. Many of our wasteful conflicts could be more easily resolved through a neutral international power. Conflicts would still occur. Conflicts over prestige or power, as much as for various crusades as for a true state, still lead to human and environmental destruction. The Security Council would be charged with the responsibility to avoid massively destructive forms of conflict, such as biological war

or nuclear war.

For that reason, the UN Security Council and its force has to consider the broadest meaning of security: It is for people to have the resources and opportunities to provide themselves with their needs. Thus, security has to be addressed on many levels. For example, what do forests have to do with peace? Of the fourteen nations requiring UN peace-keeping operations since 1990, twelve of them have lost over 90 percent of their forests. Perhaps peace-keeping should be abetted by tree-planting. As ecosystems are destabilized, nations become less stable, and must be helped with more than social conflicts.

The UN could propose an adaptive cosmological framework to place human values within a global ecology and to balance human development and the preservation of wild places. The framework could protect the integrity of culturally-based nations and to address global issues. Global and local issues would be differentiated; the myths of global communities and one-world people would be explained and discarded. Pretending to be world people is a mistake based on a misunderstanding of human limits. People are the products of places and cultures, of land and nations.

Each culture develops rules for living together. A common culture provides an ideal framework for public and private decision making. The Sami in northern Scandinavia have institutionalized ways of avoiding conflict, for instance, by shaming those who would impose their will. The Fipa of Tanzania use cooperative exchange rather than competition to keep the peace. The Akawaio of Guyana believe that community disharmony upsets the spirit world, resulting in illness and misfortune, so harmony is worked for.

The individual in a culture is responsible for the style and simplicity of their life and for its effects on nature and society. The individual is responsible for being tolerant of others in the culture, and is free to make many kinds of choices. Individuals could assimilate new knowledge from their experiences without changing if the experiences fit in the framework of their cosmology, that is, if the experiences aligned with their internal representations of the world. This may also allow them to ignore or judge unimportant events that did not fit. Jean Piaget noted that when individual experiences contradicted their internal representations, they had to change their perceptions of the experiences to fit their internal representations. He called this accommodation, the process of reframing personal mental representation of the external world to fit the new experiences.

Accommodation can lead to learning. When the world violates our expectations, we can fail, but by accommodating this new experience and reframing our model of the way the world works, we can learn from the experience of failure. In a scientific view, ethics and cosmology are separate. But in a good mythology, there is a coherence between areas. The individual feeds back into the cosmology in altered form what has been received. It is almost like a closed loop between cosmology, culture and the individual, even if human cosmologies are contradictory.

The emphasis on the otherness of nature or of fellow humans creates a gap between humans and their environment. In contemporary cosmology, there is no room for the intrinsic worth of nature. But the operation of science—not as a side-effect—undermines the scientific cosmology and provides the elements of its alternative: Wholeness and relatedness, with humanity embedded in the system.

8.2. Regional Design Factors: Commons

Traditionally, a commons was a territory managed by a community so that individuals could share the land for grazing or farming. This form of use characterized many tribal groups for 40,000 years. The commons were only open to the members of the community, and perhaps to a few who asked permission. Community beliefs or a kind of ecological ethics discouraged overuse, in that overusers were shamed with informal sanctions or forbidden to continue using the land. In a sense, any territory not explicitly claimed by one community is a commons. That would include the atmosphere and oceans especially, or rather air and water in any form, since these are global things and can move between systems, and their character is determined by the globe itself. Some global economic or ethical method of management, not just for human use but for nonhuman use, must be devised.

In a traditional English village, inherited bundled rights provided commoners with rights of grazing and gathering fuel wood non-destructively “by hook or by crook,” which indicated the way wood was gathered by shepherds. The form “commons” is plural, and refers to the whole group of commons, subject to these effects.

8.2.1. *Tragedy of the Commons*

Garrett Hardin extends the idea of the commons to rest on the idea of a carrying capacity of the territory, which is a very dynamic concept, susceptible to change by the weather, season, food preference, or other things. When the commons is not tempered by rules, then an individual user gains all the advantage and the disadvantage is shared by all users. Ecological degradation is assured and the system collapses, a tragedy due to the “remorseless working of things” in Hardin’s words. In a limited system, the self-interest of one person cannot decide the public good, or the ecological good. So, the “invisible hand” does not provide a long-term solution. The hand needs to be visible. Necessity needs to be recognized by freedom, as Hardin restates Hegel.

The misuses of commons, some of which are alluded to by Hardin, include: Uncontrolled human population growth, depletion biodiversity, transformation of fossil fuels, pollution of waterways and the atmosphere, logging of forests, overfishing of the oceans, private vehicles jamming public roadways, tossing of trash out of automobile windows (littering), graffiti, poaching, noise pollution, and email spamming. Each of these misuses places a burden on most of the other users.

Privatization is one possible solution. However, unless individual ownership includes some regional cycles or global resources, then there might not be incentives for sustainability. One problem is that global things cannot be enclosed like land. Regulation is possible, as is payment by the polluter, a form of taxation. Hardin considers these as forms of enclosure also. One solution would be the return of many commons to the cultures that adapted to them and have had cultural rules governing their use. Hardin’s suggestion was “mutual coercion, mutually agreed upon.”

Many of our less wholesome behaviors, such as rapid technological change or wars, can disrupt tradition and lead to misuse of the commons. If the commons were presented as a prisoner’s dilemma for a community, then individuals would have two options, cooperation or defection. Defection, or private mismanagement of common areas, can lead to economic

madness, as Paul Shepard indicated. If there are unavoidable costs to defection, then it would be the less likely choice.

The tragedy of the commons is not that the traditional commons system did not work—it did, because it was controlled ethically in a community—it is that other kinds of commons have no such rules governing their use. The tragedy occurs especially when there is a transition from an ethical community use to a free market system that encourages overuse.

In a larger sense the whole planet is the common, and its limits are obvious, between the sun and the greater vacuum of interstellar space. The photograph of the earth made a logical connection between the common earth and the necessity of conservation. So, if the earth is a commons and humans are threatening the health or existence of the commons, then humans need a common ecological ethic, or some set of rules that they can respect.

In another sense, most problems are local not global. So, at the same time, we have to take responsibility for our local environments, and respect the cultural carrying capacity, as a term for the whole integrated concept of capacity that includes human luxury as well as minimal eating and nutrition.

8.2.2. *Actions Profits & Losses*

Modern industrial culture places an emphasis on individualism and competition. Cooperation, with an understanding of rights and responsibilities, is based on cultural understanding. This kind of understanding, once prevalent in many cultures, is the reason why the tragedy of the commons did not always occur with common resources. Cooperation is crucial. B.F. Skinner suggested that a genetically-based “short-term egoism” leads to the environmental Tragedy of the Commons. We can choose between the tragedy of the commons or the tragedy of total control, or we can expand our cosmologies. We are tragic because we have to accept responsibility for our actions.

Every action entails a gain and a cost (or profit and loss). Profits and losses are distributed privately, socially, or environmentally. Unfortunately, the modern system privatizes the gain and externalizes the loss to the “commons,” considered as a pool of “unowned resources,” where in traditional societies, it was surrounded by rules for use. As long as this is possible, it is profitable to charge the cost to the environment. Externalizing costs works fine in an uncrowded world, where the costs are negligible and can be absorbed by natural processes. Resources were traditionally seen as free for the getting; air and water were seen as free sinks. Modern economies, embracing the notion that “nature is capital,” draw on the accumulated “capital” of ecosystems for production. By ignoring the real cost of the capital, as well as the costs of natural services, such as nutrient recycling, soil building, and atmospheric renewal, these economies create a temporary wealth. Decisions regarding resources are made on short-term economic grounds and lead to material shortages and environmental degradation.

Economists try to bronze the economy in its current structure; but it is a changing system. Since it is changing, strategies that are appropriate at one stage are totally inappropriate at another—this is the remorseless working of tragedy, where successful strategies are applied in inappropriate circumstances. Tragedies imply conflicts larger than the individual or even society. The external order of things or the cosmic plan is challenged, even if the cosmos is the size of a city. The source of tragedy for economics is a fatal flaw of the world-view. This is the root of Hardin’s tragedy of the commons. The tragedy of the commons occurs only when people are locked into a system of self-interest through economic gain; it could not happen in

a culture that understood common holdings. Hardin's definition of tragedy is the working of fate. But economic tragedy results from the failure of a cosmology: humans are responsible, not chance or fate. We can choose between the tragedy of the commons or that of Leviathan, or we can expand the cosmology using ecological knowledge and wisdom and the limit economics to a sustainable place in the cosmology.

8.2.3. *Resolution of Tragedy*

The present causes of the ecological crisis lie in the combined action of technological advance, population increase, and conventional, erroneous ideas of the nature of humanity and the environment. Garrett Hardin asserts that the problems of the ecological crisis are direct results of the tragedy of the commons reproduced on a global scale. In a sense all global resources, are part of a resource commons, due to its mobility or depth in the earth. Therefore, overpopulation, pollution and resource depletion can have no technical solutions; they can only be ameliorated through political reform, which can only result from changes in perception.

Privatism or socialism could work, depending on population size, resource distribution, traditions, or other factors. Privatism works well within a system, with intrinsic responsibility. The problem with the socialism is its contrived responsibility; who shall watch the watchers? Commonism, a systems of cultural commons, or altruism, might not work as large systems. One necessary condition for the preservation of finite resources is sovereign power. To share resources without the discipline of power invites the tragedy of the commons. The limit of sharing has to coincide with the limit of sovereignty; otherwise runaway destruction could result.

Any kind of aid is a distribution from a commons, as Hardin notes. Dealing with a global commons is more effective through laws that end destructive behavior. Furthermore, laws are a second-order altruism; an individual does not risk acting as a lone altruist, in violation of Hardin's Cardinal Rule of Policy, which is to never ask a person to act against his own self-interest. If it can be demonstrated that the long term effects of egoistic actions are harmful, people may be persuaded to forgo short-term gains. To prevent a tragic end to commons, the system must be changed. People will be reluctant to change because of the uncertainty of technological forecasting and political stability.

The Tragedy of the Commons could happen in a mass economy, although not necessarily in an information economy, if people were truly rational actors. Hardin believes that coercion, centrally controlled by majority rule, is required for survival. Self-interest and knowledge of capacity could also avoid tragedy. J. Martino claims that private property can eliminate the tragedy also; self-interest of the owner dictates common sense. In this case, a global socialism would work because it would be responsible to national cultural units, whose interests would be represented. Economic cooperation in world of scarcity will not solve environmental problems.

The UN could create a Commission on the Earth. The Commission would have trusteeship over global commons. Boundary issues need to be resolved first. The Commission would limit national jurisdiction of oceans to 20 miles from the border, rather than 50 or 200 miles, to protect ocean resources. Furthermore, it would have a say on continental shelves and shore fisheries. The other 65-70 percent of the surface of the planet has to be regulated as a common area. The Commission could also charge Use taxes, which would have the effect of

limiting the use of nonrenewable resources, such as coal or oil, or the use of slowly-renewable resources, such as forest products or fish, located in global commons, such as the atmosphere or ocean. This would discourage overexploitation of previously 'free' resources.

8.2.4. *Fate & Tragedy*

Humanity can still be a part of nature and still be tragic, however. Even if moral laws are natural. Tragedy is more than an ethical conflict. Tragedy can imply conflicts larger than the individual or even society. Becker claims that the tragedy of evolution is that evolution produced a limited animal with unlimited horizons. For him, tragedy is wanting an earth that is perfect, a heaven abstracted from imperfection. Of course, the swing of the pendulum ensures that humans cannot create a perfect place. In the sense of employing a successful strategy in all circumstances, perhaps natural selection in evolution is tragic (the tragedy of reality)—M. W. Fox and Garrett Hardin hold this view. Modern science is one-sided (or single-visioned), in denying poetic knowledge. The attempt to avoid the pendulum (enantiodromia), without understanding the operation of nature, ends in tragedy.

The definitions of tragedy can be linked to cosmology, the image of the place of humanity in the universe. Tragedy challenges the external order of things (the cosmos), even if the cosmos is only the size of a city. The fatal flaw of the individual is the fatal flaw of the world-view of the individual. This is the root of Hardin's Tragedy of the Commons—people are locked into a system of self-interest through economic gain without being bound by traditional rules for sharing or cooperating. Hardin's own definition of tragedy is "the working of fate." But, this kind of tragedy results from a failure of cosmology; humans are responsible ultimately, not fate or chance. Humans are tragic because they are responsible for their actions. They can choose a tragedy of the commons or of an institutional Leviathan—or they can expand or alter their cosmology.

8.3. [Empty Topic]

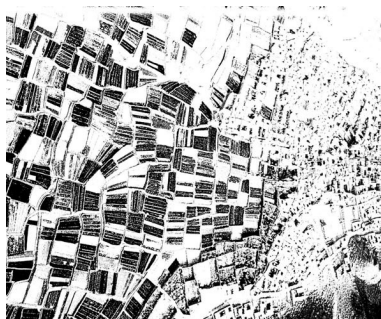


Figure 281-1. Ancient Iranian City

8.4. Regional Design Factors: Politics & Nations

For Aristotle, politics was the science of the possible. The city was a human artifact whose structure could be modified by reason; it was potentially a work of art in which only the capability of the artist limited the expression. The city was made for the amateur; and it produced more complete men (women were erroneously considered lesser beings at the time). The city was necessary for politics then, as face to face communication. Now, communities are different, larger and dispersed, so politics has to change. As a science, politics, or ecocybernetics (a neologism meaning governing the house) was concerned with two things basically, a way of distributing power and luxuries internally within society, and a way of surviving contact with others.

Politics is the science of government; it has to do with the regulation and government of a nation or state, the preservation of its safety, peace, and prosperity, the defense of its existence and rights against foreign control or conquest, the augmentation of its strength and resources, and the protection of its citizens in their rights, with the preservation and improvement of their morals. Politics depends on common rights, trust, information, and consciousness.

The function of politics is to ensure that decisions are taken at the right level. A state protects individual freedoms, guards national culture (values and identity), and holds groups accountable for use of power. The logic of individualism creates conditions that require constraints. Politics has to make them palatable. Although we realize that nothing in nature is without some limit or cost, we may dislike giving up what we now consider (wrongly) as rights. Humans may have to expect much less than they want, while expectations are rising.

Ultimately, politics is about the definition of reality itself. Social reality is created. Different societies have had different realities. The Athenians despised the merely wealthy, for instance, and respected community service. North Americans, on the other hand, revere wealth; community service is romanticized on television but hideously underpaid. Politics is also the art of creating new possibilities for human progress. The current system is defective, however. Although it is admirable to work within the system to prevent further environmental degradation, it might be necessary to produce a change in consciousness that would lead to a new political paradigm that considers the entire political system.

Ecological, economic, social, and religious phenomena are part of the broad definition of politics. The basic goal of politics is the “survival of the community” as William Ophuls identifies it. Politics is the interactive means of providing the basic food and necessities of a community. As survival is survival within nature, politics rests on an ecological foundation. The organization of a community must accord with natural laws. Political participation depends on information, much of which can be provided by ecologists.

Politics occurs, it is now recognized, in an ecological context. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. Ecological consciousness must be identified with political consciousness. Politicians need to think about the hunger and squalor of billions of human beings and the destruction of habitats with billions of ambihuman lives, before concentrating on missiles and private fortunes.

An ecosystem, if not a watershed or region, is a good candidate to be an independent political unit. It is a governable size. It has relatively clearly defined boundaries, as an

ecosystem, that is the ecological community including humans, and not a state or county whose boundaries have been determined by rectangular grids at human whim. The first step would be to form an independent government for each ecosystem or watershed. This kind of government, more clearly defined, might look different.

8.4.1. *Forms of Governing & Leading*

There are many ways of leading people. Some ways offer models to follow; others represent people in group decision making; and, a few make all decisions themselves. There are formal and informal ways. Almost every way, however, involves more prestige or status for the leader. Sometimes that translates into more meat, more goods or more wealth.

Leadership is the process of leading, that is, providing direction to others. Political leadership, the sense used here, is often formal and refers to a person in a position of authority, as a result of possessing skills at directing (Number and kinds of leaders are compared in Table 841-1). Leaders, or headmen, help others by choice. Big men distribute the products of their own activities. Chiefs redistribute the fruits of other's labor. Kings take a percentage of resources from the peasants and give it to retainers or use it for public or religious displays. Emperors often represent on a larger scale by far.

Table 841-1. Political Systems (after Aristotle)

Number of Rulers	Kind of Ruler	Ruling in Interest of	Chosen by
One	Leader (headman)	Band	Consensus
	Big man	Tribe	Consensus
	Chief	Chief Nobles	Ancestry Gods
	King Emperor Dictator	Monarchy City-State Tyranny of Few Self/Power structure	Self Parent Self Military
Few Collective	Triumvirate Co-ruler	Aristocracy Oligarchy	Citizens of State Few (Rich)
Many	Prime Minister President	Polity Voters Democracy Ochlocracy	Voters People or College Poor People
All	People Anarchy	Self-All Community anarchy Direct democracy	All People

Dictatorships needs great leaders, or at least powerful ones, to be successful. A dictator may be self-appointed or popularly backed or appointed by a military force. Idi Amin in Uganda, was an example of the latter. In some states, the dictator is described as a president; Fidel Castro in Cuba was also the head of the Communist party. Kim Jong-il in North Korea seems to have complete power and refers to himself with numerous titles.

Rome once had a ruling triumvirate. Bosnia and Herzegovina has a three-member Presidency, each of which are elected by a different constituent nation. The position of the President of the Presidency rotates between the members. Modern Switzerland invests leadership collectively in a seven-member Swiss Federal Council. The President is a member of the Federal Council elected by the Swiss Federal Assembly for a year and is merely *primus inter*

pares (first among equals).

Some states have a Parliamentary system of government, in which the President is the head of state, sometimes with only ceremonial duties, depending on the constitution, and the Prime Minister is the head of government. Countries with this systems include Germany, India, Ireland, Italy and Singapore.

In nations with a Presidential system of government, the President is the head of government and the head of state. The United States and Venezuela have this system, where the President is more powerful. Democracies need effective and educated citizens. Democracy is the work of the people (after the Negro spiritual: “We are the ones we’ve been waiting for”).

Leaders themselves may be influenced by choosers or controllers. Controlling groups such as the military, political parties, ruling elites, or religious elites sometimes place higher expectations on the leader, such as transformational change. The leaders may encourage their followers and believers to worship leadership. The followers may become uncritically obedient.

In the United States, the President is elected by the Electoral College, which is made up of electors chosen by voters in the presidential election. Each elector is committed to voting for a specified candidate determined by the popular vote in each state. However, due to skewed representation, it is possible for the candidate with fewer national votes to win the electoral votes in the Electoral College and get the presidency, as happened in 1888 (and again in 2000).

Leaders, with choosers and controllers, are part of the governing process. The forms of government range from tribal leaders and chiefs to anarchy and direct democracy. These forms work best with small populations where everyone is known, even if they do not share the same culture. Other forms of government, such as authoritarian dictatorships, monarchies, and republics, have worked with larger populations. At the largest sizes, the bureaucracies and infrastructures have more in common, regardless if the government is socialist, communist, parliamentary, or representative democratic.

Larger nations require larger governments, to make laws to accommodate differences in cultures. Specialists are required to resolve conflicts. The specialists often have a monopoly on weapons and the spectrum of information. A bureaucracy is needed to run the government more effectively.

Table 841-2. Governments

<i>Leadership</i> Government	<i>Egalitarian</i> <i>Leader</i>	<i>“Big man”</i>	<i>Chief</i> <i>Hereditary</i>	<i>King</i> <i>Hereditary</i>	<i>Representative</i>
Bureaucracy	None	None	None Crony level	Many levels	More levels
Monopoly on Force & Information	No	No	Yes	Yes	Immense
Resolution Of conflict	Informal	Informal	Central	Laws, judges	Laws, judges, specialists

At the largest sizes, the bureaucracies and infrastructures have more in common, regardless if the government is socialist, communist, parliamentary, or representative democratic.

8.4.1.1. Traditional Small-scale (Elders, Chiefs, Kings)

The Coeur d'Alene people had strong leaders. Each village had a council with male and female members. A large village had a headman or woman who regulated economic and religious affairs. Their only real power was their persuasive abilities and the public esteem they built up. Chiefs were elected or deposed by the council. The band chief regulated basic resources. Next in authority were a war leader, hunting leader, and shaman, chosen for their respective skills.

Marvin Harris shows how headmen are associated with hunting societies, big men with horticultural societies that are larger, and chiefs, still larger, and starting to accumulate goods. Headmen are more informal, in bands of 50 or villages of 150. Every one knows and understands others; reciprocity is the bank. Headmen are leaders without power. Big men give away extra wealth. Chiefs accumulate it.

Chiefs have proven ways to keep the underlings happy or at least resigned. They arm the elite and disarm the public, that is, monopolize force. They use the monopoly of force to maintain order and reduce violence. They redistribute some of the wealth in public displays and games, a kind of informal tax refunds. Chiefdoms were successful in the Pacific Northwest and Hawaii.

Kings enlisted ideology or religion to justify the transfer of wealth to the king and rich retainers. The shared religion also makes strangers act more peacefully without kinship. It gives people a reason to sacrifice their lives for an institution, a nongenetic reason. The king was the central human representative of power. The Mayan king gave blood, with other nobles and prisoners. Blood is the home of the soul; it is valuable and the most powerful gift.

Mesopotamian cities had councils of elders to make decisions. They would appoint a leader to lead in war or trade. The word for this leader, *lugal*, eventually came to mean king; after 4800 YBP, gods changed from natural forces to war gods. Agriculture gave a surplus; that and property lead to excitement of war. In China, in the Warring States period, the nature of war changed: from an Aristocratic monopoly of soldiers to one with standing armies, professional leaders and peasant soldiers. China. New towns were planned and built by ranked lords at the edges of the state. The king gave land, title, ritual things, and a clan name. The King served as his own priest because he could contact his ancestors.

8.4.1.2. Modern Large-scale Government

As leaders had more followers or constituents, often approaching a regional level, they needed help addressing problems of income and payout. They needed a large bureaucracy to maintain records and make local decisions. For example, large-scale irrigation appears in Egypt first in 7100 YBP. In Mesopotamia, large-scale water systems were first managed by religious leaders, then later by secular leaders. As problems developed, temporary military leaders became permanent hereditary kings. Palaces were built and staffs numbered thousands.

Power became centralized in the king. As the populations became larger, the king had to have representatives. Centralization and representation became necessary properties of large-scale government.

8.4.1.3. The Importance of Leadership

Leadership can refer both to the process of leading, and to those entities that do the leading. Leadership can have a formal aspect, as in most political or business leadership, or an informal one, as in most friendships. A leader is assumed to have special skills or competencies.

Leaders of bands or tribes were often specialized in specific activities such as hunting or social integration. Although leadership can be exhibited by an individual, either a group of people or a heroic character can show leadership.

Leadership is often confused with transformational change, although usually leaders are the last to change. Leadership may also be associated with respect, obedience, or worship of the leader. National leaders may be presidents or queens who make the decisions for their countries. Global leaders, however, will have to address and balance a wider spectrum of needs.

Even in representative systems, leaders may have ceremonial or reserved powers. Leaders need to have idea people (like F.D. Roosevelt had), but they also need to have jesters and clowns to mock their mistakes and pride. In most every nation, leaders have too much power, as well as too little information, humility or wisdom.

8.4.1.4. Forms of Governments

People have chosen, or allowed, or suffered many kinds of governments and institutions, including rule by king or co-consuls, presidents or oligarchs, communism or democracy, aristocrats or anarchy. Societies are constituted by people and their ideas about government and justice, among other things. Ideas and behavior continue to evolve in a natural and then cultural contexts. The individual human being is a result of a family and local community, but law evolves in a larger culture. Law is now an important part of social structure.

Humans consider themselves to be self-creating and self-ordering. But, that is because they are part of a context of self-ordering processes. Government is part of that self-ordering process, wherein specialists make decisions based on their expertise. Specialization is built on trust. We trust that others will produce enough grain for them if we make a plow for them. Government has to balance giving and receiving of things and services to preserve society.

But, governments do not always balance giving and receiving very well. Since they are run by people, and people tend to put their own interests first, governments can be tyrannical about refusing to distribute power and goods. Which tyrannies are acceptable? The abuse of power by kings, or abuse of power by corporations? Unjust executions, or cancer from toxic wastes? Government mismanagement, or the abandonment of communities by capital?

Governments are accountable to the laws that they make. Enforcing the law may keep governments more balanced.

8.4.1.4.1. Excellence & Law

What is government? Tribal government was based on customs and who was best at certain things, from hunting to resolving conflict. In tribes and empires laws were formed to overcome differences in customs. Government now is based on laws. But, it also needs to be based on information as well as on general common human values (and shared human rights).

8.4.1.4.2. Separation of Powers & Functions

Aristotle, the Greek philosopher of 2350 years ago, recognized the importance of a “rule of law” for states, as well as a central government with a separation of powers. The framers of the U.S. Constitution wanted to form a government that did not allow one person to have too much authority or control. While under the rule of the British king, they learned that this could be a bad system. Yet government under the Articles of Confederation taught them that there was a need for a strong centralized government.

With this in mind the framers wrote the U.S. Constitution to provide for a separation of powers, or three separate branches of government, a legislature, executive, and judicial. Each has its own responsibilities and at the same time they work together to make the country run smoothly and to assure that the rights of citizens are not ignored or disallowed. This is done through checks and balances. A branch may use its powers to check the powers of the other two in order to maintain a balance of power among the three branches of government. The checks and balances, combined with a separation of powers, gives responsibility to each branch to oversee the others, but the branches must be equal; partly due to overlapped responsibilities.

8.4.1.4.2.1. Legislative Branch

The legislative branch of government is made up of the Congress and government agencies, such as the Government Printing Office and Library of Congress, that provide assistance to and support services for the Congress. Article I of the Constitution established this branch and gave Congress the power to make laws. Congress has two parts, the House of Representatives and the Senate. The functions of the legislature are: To make laws, and To check the executive branch by confirming appointments, and investigating executive branch activities.

8.4.1.4.2.2. Executive Branch

The executive branch of Government makes sure that the laws of the United States are obeyed. The President of the United States is the head of the executive branch of government. This branch is very large so the President gets help from the Vice President, department heads (Cabinet members), and heads of independent agencies. Typically, the President is the Leader of the country and commands the military. The Vice President is President of the Senate and becomes President if the President can no longer do the job. The Department heads advise the President on issues and help carry out policies. Independent Agencies help carry out policy or provide special services.

The executives could include monarch, prime minister or a cabinet. The functions are: To execute laws; To execute policies; To Control policies; To appoint officials; To Command the military; and, to Veto legislation.

The executive branch could be headed by an Executive Council of seven, with these specialties: Internal Coordination, External coordination, Ecological affairs, Cultural Affairs, Religious affairs, Economic Affairs, and Communication (Press). This Council would elect a President for Internal affairs and a Prime Minister for external affairs.

8.4.1.4.2.3. Judicial Branch

The judicial branch of government is made up of the court system. The Supreme Court is the highest court in the land. Article III of the Constitution established this Court and all other Federal courts were created by Congress. Courts decide arguments about the meaning of laws, how they are applied, and whether they break the rules of the Constitution.

The functions of the judicial branch are: To maintain the integrity of the Constitution; To interpret laws; and To check the executive branch by questioning enforcement of laws?

8.4.1.4.2.4. Other Branches

Are three enough? Or too many? All three deal with the rule of law, to make, execute, and interpret laws. There is no reason there cannot be a fourth or fifth branch. People have

suggested the “people” or the press as a fourth branch. The Philippines have three branches plus three regulatory commissions, one for civil service, one on elections, and one for auditing all accounts. The Netherlands have a Water Authority Board. Iran has an equal religious leader and Board of Guardians, although they may have more power than the traditional three branches. Some countries in Africa recognize the role of tribal leaders in government.

Is the rule of law enough for nations? Should there be rule of information or rule of religious beliefs? The formal power of beliefs might be separated into knowing, expressing and wise application. Are those enough to be separate? Informational power supports law, but it might also be more important than law under some circumstances, and law should be allowed to support information. An informational power might be separated as well, into research, applications for planning and wise assessments.

Is one form of government better than another? How could we tell? Some dictatorships have been more benign than democracies. Should we forbid some forms? Should we search for a better kind of representation?

8.4.2. *Functions of Politics*

The functions of politics are internal and external. Internal functions are characterized by activities like the fair distribution of food and rewards. External functions are: To coordinate interaction with other nations; and To decide matters of exchange of people through emigration and immigration.

8.4.2.1. Internal Functions of Politics

Internal functions are: To promote the survival of the nation and communities; To preserve the balance of society; To maintain the affairs of the nation and communities; To guarantee fair distribution of food, goods, and necessities; To manage the distribution of power; To preserve the safety of the nation with laws and defense; To represent the citizens, to educate them, protect their rights, and remind them of their morals; To resolve conflicts between citizens; To regulate the activities of citizens regarding safety of the environment; To encourage conversation and communication; and To moderate the forces of change (internal/external).

8.4.2.1.1. To Promote Survival of Communities & Nation

Politics has to be successful enough for a new generation to take over ruling the culture and nation. If rulers promote the wrong images, that do not fit the environment, eventually a nation will collapse.

8.4.2.1.1.1. *To Preserve the Operation of the Environment.* Nations are embedded in places. If the place itself, the environment, fails, then no political assurances will be able to feed hungry people. So, political decisions should not interfere with the operation of global cycles or local renewal.

8.4.2.1.1.2. *To Preserve the Balance of Society.* Place sustains government. Land sustains government. Land produces food and resources, but the land is not equal or consistent. Poor land does not produce as much as rich land. Agriculture in general does not seem to produce as much wealth as business. Business does not seem to produce as much wealth as artists (symbols and abstractions have fewer limits on productivity). So, government needs to preserve some balance and equality by giving and taking. Individuals are produced by a community. So, the community in place seems to be the source of most of the wealth. Restoring balance

in a small community can dislocate people. Leon MacLaren states that balance can be restored by depression, war, or revolution, and it can be painful. Of course, planning and conscious adjustment might be less painful and less risky.

8.4.2.1.1.2.1. To Encourage Conversation & Communication. We can best understand the social aspect of culture by realizing that the central function of human symbolization is communication and requires adherence to understood conventions. Constant communication allows a culture to be coherent. Lack of communication can lead to unhappiness or violence.

8.4.2.1.1.2.2. To Manage Individual Civic Relations & Conflicts. Many cultures have built-in limits to local kinds of conflict, but conflict between cultures requires some laws or understandings. Behavior has to be understood in a context as meaningful. Sometimes conflicts are the result of language, behavior patterns or simple geography. There has to be a path to resolve conflicts, either through consensus, mediation or neutral judgment.

8.4.2.1.1.2.3. To Decide Limits to Growth Development or Movement. Keynesian economic theory, the predominant theory in industrial countries, holds that the full utilization of resources is necessary to ensure full employment and the maximum social good. This economics depends on economic growth to avoid crisis. The major premises assume that: Population will grow, that social good is related to the equitable distribution of material products, and that if resources are limited, technology can erase the limits. The economist Kenneth Boulding referred to this as a cowboy economy, an economy that has yet to bump against the limits of wealth.

In the U.S., the mentality of the frontier bloomed as the physical frontier was being closed. This mentality assumed the nature of a myth, that all people would prosper in the frontier way. Even though the 1890 census recognized that the frontier was no more, and warned people to use what they had, the people themselves have sustained the myth of limitlessness. The myth has become stronger than the logic of limits. Corporations and banks have used the myth to offset the dismal flavor of their economics. The victims have been tricked into passionately defending their own exploitation and that of the environment.

Growth is rarely an unlimited process in nature. Unlimited growth is only an economic characteristic if the economy refuses to recognize physical and biological limits. Because people seem to have unlimited wants, some political rules need to be in place to allow equal distribution before some can amass vast fortunes.

One solution is to work within limits of sustainability. Population could be stabilized. Consumption could be stabilized, especially with a shift to recycling and solar energy generation. The technology already exists, but political problems are more difficult.

8.4.2.1.2. To Manage the Affairs of the Communities & Nation

Hutterite communities were able to manage their community as long as it was less than about 150 people, Garrett Hardin noted. With more than that, distribution of goods failed, due to some doing less than their share or getting more. So, the Hutterites split communities into two when they got too large. The scale of community can make some things work better. The force that keeps individuals from laziness or greed seems to be shame, which seems to work as a force only in smaller communities. In a small community, a person can be shamed into working harder or into being less greedy, but in larger communities shame does not work as well. Maladaptive behavior may be less visible or the malcontents may form a subgroup that

justifies their behavior. Hardin suggests that most utopias do not consider such a change in scale while describing sizable communities.

Many archaic cultures mismanaged their natural resources, but got away with it because their impact was relatively small. Some cultures were not as lucky, the people of Ur, for instance. Luck, as well as size, has a lot to do with the success of some human cultures. Many other cultures mismanaged the affairs of communities, but they were able to survive because of brute control.

The industrial cultures are mismanaging their resources and affairs, but may not be able to control or organize—or luck—their way out of their problems. Modern society has benefited from modern means of management. In fact, management has made industrial operations, from science to agriculture, possible. But, to continue without disaster, it needs to re-empower local voices, especially indigenous peoples, poor, displaced, and women. It needs to encourage unique local management solutions, such as the water management on Bali. It needs to adjust to optimum scales that are more efficient and just.

8.4.2.1.2.1. *To Guarantee Fair Distribution of Food & Necessities.* With the complexities of civilization, with various levels of responsibility and duty, politics has to make sure that necessities are distributed in a timely manner. The infrastructure, that is the bureaucracy, the coordination, storage areas, trucks, and other things, have to be in place and functioning.

8.4.2.1.2.1.1. Resources (Managing the Commons & Private Properties).

Traditionally, a commons was a territory managed by a community so that individuals could share the land for grazing or farming. This form of use characterized many tribal groups for 40,000 years. The commons were only open to the members of the community, and perhaps to a few who asked permission. Community beliefs or a kind of ecoethics discouraged overuse, in that overusers were shamed with informal sanctions or forbidden to continue using the land. In a sense, any territory not explicitly claimed by one community is a commons. That would include the atmosphere and oceans especially, or rather air and water in any form, since these are global things and can move between systems, and their character is determined by the globe itself. Some global economic or ethical method of management, not just for human use but for nonhuman use, must be devised.

Hardin extends the idea of the commons to rest on the idea of a carrying capacity of the territory, which is a very dynamic concept, susceptible to change by the weather, season, food preference, or other things. When the commons is not tempered by rules, then an individual user gains all the advantage and the disadvantage is shared by all users. Ecological degradation is assured and the system collapses, a tragedy due to the “remorseless working of things” in Hardin’s words. In a limited system, the self-interest of one person cannot decide the public good, or the ecological good. So, the “invisible hand” does not provide a long-term solution. The hand needs to be visible. Necessity needs to be recognized by freedom, as Hardin restates Hegel, again.

The tragedy of the commons is not that the traditional commons system did not work—it did, because it was controlled ethically in a community—it is that other kinds of commons have no such rules governing their use. The tragedy occurs especially when there is a transition from an ethical community use to a free market system that encourages overuse.

In a larger sense the whole planet is the common, and its limits are obvious, between the sun and the greater vacuum of interstellar space. The photograph of the earth made a logical

connection between the common earth and the necessity of conservation. So, if the earth is a commons and humans are threatening the health or existence of the commons, then humans need a common ecological ethic, or some set of rules that they can respect.

In the case where many people and groups, from different cultures, are placing demands on global commons, such as the atmosphere or ocean, which are not claimed by any culture or nation, rules and ownership have to be put in place. At the regional level, the nation has to claim ownership and make explicit legal limits. At the international level, the UN (or a new governing body) has to claim ownership and pass laws limiting use—always careful to set aside resources necessary for the functioning of regional and global cycles and systems.

In another sense, most problems are local not global. So, at the same time, we have to take responsibility for our local environments, and respect the cultural carrying capacity, as a term for the whole integrated concept of capacity that includes human luxury as well as minimal eating and nutrition. This carrying capacity determines what percentages nations share, regardless of their populations or demands for luxuries.

8.4.2.1.2.1.2. Goods. People made their own goods in foraging societies. For the Desana, goods from the gardens support people, although small numbers of extra goods are traded for clothing, machetes, soap, salt, aluminum pots, fish hooks, and rarely a gun. With farming came specialization, and more goods that could be made and accumulated. Goods became a form of wealth, especially in groups like the Kwakiutl. In Crete, written records show how goods were directed to the palaces and redistributed from there. The demand for goods between Europe and China resulted in the introduction of the camel in the Trans-Saharan trade and boosted the amount of goods that could be transported. Donkey caravans from the Mediterranean brought obsidian and other goods to Mesopotamia, and ivory combs from the Indus river. The value of goods was determined by supply and demand.

Industrial farming depended on a new kind of market, a large market for cheap goods. The English encouraged trade to increase the number of goods. The industrial revolution decreased contact with the natural world and objectified what was left. As a result of drastic changes in the production of economic goods, other political, social and even psychological changes occurred. Other kinds of order were de-emphasized. Human relationships became based on economic allegiances instead of kinship, and were formed in societies, not communities. Money became a symbolic representation for the value of labor and land. Land and labor became commodities.

Economics has become more and more global. Where peoples used to trade material goods, fish for roots or feathers for leather for instance, now all things have a common symbolic value, most often expressed in yen or dollars. This means that whoever works cheapest, and with the lowest cost of living, sells the most.

As the automated production of goods became more efficient, goods-producing jobs declined. The goal of production moved from the production of goods to efficiency. Needs are almost completely defined in terms of commodities. Even relation needs a commodity, travel, to be fulfilled. Once the need is defined and partly satisfied, it becomes a right. From walking to the right for passenger miles at high speed in a mere fifty years.

The material goods of human societies has been increasing. How many of us can carry everything we own on a bicycle or horse? Goods are privately owned more often. Items that used to be shared in neighborhoods or communities, such as lawnmowers or radios, have many separate individual owners. While this is good for the modern economic system and for the

ideal of convenience, it weakens social bonds, dependencies, and trust. Private goods, like gardens, are also public goods, especially in a city to renew the air. Private good, like a loaf of bread, can be owned and not shared. Public goods are those that can be enjoyed in common, since one consumption does not subtract the possibility of another consumption. Air is a good example, although there might be a time when air is rare.

Stung by the suffering of people with new unsatisfiable needs, modern governments have offered to produce more, safer goods, instead of ecologically analyzing the relationships of needs to satisfactions. People have to imagine and construct new frameworks so that they can develop satisfactions that are not dependent on commodities.

Surprisingly, once basic needs are met, for food shelter, respect, and confidence, according to Abraham Maslow, then happiness is not increased much by additional material goods or money. The things that make people unhappy are when their higher needs, such as self-esteem, are not met. Lack of love or security, lack of communication or appreciation lead to unhappiness. People try to balance their lacks by acquiring more money or things. The culture has to be meaningful, as well as secure and equitable, with lower extremes between wealth or status.

8.4.2.1.2.2. *To Guarantee Fair Distribution of Power & Rewards.* Power in physics is the capacity to move. Socially it is the capacity to act. Power is the capability of making things move or happen. Power is not only making things happen, it is a way of controlling which things happen. Having power determines who gets to decide. Power allows dominance. If power is concentrated in one or few people, then there are fewer opportunities to challenge or limit it. Concentrated power can lock or gridlock patterns of movement; this is not always healthy, since many problems need many different solutions. Absolute power is no longer accountable to lesser power.

In archaic societies everyone has some power. Power is given to those who have better abilities, at hunting, healing or coercing. The real power there is the ability to persuade others. First persuasion yielded power, then strength, then knowledge. Power can come from strength or a connection to another form of power, ancestral or holy. Power can be derived from the permission or weakness of others.

The creation of large dense communities required new forms of power, due to size and organizational problems. No matter how big the bureaucracy, for a while it only controlled human muscle power. That limited their reach, regarding armies or builders (of pyramids). Traditional states had trouble controlling regional potentates or their armies completely. New forms of energy expanded human power and control.

Scale of governments or corporations gives them more power. Management techniques, or technology, can augment power. Power allows more waste. But, power diminishes the ability to see or feel, or suffer, the consequences. Power often reduces the perceptions of those who have it, such that they use power to simplify ecosystems rather than imagine working inside the systems. Having rewards gives people more power. Such power can be expressed in buying patterns as well as bribes.

Corporations increase their power temporarily because of our failure to grasp their nature. Misunderstanding of power or nature can allow a temporary expression of power. The competitive way of life, as it dominates, distorts the meaning of power and demand, and causes imbalances of power and demands.

Governments with concentrated power can be tyrannical about redistributing power or rewards. Inequality in rewards is maintained by the concentration of power. Rewards and power are treated as primary needs, which results in imbalances. Power can lead to detachment from primary needs and natural wealth. Rewards give more power, so that the two form a positive feedback loop that sometimes cannot be controlled, by the user or the less powerful. The cycle becomes self-reinforcing.

If power is spread more evenly, through many leaders and many kinds of leaders, then they can check each other and power is balanced. Under many constitutions power is dispersed by dividing into separate branches. Humans are momentarily powerless to replace or transcend the circuitry of natural or cultural systems. People often have the power to deny using the power, especially for activities that can destroy place or human values.

8.4.2.1.2.3. *To Promote Safety & Security.* Without safety and security of the primary needs of food, clothing, and shelter, there will not be a cultivation of secondary needs that promote higher culture. Ultimately security is the availability of food, materials and energy. There are levels of security, starting with a healthy ecosystem, and the ability to use it, protect it, and restore it. Security also requires that resources be available to be used, conserved and substituted. Socioeconomic security requires a healthy culture that can distribute basic needs equitably and efficiently. For people to be secure in their own skins, all of their needs, such as self-actualization, have to be encouraged.

Safety is a basic human need, physiological and psychological. Safety is increased when people accept limits on their social behavior, when natural disasters are anticipated, and when technological extremes, such as nuclear accidents and wastes, are safeguarded. Safety does not mean wiping out large predators, such as alligators or sharks, to ensure that no one ever gets bitten or eaten; it means reducing exposure to wild animals, by reducing the overlap or reduction of territories. Animals have to balance their own safety with migration and food-getting. Safety does not mean killing every form of bacteria or virus; it means limiting exposure, being healthy, and preventing the spread of pandemics through accelerated travel and sharing. Ecologically, safety means leaving functioning ecosystems outside the circle of human domination.

Safety is increased with higher standards for sanitation as well as for technology. It means minimizing the potential for harm in a work or play situation. This occurs when governments and corporations take higher risks than the communities and cultures, accept a burden of proof for new developments, and accept higher margins of error and certainty. Safety is increased with laws, such as those concerned with cheating, thieving or killing. Laws that limit dangerous things, such as alcohol or guns, expand safety.

8.4.2.1.2.4. *To Adapt to Internal Forces of Change.* The principle of change indicates that nature is in flux, culture is in flux. Politics is concerned not only with how power and authority are exercised but with how these relationships get transformed. We are interested in the forces that sustain consensus as well as in the forces that bring about change. Intensive change is the development of consciousness or social sophistication; it is characterized by consciousness, connection, and communication. This should apply to cultures also. Extensive change results in the development of cities and technology; it is characterized by conquest, colonialization and consumption.

As humans stay in place, they tried to extract more resources from the same area. This requires new ideas and technology. Which resulted in denser settlements, which resulted in new technology and new social organization. This is extensification. Innovation is influenced by the growth and intensity of population, by the expanding and intensified activities of states or cities, and increasing trade and commercialization. The ease of communication also increases rates of innovation. Perhaps that is why it went east-west in Europe and Asia and north-south in the Americas. Accidental innovation became a culture of innovation, that is, a part of the culture that was encouraged and used.

Civilization is shaped by extensification and intensification, and complication and complexification, although on a local level there were booms and busts of individual civilizations. Why do countries lag behind in industrialization? Why do they need to join the race? Economists argue that their policies or attitudes are at fault, that their environment might be poor. That they are unorganized. That they are fearful of change or exploration. That does not seem likely though. Often the problem can be resources or domination, but sometimes, it is the social predisposition to change, as a result of historical or cultural factors.

8.4.2.1.3. To Represent Citizens

The early Sumerian temple tower, with a hieratically organized city surrounding it, became the model for the Hindu world mountain Sumeru. The king was the central human representative of power. First there were cities and then empires of cities, with kings to represent citizens. Leaders always try to represent members of a group.

In archaic cultures, when people could not present themselves at every meeting, it was useful for someone to represent them. Some degree of household autonomy is sacrificed to some larger order group in return for greater security against attacks by enemies or from starvation. A government promises to judge disputes in values and to protect its citizens from external attack.

The people of a nation-state were first given full sovereignty officially in 1648, with the Peace of Westphalia. Representative governments still use that sovereignty to claim responsibility for their actions, without recognition of any international body. They also represent citizens in matters of economics, to attempt to guarantee access and fairness.

8.4.2.1.3.1. *To Educate Citizens Scientifically & Morally.* Thomas Huxley thought that people in nature were Hobbesian, unfit for civilization unless culture educated them. The same essential belief was held by Sigmund Freud. But, the contexts were, and are different. The thought of Huxley was dominated by ideas of competition and fitness, and that of Freud by individuals in society, from hysterical women and conflicted children to selfish businessmen and power-blinded leaders. The context now is drones in an industrial flatscape.

The modern state has an educated bureaucracy to manage information. It requires compulsory education, resulting in mass education and mass literacy. Mass literacy disenchant the cosmos by undermining traditional and magical ways of thinking. Testing traditional knowledge became a habit. Difficulties of dealing with a half-hearted half-educated public, of dealing with a hard-hearted, hard-headed professional elite, only add to the problems of a culture.

Education may be a necessity, but it has to be a freely offered broad education, based

on rich philosophies and sciences. It has to be adaptive. Tribes in the Brazilian Amazon, for instance, have stopped using chainsaws and tobacco, to live more traditionally. They also set up educational centers to show others how it is done.

8.4.2.1.3.2. *To Protect the Rights of Citizens.* In a traditional English village, inherited bundled rights provided commoners with rights of grazing and gathering fuel wood non-destructively “by hook or by crook,” which indicated the way wood was gathered by shepherds. The form “commons” is plural, and refers to the whole group of commons, subject to these effects.

As rights have expanded, they have also been made more explicit in laws and codes. There is a form of an International Bill of Rights, covering human and ambihuman. This would cover workers rights. Residents expect to have equal rights and opportunities.

8.4.2.1.3.3. *To Outline the Duties of Citizens.* In addition to having rights, citizens also have responsibilities to participate in government and to live as wisely as possible, to make good places. Often, duties have to be made known through education and communication from the government.

8.4.2.2. External Functions of Politics

External functions are those outside the boundaries of the nation. But, those functions may have dramatic influences on the shape and course of a nation.

8.4.2.2.1. To Coordinate Interactions with Other Nations and Cultures

The possible kinds of interactions of groups or cultures are: To ignore each other; to exist separately with trade or contact; to compete for resources and people; to cooperate with each other; to fight for dominance or territory; or to destroy the other.

For interactions leading to violence, a number of trends that can be seen. These are feedback loops that loop around to the beginning, also. For instance, the failure of neighboring economies can lead to the failure of trade, or the failure of negotiation. The failure of defense, the failure of contextual system, and the failure of a structure for individual participation can lead to the collapse in the meaning of participating. The fragmentation of social responsibility can lead to an isolated self-image (unrelated to the external), to lack of self-confidence, and to a decline in participation. Conspiracies for societal control can lead to international conflict, government intervention, guerrilla warfare, and massacres.

On the other hand, alienation can lead to selfishness, gangs, and anarchy, then neighborhood control by criminals, psychological stress of urban environment, substance abuse, family breakdown, lack of control, and violence. Prejudice can lead to segregation, discrimination against indigenous populations, destruction of cultural heritage, ethnic disintegration, an inadequate sense of identity, psychological alienation, and violence.

Conflict starts with people, but extends to animals, natural events, and nations, leading to the unfortunate metaphor of war. What is a definition of war? Does it have to do with the number of battles or dead? Or with having a professional army? Does it have to have a beginning and an end? Does it have to be a certain scale? Does it have to be agreed on by both sides or all parties? The whole process and its effects are complex. As violence and conflict occurred on larger scales, they were called wars.

8.4.2.2.2. To Decide Matters of Emigration & Immigration

National governments have the right to determine their own immigration policies, even though the policies are influenced by many other factors, from disasters to invasions, outside the control of governments. Governments need to balance emigration and immigration in a context of a satisfactory population suited for its environment.

8.4.2.2.3. To Adapt to External Forces of Change

Extensive evolution is the horizontal spread of species. Extensive change is the spread of cultures through many ecosystems. Human migration was a form of extensification. That is, when the size of foraging communities made hunting and living problematical, some humans moved away. Only when they could not or would not move, did it become intensification, which required different strategies to live, such as intensive food-gathering strategies. Exploitation of new areas shows the ecological power of the species. Intensive development of a place shows the creativity of the species.

Politics has to adapt a culture to external forces, from climate change to invasions of exotic plants and animals. A culture cannot escape the rhythms of nature. Some events, such as earthquakes or floods can be anticipated with plans and architectural designs.

8.4.3. *Ecological Politics & New Functions*

Ecological, economic, social, and religious phenomena are part of the broad definition of politics. The basic goal of such a politics is the “survival of the community” as William Ophuls identifies it. Politics is the interactive means of providing the basic food and necessities of a community. As survival is survival in nature, politics rests on an ecological foundation. The organization of a community must be in accord with natural laws and limits. Political participation depends on information, much of which can be provided by observers and scientists.

There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. Ecological consciousness can complement political consciousness. The ecological, social, and political problems of today do not have simple disciplinary solutions. The problems are cosmological and must be solved on that level. But a single cosmology cannot solve all problems in all places. Where human understanding is still underdeveloped, humanity cannot afford to suppress the diversity of thought necessary for adaptation to the diversity of environments, or to eliminate ecosystems and the societies adapted to them, which explains why archaic cultures are valuable. Practicing a holistic, or metapolitics, is the recognition that humans are part of a larger community, a larger whole that includes all humanity and all the earth, with its species, habitats and resources.

8.4.3.1. Deciding Goals for Ecological Politics

The government of a community is a framework to maintain the lives of people. For the original archaic peoples, tribal teachers were adequate. In our representational republic, representatives are relatively uneducated, except in law, and less capable of institutional change. The functions of government are to support the functions of politics with specific actions,

such as: To make laws; to decide the meaning of the laws, how they are applied and related to a Constitution; to lead the country and to make sure the laws are obeyed. These action specifically include: To protect the nation; to command the military; to manage internal affairs; to coordinate national activities; to manage external affairs; to represent the nation to other nations; to coordinate trade; to coordinate information; and, to coordinate education.

8.4.3.1.1. Expressing the Purpose of Government

Central government has lost sight of its own purpose, which is not the sum of special interests or its own desire for perpetuation. Government has always had other reasons for existing. Some of these reasons are to:

1. Hold a vision of the common good, where 'common' means common to all beings in the ecological community as well. Make goals conscious, with some flexibility to enhance the vision over time. Balance public and private interests.
2. Coordinate the means to satisfy the long-term needs of the community, balancing freedom and regulation. Tie rates of consumption to the limits of the system—this means controlling resources and land use, in essence determining the physical shape of the community.
3. Regulate the community. Link it to cultural values. Determine the closure and openness of the community; rates of increase or decrease, through births, deaths, or immigration. Encourage or discourage some forms of technology or trade. Provide work opportunities to members.
4. Protect the community from internal and external threats: natural disasters, criminal elements, and other communities. Most of these threats are unavoidable. Some are long-term and rare; others are constant and of low intensity. Some are part of the human condition; others the result of historical balances that cannot be restored easily or quickly. We need to be aware of them and minimize the damage.

8.4.3.1.2. Increasing Participation

John Dewey believed that personal face-to-face communities were necessary to a free and open government. The local communities need not be isolated as they have been in the past; they are more open and active, connected to other larger communities. Government requires trust and goodwill; these arise more easily in communities of acquaintances.

Citizenship is too complex for television or even electronic global villages; it must exist in the community, in person, in place, where individuals can learn about each other in context. Government by local meeting assumes the common sense and wisdom of the common person in an open exchange of belief and need.

Often this kind of involvement takes more time than just voting annually or having one person decide for many. The effect of presenting a problem before a traditional American Indian council was to slow down response by passing it to the entire constituency and getting a consensus. This ensured due consideration.

To encourage the participation necessary for effective democracy, or communism or socialism for that matter, government should solicit public opinion. Land-use agencies do so. Government should offer real power to people—power should devolve to lowest level—by changing the local political institutions to start. Montana or Vermont in the U.S. offer examples of how to change local participation.

8.4.3.1.3. Taking & Yielding Powers

Central government must shrink in order for local government can expand. Some things must be done at a regional level, such as the protection of watersheds, rivers, and the atmosphere, to make sure of minimal protection. Some protection must be enforced at the international level.

Following the federal model, delegated powers go to the highest level, and reserved powers to the community. So, a new national government would coordinate internal and external defense and security; maintain law and order; and, set ground rules on economic exchange to ensure fairness. The most important responsibility of government is to set standards for itself and its institutions. The constitution would instruct the courts to interpret clauses as narrowly as possible.

The new nation would have an administrative department to handle taxation, budgeting, and purchasing. It may coin local money, perhaps on the model of the Local Employment and Trade System—LETS—on Vancouver Island in Canada, which records credits and debits on a computer, which can then only be used locally. There may be departments to protect the civil rights and liberties of the people and a department to protect the environment. Environmental disputes could be resolved by mediation, as was developed in Seattle in the U.S. in 1980s. The nation would also conduct foreign policy, provide technical services to communities, and maintain regulatory offices.

To avoid insularity, being set against the rest of the world, each nation could create an office of global communication, which could set up connections similar to sister cities program. It might be beneficial to join confederations of other similar areas, especially those that could offer complementary crops, or a larger union, such as the United States, for preferred trading.

Spending on education, roads, welfare would be done at local level. There is some risk, especially with education or wilderness restoration, but the breakdowns and errors will not be devastating as with centralized planning. Citizens will need to do some of the work of government as well as make the decisions. They should have total control over some things. The judgments of the people are more important than the efficiency of those judgments. It may not be necessary to have many separate authorities or committees; it might be better to integrate policy-making bodies so they are not too specialized.

With centralization of functions, money has become the primary source of security for most people. Welfare, as giving money to those who do not have it, may reduce homelessness or disease, but it cannot restore family. Family needs a supporting community context—institutions. Decentralization, and the power it would return to local communities, may also help the family as a source of security. Money is an enormous simplifier, but many things cannot be simplified. Decentralizing would make government and economics enough of a small scale to be understandable and manageable.

Decentralized communities fitted to their ecological location are more suitable and livable than urban spreads. Some cities may still be fairly large and dense like those envisioned by Paolo Soleri. Some may be smaller and rural like those suggested by Murray Bookchin. Their relation to support areas would be more explicit and include large amounts of natural and domestic vegetation. As much as possible, the cycles of materials would be closed.

As cities become more sustainable, their forms may change. They may become more compact, with more multiple-use streets, as a focus for human activity, and less involved

with cars; buildings could use solar power, efficient heating, perhaps integrate roof-top crops; integrate older buildings into new groupings to integrate services, play, and work, with living; local public spaces and services; recycle waste into cycle; regenerating derelict land, either as green area or new construction.

Preconditions to a sustainable, steady state, economy include pollution control and the redistribution of resources more equally. The redistribution of resources and improvement of environmental quality are more important than increased production by sophisticated technology. This strategy calls for social and educational organization more than technological style. Styles of technology must be determined by culture and context. Such development requires a local authority working with suitable economic and ecological conditions. No authority can be effective without the participation of the people.

8.4.3.1.4. Prescribing an Optimum Size

To restore participation, we have to consider the limits of participation. The current large populations of many places may seem to be too large for direct democracy, as does any of the projected optimal populations.

Twenty five thousand people is large for direct democracy. Many of the cities and towns in an area are approaching this size; thousands have already exceeded it. The size has to be small enough for people to meet and “exercise government” in James Madison’s words. Kirkpatrick Sale concludes that the optimum size for direct meeting is five hundred. Participation becomes more difficult as the size increases. Bryan and McClaughry suggest 2,500 as a maximum, since in larger groups people cannot all know one another and the assemblies tend to become a debating forum for a few.

Putting these figures together, we could design neighborhood sizes to be from 500 to 2,500; these neighborhoods would make up communities of 5,000-25,000; and the communities would bring a regional or even national population to 400,000-500,000. Differences in size seem to be close to powers of 10. Each Community legislature would be 40-60 people. Perhaps these sizes are close to the optimum; and, these numbers are similar to those in Christopher Alexander’s *A Pattern Language*. About 3,000-4,000 people are needed to support an elementary school. The Swiss are a good model for government levels—with a national government equivalent to the Swiss national, communities equivalent to Swiss cantons, and neighborhoods to Swiss communes.

There is a point in critical mass reaction where the mood of the mass becomes indifferent. As long as the size is small enough for recognized identity, people will behave with concern. At a larger size the ideology, which is capable of anything through indifference, can take over, according to Leopold Kohr.

Small communities are essential to the democratic ideal and other ideals. The uniqueness of place gives belonging and identity. The whole community gives meaning and richness to life. The population density of some places may cause some difficulty, however. People will not be within walking distance, but may have to travel 20-30 miles to meetings or communicate remotely through telephone, computer, paper, or friends.

8.4.3.1.5. Protecting Ways of Life

Compartmentalization avoids the need to compromise every ecosystem for human use. Multiple mixed-use systems should only be part of the picture. First, the government could

ensure a protected environment of mature ecosystems, then productive systems, and then multiple use, and urban areas. This could be done through function (not activity) zoning. The landscape needs to be zoned (compartmentalized) to provide a safe balance between protected ecosystems and used ones. Restrictions on land and water are one means of avoiding overpopulation or overexploitation.

Long before the limits of food or space are reached, or the ecological balance is lost, or a vital minimum is exhausted, phosphorus, for example, the quality of life will sink lower. Regardless of how much protein or energy can be provided to support human life, human happiness will be problematic in large, insecure populations. The question is not how many people agriculture and technology can support in one place at once, but what kind of life is possible for those who have no choice but to live in that place. The limiting factor is that condition in the environment that approaches the limits of tolerance of individuals. The population density may be the limiting factor. It may be living space. It may be wilderness. It may be beauty—aesthetic space.

Peter Drucker points out that economists from Adam Smith to the conservative F.A. Hayek argued that it is impossible for governments to control or manage the economy, especially in an information age. Recognizing, on the basis of mathematical models of complexity, that detailed management of the biosphere is beyond human capacity, a government should minimize its management, to coordination of communities or larger alliances. The biosphere is dominated by natural communities of which we are largely still ignorant. Detailed planning of complex open systems is not necessary. Planners are not in a position to attempt detailed models of future situations because many relevant parameters remain unidentified, and many of those known cannot be quantified. Plans can be made within the limits of variables, although it is not safe to be limited by lethal variables, as Gregory Bateson recognized. Closeness to limits reduces flexibility, that is, uncommitted potential for change. Vagueness and lack of detail are acceptable in planning, because people will fill in the details. Furthermore, it is almost impossible to plan every detail of a dynamic chaotic system. That does not mean stagnation, that a rice field must always remain a rice field or a town a town. What the government should preserve is the pattern, not the details, is limits, not directions. The limits are to be applied to scale not development.

Therefore, we must limit human intrusion into every system. Government should zone some segments to be free from human activity, and tailor human-made systems to approximate the form of the natural systems replaced. Interference is a broad term for the negative side of human activities. There are numerous forms of human interference: Overexploitation, introduction of exotic species, pollution of air and water, and the subsumption of habitats, in shape and size. Interference is caused by large human population growth, with its requirements of poverty, inadequate metaphors and images, which are too anthropocentric or short-term, uncontrolled change or transformations, as a result of colonialization or revolution, and political or economic failures, from wars or market internationalization.

8.4.3.1.6. Paying Costs & Leveling Extremes

Relative to European communities, many nations have less funding for public services, such as parks and public transportation. Some nations have traded public support for higher levels of private affluence, which has not made people any happier. In fact, they are more insecure; and they can become far poorer, and then second-class and neglected.

Many cultures should try, like Sweden, England and Japan have tried, to weaken the connection of material reward for achievement. Income distribution is too unequal. Full internationalization through trade would bring only greater extremes, which most populations can least afford.

The communities could levy taxes on property. But, there is a discrepancy in the wealth of communities. The nation could collect income taxes, and communities could claim a percentage of taxes collected. The community and nation could both tax the same bases: Income, sales, meals, property, and fuel, as many nations are now. The nation would set a ceiling on each tax; the community rate could be zero on some. Or the communities could do all taxes and give the national government a percentage, although differences in wealth might be maintained; then the state could return a percentage to make up equality in education and environmental protection. The important thing is that taxes are used to direct development and reflect the true costs of the society that people want.

Government could change taxation procedures to reduce growth instead of stimulating it. Talcott Parkinson suggests that taxation beyond a certain point yields declining marginal returns. Government could use a single flat rate tax at some percentage, perhaps from 10 to 25; and then pay everyone a fixed amount of income for basic needs, from 3,000-10,000 USD.

Similarly, property taxes could be appropriately scaled to use. One way to keep farms as farms is to tax land by use. The more important the use, farming for instance, the lower the taxes. Buying farmland for shopping centers would result in discouragingly high taxes. It is difficult to persuade people to pay more in taxes, to vote to keep less of their income. But, through education or understanding, a culture could expand the understanding of the self and expand self-interest in that way. Some catastrophe might work towards equality, but that might have other high costs to society.

Of course, most of these taxes could be eliminated entirely, if only environmental uses and losses were taxed. Some taxes, such as luxuries or heroic income, might be maintained temporarily until the extremes of ownership and wealth are leveled. A discussion of taxes is expanded in the book *Global Emergency Actions*.

8.4.3.1.7. Meeting Limits of Government

When a place has a reputation for being small and livable, it attracts more people, until it is no longer small and livable. But, imposing the limits and stopping growth are problematic. Government could impose limits on birth through licenses, perhaps risking rebellion, through limits on housing and public services, possibly causing shantytowns, or through peer pressure, which could contribute to social disorder. Nature is self-organizing, and society is self-organizing, but we need to recognize some limits and define others, and take responsibility for keeping to those limits in order that the self-organizing process not break down. Limits are fundamental to understanding nature and life.

8.4.3.2. Limits of Ecological Politics

The basic goal of politics is the 'survival of the community' as William Ophuls identifies it. Politics is the interactive means of providing the basic food and necessities of a community. As survival is survival within nature, politics rests on an ecological foundation. The organization of a community must be in accord with natural laws. Political participation depends on information, much of which can be provided by ecologists. Politics is the interactive means

of providing the basic food and necessities of a community. Misguided politics arises from the wrong relationship of words and symbols. Things are regarded as symbols for words in totalitarian states, which have the advantage of reducing individuals to stereotypes, which can be tortured or disposed of without involvement. Such semantic prisons confine and warp thought. People become prisoners of an order that rejects new knowledge and solutions.

As survival is survival in nature, politics rests on an ecological foundation. The organization of a community must be in accord with natural laws. Political participation depends on information, much of which can be provided by ecologists. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. Ecological consciousness must be identified with political consciousness. The ecological, social, and political problems of today do not have simple disciplinary solutions. The problems are cosmological and must be solved on that level. A single cosmology cannot solve all problems.

Ecological politics may not be enough to contribute to redesigning or 'managing' the planet. Our genetic make-up predisposes us to some things and pushes us in some directions. It makes limits on our plasticity. It could promote behaviors that damage the environment, and hence our long-term interests. If we are limited by stone-age genes, then some progeny behaviors may be ineffective, and others effective. For example, maybe we must have contact with the natural environments where we evolved—or suffer psychological and physical harm.

There may be fundamental human limitations that could derail it. What if humans have genetically-based urges for sex and reproduction that cannot be limited and cause overpopulation (as Paul Ehrlich expected)? Politics might be successful after a certain density has been reached; the Chinese experiment might furnish some enlightenment, both on the sort of density and on the time lapse for reduction. Or, what if humans have a genetically-based "short-term egoism" that leads to environmental Tragedy of the Commons (as B.F. Skinner considered)? What if human egoism is tempered by genetic tendency to live in groups and to behave altruistically towards kin, but only the kin, and not others (as E.O. Wilson wondered)? That limit might guarantee unending conflict. What if a genetically-based denial caused us to always underestimate the probability and severity of environmental threats (as Garrett Hardin expected)? That might mean we would be caught regularly by catastrophes. What if our old brain is not adaptive and does not perceive or respond to gradual environmental deterioration (as Robert Ornstein worried)? That would mean that we would be surprised by slow, invisible or long-term catastrophes. Have we been surprised? And, finally, what if the human brain cannot comprehend the current complexity of our own social systems, even ecological politics, which might act in counter-intuitive ways (as Jay Forrester suggested)? What then?

Ecological politics could be derived from our ecological identity, but that identity may not be comprehensive enough to be effective in politics. Maybe our perceived dominance over nature will be a problem that politics cannot solve. Certainly ecological politics is going to be more complex than traditional politics, which was after all designed for the human city. Perhaps we could create an open, self-conscious ecological politics.

For this politics to be global, it would have to address all cultures and all interests (nonhuman and human). A global ecological politics would have far more restraints on it, and limits to it, from the complexity of the emergent global connections and structures. Global ecological design could offer advantages through designing good societies based on healthy ecological places.

8.4.4. *Designing a Good Society*

As the basic goal of politics is the survival of the community, politics has to strive for a good society—that is, a society that is based on the properties of a good culture in a good place. These basic properties develop into the properties of a good society (Table 844-1). We need to design for limits for conflict; maybe that means a limited arena for conflict or maybe a form of competition that would resolve conflict.

Table 844-1. Contrasted Properties of Different Levels of Patterns

— Nature —		— Culture —		— Design —	
<i>Field</i>	<i>Ecosystems</i>	<i>Place</i>	<i>Culture</i>	<i>Good Places</i>	<i>Good Society</i>
Process	Course	Dynamicism	Conduct	Action	<i>Method</i>
Autopoesis	Self-making	Identity	Wholeness	Individuality	<i>Extension</i>
Differentiation	Diversity	Uniqueness	Flexibility	Richness	<i>Variety</i>
Integration	Construction	Investment	Adaptation	Conviviality	<i>Cooperation</i>
Constancy	Stability	Regularity	Endurance	Consistency	<i>Loyalty</i>
Development	Productivity	Renewal	Vitality	Health	<i>Harmony</i>

8.4.4.1. Method

Method is a way of considering process, course, dynamic change, conduct, and action. More than just courses or actions, ecological designs are methods to create good societies in good places. A science like ecology may be limited by its method, but in ecological design, method is a way of addressing limits to create the conditions for a good society. Play is the method of learning for most juvenile animals, but in ecological design, play is a way of creating imaginative experiences that can describe and test experiences scientifically and aesthetically.

8.4.4.2. Extension

Design combines the self-making of a place with the wholeness of a culture, in context of the identity of an ecosystem, to create good places and extend those properties into a good society. Human identity becomes an extension of the self to a place. This identity is a form of rootedness in place. The extension of identity creates an ecological democracy that fits the self to the larger Self that extends through local animals and plants and supporting ecosystems. The creation of good societies can be expanded to include for all residents of the territory of supporting ecosystems, including people, domestic plants and animals, wild associations, and even plants and animals that can not live well with people, such as large carnivores. The uniqueness of place gives belonging and identity. The whole community gives meaning and richness to life.

8.4.4.3. Variety

Variety is based on differentiation, diversity, uniqueness, flexibility, and richness. Diversity at the ecosystem level and uniqueness of a place promote flexibility at the cultural level and richness in good places. Animation and ecological value change the differentiation of the field to the diversity of the ecosystem. The addition of communication and cultural values to that characteristic of the ecosystem results in the richness of place. And, the addition of social

values and awareness of the uniqueness of a place leads to variety in a good society. The design of a good society requires the property of variety.

In ecological design, because things change, the design of a good place and good society should be open to the types of processes that could, if ignored or denied, destroy the design. Maintaining community diversity means maintaining or restoring, in previously degraded areas, the variety of ecosystem types that result from natural disturbances at a variety of scales through short and long time frames in a landscape. Because energy and material cycles need to fit the ecosystems, designers need to increase and scale the variety of energy sources.

8.4.4.4. Cooperation

The construction of an ecosystem contributes to investment in place, which encourages the adaptation of a culture to place. A culture uses conviviality to make a good place and cooperation to design a good society. The culture and the ecosystem (environment) co-adapt. The process of adaptation involves a self-presentation that offers the possibility of new symbiotic relations. If our old human brain is not adaptive and does not perceive or respond to gradual environmental deterioration—as Robert Ornstein worried—then that may explain why we are surprised by slow, invisible or long-term catastrophes. Cooperation, which can be enhanced through design, can increase conviviality so that we start to shape a good society that diversifies in response to catastrophes that are regular and disruptive.

8.4.4.5. Loyalty

The stability of an ecosystem contributes to the regularity of a place, which sets the opportunity for the endurance of a culture to place. A culture uses consistency to make a good place and loyalty to design a good society. Most environments, however, are characterized by fluctuations, irregularities, and uncertainties. As an adaptive system, a culture can change as its ecosystem changes. Designs for a good society have to be based on the regularity of a place and the endurance of a culture in the context of ecosystem stability. Design takes the consistency of a good place and lets loyalty emerge from the process. Dissent occurs within the context of loyalty. Freedom is expressed within a context of law that limits it and protects it. This avoids runaway feedback.

8.4.4.6. Harmony

Harmony is related to wholeness—indeed, health can be defined as harmony in a whole context. The flowing movement of the implicate order (David Bohm's word) is harmony. But, since the flow and order of the holomovement are imprecise and uncertain, perfect health or perfect harmony is not possible. We recognize breaks in harmony as disease or disorder. Health is a form of harmony, not a characteristic of things or bodies. A culture uses the health of the system as a basis to make a good place and the harmony of the system to design a good society. Health is the overall ability of a system to maintain itself under a normal range of environmental conditions. Ecosystem health is one of the goals of design, not an end point that can be reached once, but as a continual striving and balancing. This means we need to consider long-term balance to have any kind of sustainable pattern. Natural processes are concerned with long-term harmony building as a fundamental property of that design at that level of value. In ecological design, harmony is good fitness with the environment that results in a meaningful and flexible order on the time frame and scale of living processes.

8.4.5. Discussion: *Imperfect Design in Incomplete Harmony*

Human survival is not guaranteed. The perfection of a place or society is not possible. The properties of a good society—method, extension, variety, cooperation, loyalty, and harmony—are indefinite and incomplete. Although the properties can inform ecological design, which can improve our situation on a developing planet, they cannot be used to create ideal, permanent utopias.

Cultural system health is a measure of the harmony of the overall physical and ecological degenerative and regenerative processes, which may recycle thousands of human dwelling places, especially those badly sited in earthquake or tsunami zones. The ecological designer should take care to create good places, but on the global level especially, be aware of short or long-term destructive processes at work. At the global level, harmony has to include the whole order and geological time.

Design has to participate in the political actions of a society. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. The restriction of freedom, either through tyranny, cultural uniformity, or crowding, results in a decrease of variety, which is created by spontaneous play, which is necessary to flexible and enduring social systems. If we wish to advance through design, to harmonize on higher levels of development, we must preserve and promote variety. Ethical, aesthetic and utilitarian reasons all support efforts to conserve the variety in nature.

Regional ecological design is the creative modification of ecosystems to repair or enhance their ability at self-organization and maintenance of their complexity and diversity. The pattern has to be small cells under a unit larger than the largest cell. That allows harmony and management by ensuring a physical and numerical balance. Then, central authority, for design or politics, can be relatively weak.



Figure 842121-1. Desana Maloca in southeast Columbia in the northwest Amazon

8.5. *Regional Design Factors: Cultural Solutions*

Intelligence, for Edward Hall, is paying attention to the right things at the right time. Western culture uses a highly specific classification system to deal with the specifics and details—to the exclusion of whole patterns. Other cultures depend on myths to comprehend wholes, but they have less success with the details of invention. Can cultures learn from each other?

What can modern cultures learn from traditional ones? First, they can learn or relearn how to have children based on limits, not on some abstract right to reproduce. Next, they can learn the art of sustainable living in fragile ecosystems. They can learn how to share and distribute the goods of a society equitably. And, they can learn how to resolve conflict by resolution, or at least how to fight personally.

Traditional cultures can learn some things from modern cultures, also. For instance, larger networks of trade—archaic cultures have always known how to be specialists and how to trade. They can learn the use of appropriate technology. They can learn some forms of larger communication. And, they can accept common rights and standards of universal human cultural behavior.

This is not a complete list. Both traditional and modern cultures will have to learn new things. Some cultures do better at the prospect of greater challenges, in part due to their history, but in part due to their ability to change.

8.5.1. *The Health of Cultures*

To be truly healthy, a culture (or a global cultural institution) has to address the issues of growth, development and maturity, especially as related to size and scale. We know that life is geared for overproduction and that cells and bodies of organisms have corrective actions, such as signals to trigger cell death. We know that growth is the first phase to maturity, and when maturity is achieved, growth stops, although the organism can continue to develop. In cases where the signal to stop growing is absent or lost through interference, growth continues until death results from collapse or cancer.

Ecosystems can act in similar ways, where growth can stimulate overproduction, which can establish an environment for new, less pioneering species. The new species corrects the growth of the old by making conditions adverse. Maturity is a correction in general as a mature system closes itself to invasion by other invasive pioneering organisms. Cultures grow also and received signals from environment. Usually, the environmental signal slowed growth. After the application of agriculture, however, with all of its technological advances and social changes, such as permanent dwellings, signals were either ignored or overcome by technological or social changes. The human population has been free to grow tremendously, although large-scale disturbances, such as earthquakes or long droughts, have acted as signals and caused many cultures to collapse.

Cultures now, and especially any pancultural global institutions, have to address the situation of exponential human growth and its effects on institutions and ecosystems. They have to find a way to signal human populations to stop growing beyond the ability of institutions to manage them or of ecosystems to support them. Cultures can do this by modifying how they imagine places, in terms of their images of the planet or cosmologies. Cultures can apply their understanding of ecosystems and the cultures themselves to use

ecological designs and political processes to fit their health and prosperity within the health and vitality of ecosystems.

Table 851-1. Conditions for a Healthy Culture

<i>Condition</i>	<i>Meaning</i>
Sources of energy / material	External, internal provide basic needs
Groundedness (boundedness)	Locality, isolation, security
Identity	Unique patterns, stability, resistance
Vigor	Productivity, health
Participation	Relation to other cultures, systems
Adventitiousness (continuity)	Ability to adapt / absorb
Sophistication	Self-maintaining, developing, aging
Complexity	Development of diversity
Heterogeneity	Toleration of diversity
Comprehensiveness	Acceptance of everything
Flexibility	Looseness, capacity to change
Renewability	Self-creating, self-renewing
Balance	Harmony of limits / extents

All cultures need to have certain conditions to keep being healthy; if one or more of these conditions fails, then the culture may fail. An incomplete list of conditions is in Table 851-1. For a longer discussion of health, refer to previous sections (8.4.4.6 and 7.2.3).

8.5.2. *Comparing Ecosystems & Cultures*

Cultures have a lot in common with ecosystems. Both are open, productive systems. Both have an identity that is bounded by limits and is adaptive to place. And, both can achieve flexibility and stability by maturing in place. The properties of an ecosystem include: Identity and its factors, boundedness, limits, size, definition and shape, and wholeness; Openness, related to energy and efficiency, structure, and connections; Productivity, the self-generation and maintenance of systems; Adaptation to place; Vitality; Stability; and Flexibility. By comparison, the properties of a culture are almost identical, in terms of how they describe the system. Both systems have essentially the same properties.

8.5.2.1. Needs of a Culture

Now, compare the needs of a typical human with the needs of their culture. Human needs, according to Abraham Maslow, range from the Physical—food, shelter, and clothing—to Safety, which involves law, order, and security; Psychological, which is about belongingness and love; Esteem, with its reliance on strength, self-sufficiency, competence, freedom, attention, and prestige; and finally, Self-actualization, which is expressed through health, achievement and creativity.

The needs of a culture, which include physical resources and security, are much more formal and include emergent needs: To have a dynamic order, for human health; to be complex and sophisticated, with checks and balances; and, to be comprehensive, to allow change and diversity. Both patterns need physical resources and emergent properties that let them find, benefit and enjoy using resource to make better individual or group lives. Of course, this is logical, since human beings make culture.

8.5.2.2. Responsibilities of a Culture

Notice the contrast between responsibilities and possible interrelationships with other cultures. Cultures can relate to each other in a variety of ways, beginning with the strict avoidance of others and competition with others, including violence and war. But, cultures can cooperate with others on several levels, including partnership and symbiosis. A responsible culture has to fit with the environment and display ethical treatment of all others as insiders or outsiders. Cultures may preserve themselves and possibly miniaturize their image or those of other cultures. Each of these possible relations has certain benefits or costs to a culture. Over time, it seems that cultures are becoming more cooperative and more ethical. Overall, there may be a decline in violence, and that may be related to education and travel. One perspective that has been allowed has been the concept of the outsider, which is often part of the history and cosmology of a culture.

Cultures have always had responsibilities to their members. Many of these have to do with identity, continuity and protection. Cultures have several Responsibilities, that may be assumed or voiced formally: To have consistent rules; to keep ecosystems healthy; to be economically healthy; to keep their people healthy; and, to keep the culture itself healthy. Health figures significantly as a responsibility of culture. Not only do the people have to be healthy, but the economy and ecosystems have to be maintained in a state of health. One important aspect of health is the size of the culture relative to its place.

8.5.3. *Imagining Place: Human Cosmologies*

The present crisis is a consequence of the modern world view, which is too rational and mechanical, as a result of its machine image. Problems are more than matters of policy or management; war, injustice and environmental destruction spring from a common sickness. Unfortunately, the language from a mechanical world view dominates even ecologists, Physicians and politicians. This world view impoverishes humans by claiming all consciousness for them. It claims that nature offers no joy, or love, or peace, or certitude. Emphasis on the evil of nature creates a gap between humans and the planet. There is no room for the intrinsic worth of nature. The problem is cosmological.

Cosmology is basically the complete set of ideas about the nature and composition of the universe used by a cultural system. This idea of the universe provides people with an orientation in their cosmos. A cosmology is a collective image. Ezra Pound stated that the image is an emotional and intellectual complex in an instant of time. He used the figure of a Chinese ideogram as an expression of a complex image created by throwing groups of elements together without predication, which is a characteristic of assertion of the universe. The cosmological set of ideas is common to a culture; some ideas may be shared among other cultures. Most cosmologies have to be understood in a cultural context, which means that they are not intelligible without reference to the unique culture or place they are particular to.

A cosmology rarely meshes perfectly with the natural order or the social order. The ambihuman order of nature could exist without humanity. In a sense it is indifferent. Cosmology arises out of the needs of humans. That cosmology includes so much—science, mythology, theology—makes its fitness less. To the degree that it is effective, any ideology will fit the order of nature; science may manipulate invisible particles; technology may mold metals; and, beliefs in theology may save human or ambihuman lives. But the total mix of

ideologies makes the overall fit very sloppy. As long as nature can be dominated, without catastrophe, the importance of the fit is not critical. But we do not know enough of nature to know when catastrophes occur, or how to avoid them or minimize them.

We need to create a new holocosmology that can be a framework for traditional cosmologies. We need to appreciate the wisdom of those cultures. These cosmologies are being rediscovered; their tools are dance, song and history; they are open to nonvisual communication. Everything is vital. The consequences of these cosmologies would alter the character of modern life, making it closer to human and ecological reality, counteracting the tragic consequences of war against ourselves and nature. We do not need to inflate a traditional cosmology to use for global design. That would not work. Brian Morris suggests that the worlds of St. Francis, Buddha or Black Elk, have been destroyed by Newtonian science. He recommends an ecological viewpoint and understanding. But, no world has ever been destroyed by science. Science cannot even discourage astrology or bad eating habits. Technology has ruined many habitats and aggressive cultures have smothered many smaller cultures, but that is not an indictment of the cosmologies.

A holocosmology could incorporate an ecological perspective to address the emergent features of a global effort for design. The issue is not conservation versus exploitation, but an experience of the planet distinct from these two alternatives. A sense participatory rather than manipulative, a sense as presence rather than object; a universe moving in vast cycles and rhythmic harmony instead of serial stages of beginning, progression, decay, and end.

A world view is more than skeleton of theory, it is a view of relation of human mind-heart-will to global factors. Ultimately, a model of the world—world-view or ideology—is what implicitly or explicitly guides the processes of social change and global ecological design. The basis of an ecological cosmology can be found in history, in the experiences of diverse cultures, and be expanded intentionally be defining new values.

8.5.4. *Imagination & Metabolism*

As the adequacy of a habitual view of the earth is questioned, imagination offers alternative ways of seeing. Yet, human imagination is limited, as is human knowledge. An aesthetic object should not offer a reassuring vision, which interprets or identifies nature, but a naive vision, which surprises, shocks, fascinates or seduces the senses, which awakens desire and stirs the imagination, and which furnishes a feeling of the invisible. Play is imaginative experience, natural learning entered into freely; education should be more like play than work. Vico pronounces that imagination is a turning out of one's self. An imaginative metaphysics shows how a human can become all things by not understanding them. The creativity of the imagination diffuses the world from the center of its being, creating a plenitude. Metaphor enlarges the imagination. Perception and expression are embodied in the flesh, but imagination is what makes the flesh visible; it is what allows inquiring beings to see into Being.

We must find a way to affirm the metabolism of nature as our own. Each individual is part of a world that extends around the self. There are different, partial worlds. We may see trees on a house site as encroaching, where a Dakota person may see them as standing peoples, with equal rights to the land. The self is related to each world in different ways. We may see plowing fields for seeds as an act of mastery and exploitation, where another may see it as act of tender involvement, bringing forth potential.

Since the origins of the environmental crises are in human traditions, it should be

possible to select—and create a new cosmology—from what is valuable in those traditions. If the world becomes as humans imagine it, then a larger frame will make a larger world. When cosmologies and societies were small, the amount of control and security needed was small. Although societies have grown, security has not. It should be easy to give up control that we never had; giving up trying to control may be more difficult. We need to fashion our behavior to the planet, not the reverse. Since complete security is impossible, since complete power is impossible, why try? We are already participating in the cosmos; our images need to reflect that. We are already in relationships; those are what we need to learn.

We create the organization of a cosmology, then see nature work that way. But, we create nature by seeing what the brain filters. The world is too complex for our minds, thought G. P. Marsh and many later thinkers. So, our minds have to filter out what is less important. We filter data, arguments, emotions, and information. The filter allows a total picture of the whole with relatively little information. Of course that picture might be wrong. But, it is clear, as a result of filtering and thinking. Other human things act as filters, also, especially culture.

The human desire to refine the focus has neglected the frame of reference. An adaptive holocosmology would place human values within a global framework, attaining a balance of human and ambihuman nature. The sciences, humanities and other ideologies could be balanced in a holocosmology. Perhaps human behavior could be put in tune with nature through a popular literature or poetry. Humanity is not aware of limits, of its inability to fully comprehend the universe. We have never made earth completely home; until we do, no place will ever be home.

A holocosmology could justify the wide diversity in nature and accommodation to natural laws. It could even allow a deeper understanding of the utilitarian. For example, what is the use—or the beauty—of a burned forest, as related to the function of lightening or the planetary carbon cycle? The whole idea of irreversible history sanctifies behavior, making it moral. If a life or species cannot be repeated, then it is special.

A holocosmology could show our relationships and our debts to other species. By considering only humans, and inflating them out of proportion, we diminish other species, and ultimately ourselves. Responsibility considers the interests of ambihuman nature. The interests of other beings is the same as human interests: To live and experience, then to reproduce that their heirs may, as Whitehead said, “to live, to live well, and to live better.”

Such a global framework for cultures would also consider important principles drawn from ecology. A holocosmology cannot be limited by the scientific facts of any science, even ecology. The insights of mystics and the wise should be included. Individual world views penetrate each other in a transepistemological process. Each mystic or scientist tells of a way the world is; together, these ways make a holocosmology. It is a framework for all truths.

The proper attitude of an ecological global culture with a holocosmology would be care, a positive spontaneity, but also a ‘letting be,’ a reverence toward the wild alienness of nature, a willingness to comply with the limitations of natural systems, and a willingness to reduce the dominance of natural systems and to set aside wild areas. In addition, a global perspective might define: An authentic concept of humanity, rational economic development, with respect to health, a holistic education beyond that of a native culture, a description of the responsibilities of societies to themselves, others, and the earth, and a respect for all cultures.

8.6. Regional Design Factors: Legal Protections for Large Systems

Political systems are impotent to stop the massive interference in ecosystems by international corporations. The simplest and most direct way to give the local region a voice in its own development of the earth by humanity is to incorporate it following international law. The region, with its biochemical cycles and nonhuman communities, would become one legal body. Since corporations are human constructs, however, humans would have to represent the region, with its ecosystems and the wealth of living organisms.

8.6.1. Incorporating the Palouse Region: A Thought Experiment

In early civilizations, the advancement of the state was expected to contribute to the welfare of its people. Corporations are recent devices created by states for public purposes. Most early American corporations, for example, were concerned with travel (turnpikes and inland waterways) or safety (fire insurance)—they resembled public agencies more than profit-seeking associations. In fact, the exclusive privileges and political power granted to corporations were based on the implicit promise of social services.

The association of economic development with national wealth allowed incorporation laws to be broadened. The corporation was given the constitutional rights of an individual. A corporation is a legal entity, independent from its founders, with its own rights, privileges, and liabilities. It is, however, required to obey laws and pay taxes; and it is accountable for its deeds in courts of law.

Unfortunately, as private good became identified with public good, corporations became larger, more acquisitive, and less concerned with social services. The quest for profit now has the effect of violating social amenities, such as clean air and clean water, instead of ensuring them. No responsibility is taken for environmental degradation since no right of contract or fair use of property has been breached.

Changes in societies, from rural to urban, from sparsely to densely populated, from culturally diverse to monotone, have transformed corporations and the societies themselves. Business corporations now provide the bulk of goods and services in many states. The scale of these corporations, the processes of production, and the size and needs of human populations, have altered and degraded many ecosystems and biogeochemical cycles.

Successful modern corporations create an identity based on their purpose in providing goods or services; they define their business in terms of profitability, growth rate, cash flow, and competitive position; they develop a corporate vision, with specific objectives and strategies, including long-term vision, collection of ideas and creative implementation, aggressive manufacturing, and reliable finance.

The purpose of a corporation often transcends simple financial gain—the corporation seeks to maintain its own existence, even before profit. Financial objectives (sales, assets, and profits) exist to sustain its existence. The goals that most motivate corporate managers are survival, independence, self-sufficiency, and self-fulfillment. Yet, these motives are consistent with the financial objectives of the corporation: to maximize corporate wealth. The responsibility of managers is to maximize the value of the company. Furthermore, because corporations are long-lived, that value should last a long time—a good reason for looking beyond the ten-year monetary horizon and the lives of its managers.

Although current wisdom (Milton Friedman et al.) holds that a corporation's only responsibility is to its stockholders, corporations are being pushed to include social purpose in their strategies, again. Alas, they are doing poorly at it. They do not know how much responsibility to take, or where to put limits, or whether to pursue policies that diminish their profits. Corporations have proved spotty in doing social and environmental good. It would be more appropriate to have them deal with the environment as a corporate entity concerned with maximizing its own values. Of course, that would mean no more "free" resources or environmental services.

The important advantages to incorporating a region are the same as for incorporating a business. (1) Managerial flexibility: the stockholders are separate from managers; responsibilities are assigned by needs of the corporation. (2) Limited liability: the corporation borrows and repays. It shields its members from hazards to which they would otherwise be exposed. (3) Financial advantage: the ownership of assets can benefit stockholders and the corporation. (4) Tax advantage: investments in the good of the corporation may not be taxed by any nonlocal government. (5) Estate planning and longevity: the corporation exists indefinitely beyond the lives of its participants. (6) Central management and representation: a large and complex business needs operational and managerial efficiency. Many of the participants have no direct voice in the operation—they must be represented.

One way to represent all voices and interests in a region would be to incorporate it. The region incorporated would focus on a core business: To ensure the integrity and continuity of life and all its connections and to secure the opportunity for development free from undue interference. It would operate to optimize values, like any good corporation, but the values would be ecosystem values (fungus values and earthworm values, as well as human values).

A temporary Board of Directors (the undersigned) would adopt bylaws, elect working officers, approve stock certificates, open accounts, and arrange a stockholders meeting. The stockholders would elect new directors, possibly from local representatives or directly from elections, and decide on dividend declarations.

Stockholders, as citizens of the area, would turn over common and state (or regional) property to the regional corporation, for example, the Palouse Corporation, which would issue stock certificates to the stockholders. The corporation would allocate the purchase price of stock to capital at par value. Most of the shares—the percentage to be determined by the board as necessary to the operation of ecosystems—would be treasury shares. Anything more than par value would go to capital surplus, and only capital surplus could be distributed as dividends. Stockholders have the right to receive these dividends equitably, without resort to traditional distributions of wealth.

Stock certificates denote ownership of the corporation. Although the stockholders own the corporation, they do not own the property of the corporation, the entire region, which is owned by the corporation itself. Stockholders, as individuals, communities, or cities, could make agreements about how business would be conducted, about what resources would be used or traded.

The elected board of directors would make decisions of distribution and limitation. Percentages would be deducted from the interest for the operation of the corporation and for equitable distribution to areas less favored by chance with biological or geological wealth. Furthermore, since the dividends would be distributed among people according to net

ecosystem productivity and resource availability, no advantage would be gained by areas having large populations.

The basic functioning system would be considered capital, thus limiting the amount of human use of resources and probably the size of human populations. Interest would accrue in the form of net ecosystem productivity and diverted percentages of materials, such as gold or water.

The Palouse Incorporated would solve the problem of having to value ecosystems in monetary or quantifiable terms; its systems would be untouchable capital. The human value of resources like copper, air, or water would be equated to the technological cost of recycling or producing them.

Raw material and energy are only two facets of the capital of a corporation—another is human ingenuity. Thus, human wealth would not be limited by restrictions on the availability of resources, but rather by a shortage of ingenuity.

An incorporated region would be instrumental in conditioning international corporations to their social responsibility and in internalizing all costs. This corporation and governments could use traditional means, such as credit access, low interest rates, and setting priorities on equity issues, to evoke public interest in smaller and healthier human endeavors.

The suggested articles of incorporation are:

FIRST: The name of the corporation shall be The Palouse, Incorporated.

SECOND: The purposes for which the corporation is formed shall include: The protection of functioning ecosystems and their living beings from destructive interference.

The conduct of inquiry into the operation of such systems and the role of humanity therein for scientific and educational purposes.

The taking of appropriate legal steps to carry out these purposes.

The maintenance of all real common property, including all lands, seas, and atmosphere, subject to the restrictions and limitations hereinafter set forth, to use only the interest from income therein, reserving the principal thereof exclusively for the aforesaid purposes, it being intended that the corporation be organized and operated for preservational purposes and not for pecuniary profit.

The corporation is organized as a voice for nonhuman beings and systems. No part of the income of the corporation, if any, shall inure to the benefit of any trustee or officer of the corporation or to any private individual having an interest in the corporation (except for reasonable compensation) and no trustee or officer of the corporation or any private individual shall be entitled to share in the distribution of any of the assets of the corporation.

The corporation shall not be authorized to carry on propaganda, influence legislation, participate in any political campaigns, or discriminate against human cultures.

In furtherance of the foregoing purposes, the corporation shall have the following powers:

To accept and hold by gift or judicial order any real or personal property of whatever kind, nature, or description, wherever situated.

To sell, transfer, or dispose of the interest from any such property, but not the principal or any part thereof.

To make, accept, endorse, execute, and issue bonds, promissory notes, bills of exchange, and other obligations of the corporation for monies borrowed for the purposes of the

corporation.

To invest and reinvest its funds in stock, bonds, or in such other securities and property as its trustees shall deem advisable, subject to the limitations and conditions contained in any grant or gift.

In general, and subject to such limitations and conditions as are or may be subscribed by international law, to exercise such other powers which now are or hereafter may be conferred by international law upon a corporation organized for the purposes hereinabove set forth.

THIRD: The operations of the corporation are to be conducted in the surface of the region but the operations of the corporation shall not be limited to such territory (and should necessarily address the atmosphere, geology, hydrology, and regional cycles).

FOURTH: The principal office of the corporation is to be located in the City of Palouse, State of Washington, United States of America.

FIFTH: The number of directors, who shall be known as trustees, of the corporation shall be not less than 7 (a minimum number associated with this region), nor more than 49 (the number of subprovinces).

SIXTH: The names and residences of the persons who shall be trustees until the first annual meeting of the corporation, are: [Removed]

SEVENTH: All of the subscribers of this certificate are of full age; all of them are residents of settled places in the region.

In witness whereof

(Signed 16 August 1986)



Figure 861-1. Palouse Hills in SW Washington state, USA 1992

8.6.2. Putting a Region in Trust: A Bali Example

Perhaps the form of a nonprofit corporation is not the proper approach to protect regions. Perhaps, a region could be represented well by some sort of legal trust, as are private properties. This might solve the dilemma of ambihuman species as well as future human generations, which require a much longer time frame than most plans.

8.6.2.1. Local & Regional Commons

Bali's water-sharing temple system for rice farmers is a good example of commons management. And, there are other examples of this kind of management of limited resources. The Spanish Huerta was also a system for distributing water and resolving disputes.

Garret Hardin, after criticism of his article on the "Tragedy of the Commons," pointed out that the problem was not common ownership as much so open access to a common without the limits of social structures or rules. Ocean fisheries and the planetary atmosphere are two examples of modern commons with limited restrictions. Tragedy occurs especially when social structure breaks down, as in the Mayan case after 900 CE, or when the scale increases beyond the control of any local organizations, as with atmospheres and oceans. New technologies, of course, need new rules. Overpopulation can put pressure on the commons. External corporations can put even more pressure on a regional or global commons.

The commons can be productive where there is a common culture with rules and laws. Switzerland and its alpine pastures, or the rice fields of the Philippines, are examples. The commons of the ocean and atmosphere are too large for local control, however. These real global commons have to be ruled by a global institution. This is possible because the management can be scaled up to an international body. Individual people and cultures have to recognize that the commons provides for all equally and have to have rules.

8.6.2.2. Local Trusts

In common law legal systems, a trust is an arrangement whereby property, including real, tangible and intangible property, is managed by one person, or persons or organizations, for the benefit of another. A trust is created by a settler (or trustor, grantor, donor, or creator), who entrusts some or all of his or her property to people of his choice, the trustees. The trustees hold legal title to the trust property (or trust corpus), but they are obliged to hold the property for the benefit of one or more individuals or organizations as the beneficiary (a.k.a. *cestui que use* or *cestui que* trust), usually specified by the settler. The trustees owe a fiduciary duty to the beneficiaries, who are the "beneficial" owners of the trust property.

The definition of a trust allows it to maintain an asset for future beneficiaries. For example, the Pacific Forest Trust protects private forests from clearcutting and development, through conservation easements that limit the kind of use that might harm the ecosystem. Private landowners can harvest some trees sustainably. Marin Agricultural Land Trust buys development rights to farmlands. Oregon Water Trust restores water flow to endangered streams by acquiring water rights. Could it apply to oceans? In each of these cases the owners hold the land and can benefit, within limits, from it. Would this work with nonhuman owners like the planet? Can local commons management be applied to global commons to address global problems, such as ocean and atmosphere?

8.6.2.3. Regional Trusts

The trust is governed by the terms of the trust document, which is usually written and in deed form. It is also governed by local law, although it could be governed by some new global law. There are a few basic principles for a trust: Property of any sort can be held on trust; the uses of trusts are many and varied.

Trusts can be created by written document (express trusts) or they can be created by implication (implied trusts). On a global scale, the trust would be created by one of the following: (1) a written trust document created by the settler and signed by both the settler and the trustees, and this is often referred to as an *inter vivos* or “living trust”; (2) a court order (for example in family proceedings if it were a local trust). Due to the legal limitations of the ability of nonhuman species to communicate legally, a court order would be the best way to set up a global trust.

There are formalities for establishing a trust. Generally, a trust requires three certainties: (1. Intention) There must be a clear intention to create a trust; (2) The property subject to the trust must be clearly identified. Trust property can be any form of specific property, real, personal, tangible, or intangible. In local trusts, for example, it may be real estate, shares or cash; and (3) The beneficiaries of the trust must be clearly identified, or at least be ascertainable. In the case of discretionary trusts, where the trustees have power to decide who the beneficiaries will be, the settler must have described a clear class of beneficiaries. For the global trust, beneficiaries could include any living beings alive or not born at the date of the trust. Alternatively, the object of a trust could be a charitable purpose to be held by the United Nations or organization rather than specific beneficiaries.

A Trustee can be either a person or a legal entity such as a company. There can be multiple trustees (there must be a minimum of two for a trust, usually in relation to land). A trustee can have many rights and responsibilities, which could vary from trust to trust depending on the type of the trust. A trust generally would not fail necessarily solely for want of a trustee; if there is no trustee, whoever has title to the trust property will be considered the trustee—in this case a global governing body. Otherwise, a court may appoint a trustee. Trustees are nearly always appointed in the document (instrument) that creates the trust.

The Trustee, especially for a regional Trust, has a huge responsibility. He may be held personally liable for any issues that arise with the trust. However, due to the differences between the value of the Trustee and the value of the planet, the Trustee has to be overseen by a global governing committee. There are two main types of trustees, professional and non-professional. Liability is different for the two types.

The trustees are the legal owners of the trust’s property. The trustees administer all of the affairs attendant to the trust. This includes investing the assets of the trust, insuring trust property is preserved and productive for the beneficiaries, accounting for and reporting periodically to the beneficiaries concerning all transactions associated with trust property, filing any required legal documents on behalf of the trust, and many other administrative duties. In some cases, the trustees must make decisions as to whether beneficiaries should receive trust assets for their benefit. The circumstances in which this discretionary authority is exercised by trustees is usually provided for under the terms of the trust instrument. It is then the trustees’ duty to determine in the specific instance of a beneficiary request whether to provide any funds and in what manner.

By default, being a trustee is an unpaid job. However, in modern times trustees are

often lawyers or other professionals who unwilling to work for free. Therefore, often a trust document would state specifically that trustees are entitled to reasonable payment for their work—perhaps an amount equal to the average income of a mid-range position.

The beneficiaries would be the equitable owners of the trust property. Either immediately or eventually, they would receive income from the trust. The extent of an individual beneficiary's interest depends on the wording of the trust document. The settler has much discretion when creating the trust, subject to limitations imposed by law.

Many of the common purposes for trusts are not applicable to a regional trust. For instance, privacy, wills, tax evasion, and money laundering, would have no meaning in such a trust. It would not be a protective trust, since there would be no inheritance or debts. The idea of charities might not apply well to the region, since every being is endowed with life and some skills. Although asset protection sounds like it might be useful, there is no possibility of divorce between owners or gifts to creditors. On the other hand, some Common purposes for trusts may be of interest, and these would include:

- **Co-ownership.** Ownership of property by more than one person is facilitated by a trust. Ownership of a matrimonial home is commonly effected by a trust with both partners as beneficiaries and one, or both, owning the legal title as trustee.
- **Constructive trust.** Unlike an express or implied trust, a constructive trust is not created by an agreement between a settler and the trustee. A constructive trust is imposed by the law as an “equitable remedy.” This generally occurs due to some wrongdoing, where the wrongdoer has acquired legal title to some property and cannot in good conscience be allowed to benefit from it. A constructive trust is, essentially, a legal fiction. For example, a court of equity recognizing a plaintiff's request for the equitable remedy of a constructive trust may decide that a constructive trust has been ‘raised’ and simply order the person holding the assets to the person who rightfully should have them. The constructive trustee is not necessarily the person who is guilty of the wrongdoing, and in practice it is often a bank or similar organization.
- **Hybrid trust.** A hybrid trust combines elements of both fixed and discretionary trusts. In a hybrid trust, the trustee must pay a certain amount of the trust property to each beneficiary fixed by the settler. But the trustee has discretion as to how any remaining trust property, once these fixed amounts have been paid out, is to be paid to the beneficiaries.
- **Incentive trust.** A trust that uses distributions from income or principal as an incentive to encourage or discourage certain behaviors on the part of the beneficiary. The term “incentive trust” is sometimes used to distinguish trusts that provide fixed conditions for access to trust funds from discretionary trusts that leave such decisions up to the trustee.
- **Irrevocable trust.** In contrast to a revocable trust, an irrevocable trust is one in which the terms of the trust cannot be amended or revised until the terms or purposes of the trust have been completed. Although in rare cases, a court may change the terms of the trust due to unexpected changes in circumstances that make the trust uneconomical or unwieldy to administer, under normal circumstances an irrevocable trust cannot be changed by the trustee or the beneficiaries of the trust.
- **Private and public trusts.** A private trust has one or more particular individuals as its beneficiary. By contrast, a public trust (also called a charitable trust) has some charitable end as its beneficiary. In order to qualify as a charitable trust, the trust must have as its

object certain purposes such as alleviating poverty, providing education, carrying out religious purpose, or protecting a region. The permissible objects are generally set out in legislation, but objects not explicitly set out may also be an object of a charitable trust, by analogy. Charitable trusts are entitled to special treatment under the law of trusts and also the law of taxation.

- A Spendthrift trust is a trust put into place for the benefit of a person who is unable to control their spending or handle money. It gives the trustee the power to decide how the trust funds may be spent for the benefit of the beneficiary. These are especially attractive for spendthrifts. In many cases a family member or friend has prevailed upon the spendthrift/settler to enter into such a relationship.
- Unit trust. A unit trust is a trust where the beneficiaries (called unit holders) each possess a certain share (called units) and can direct the trustee to pay money to them out of the trust property according to the number of units they possess. A unit trust is a vehicle for collective investment, rather than disposition, as the person who gives the property to the trustee is also the beneficiary.

The regional trust could have elements of a constructive trust, since it would be imposed by law as an “equitable remedy” against those holding the assets as a matter of luck or discrimination. It would have elements of a spendthrift trust, since humanity is unable to control its spending of natural capital; the trustee, perhaps an agency of the United nations, would have the power to spend only ecological interest. It would resemble a unit trust, in the sense that all human beings would possess a certain share of the interest of the planet—of course, nations would control a percentage, determined by the ecological carrying capacity, which would be divided equally among the population; this would encourage nations to normalize their populations. It might resemble a public trust, in the sense that it would have the object of protecting the planet and keeping it healthy, as the source of most capital.

Co-ownership, as a trust, could be divided between species first—that is, the ownership of the home, earth, is shared by all living beings, and all living beings should have some legal representation. For Bali, living water would have an interest. If it were a hybrid trust, the amounts of the trust interest could be paid out at the discretion of the trustee; this might be used to settle long-standing grievances and inequities. It could resemble an incentive trust, in part, because it would encourage some behaviors, such as inventiveness and frugality, and discourage others, such as waste or inequity.

There would be many benefits to setting the region up as a trust. The greatest benefit would be legal protection of many areas for ambihuman species. In fact, that would be a major purpose of a trust. A second major purpose would be to equalize the income from regional interest so that it would be divided equally.



Figure 863-1. Bali Landscape
2010 (Amy Ihrke)

8.7. *Wild Design: Creating Regional Designs*

We have had great success designing toasters and pencils. We have even had some conscious success designing parks and forests, but for the most part, designs, especially of cities and regions, and of humanity itself, have been aggregated or assembled from all of the small individual and group decisions. They often do not work well together; they do not work well with ecosystems and biogeochemical cycles. In fact, sometimes they disrupt international politics or interfere with systems and cycles.

8.7.1 *Regional Scale Designs*

We have addressed designs on small scales, from the design of idea and objects to the design of objects in interacting systems and systems of interacting objects. We have not been concerned as much with the design of objects and living beings in ecosystems joined by regional and global cycles. This is the broadest scale that we can design at our current stage of development. We can imagine and discuss redesigning the solar system and the galaxy, but we do not have the knowledge, power or humility to try that, yet.

We need big designs to address at least five major concerns. The first is the planet itself. We need to design land and ocean ecosystems in a way that lets them regenerate without damaging interference. Essentially, we are designing human systems that fit around many systems and interface with others. We need to let the system produce forests and deserts, wetlands and grasslands. Then, we might be able to influence the extent of deserts and forests; we might be able to restore some and create new associations carefully.

Our cities need to be rethought and redesigned. How can we design them so that they do not interfere with ecosystems or watercourses? How can we design them to withstand floods, earthquakes, and volcanic eruptions? If we cannot do that, where should we place them so that those threats are minimized? How can new cities withstand three 20-year droughts in 100 years? Should we have farms on roofs of most buildings? Vats of food, storage in cans or freezers for 20 years?

A third major concern is agriculture. If people are concentrated in cities, can we simply trade foodstuffs from distant farms or from wild animal harvests? We could reduce our reliance on a few foods, such as corn and wheat that are grown everywhere, often at great expense and great costs to the environment. We could reduce the number and extent of fields, and make them more organic and labor-intense.

Waste and pollution are an important concern, now that they are regional or global. Finally, population growth needs to become planned to reduce the impacts and interferences on ecosystems.

8.7.1.1. Considerations for Regional Design

The ecological design of a toothpick, for instance, requires the consideration of many factors. The goal, to clean food from teeth, has to be articulated; other goals, such as picking up food to eat or holding avocado seeds above water in a jar, can be explored. The materials are examined, as well as their source; perhaps one of the possible materials, wood, is rejected because too many white pines were cut and the ecosystem has been degraded. Perhaps another material, plastic, cannot be disposed of properly and can eventually interfere with ocean

ecosystems. Some materials, like ivory, may be rare or objectionable on ethical grounds. Some materials, such as a cattle bone, may work to reduce waste from slaughterhouses. Then the design starts: Determining the size, length, thickness, shape—round or squared, color, grooves, which of course depend on the variability of teeth, the cultural meaning of colors, and other factors. The design is then sandwiched between the manufacture, packaging, delivery, and marketing of the item. Disposal has become a recent problem. The waste could be put in a landfill, burned, or recycled—the material might be used in plywood or flooring, depending on what it is. These general concerns apply to regional design, also.

8.7.1.2. Designing Cultures & Continuous Turning

Cultures were assembled out of sets of behaviors that worked in specific environments. Although a few cultures developed behaviors that did not adapt them to their constraints, many worked well for thousands of years. Most cultures do not consciously shape their actions and behaviors. Less fitting behaviors simply drop out. Ones that work are repeated.

Design has to consider culture. Cultures are adaptive mechanisms that can change quickly that can embrace new courses under threatening circumstances (even if the threats are slow, invisible, large-scale, long-term threats). Human society has been getting more complex, and many actions are now global. Culture has to control the impulse to irrational, selfish or violent behavior with cultural rules. With the awareness of connections and greater ways of cooperating, people can control their behavior. The new technologies of communication and calculation, of observing and trading, can help the management of global commons, to combine conservative ways (of living frugally) with high-technology improvements of energy, food production and waste.

What kind of culture could we design? Can we go back to hunting and gathering, foraging, and fishing? Some of those cultures remain vital. We could set aside areas to reinstitute and protect that kind of culture. Obviously, foragers are much more flexible in terms of movement within their territory. If territories were extended north and south and upland, then threats from climate change would be minimized, relatively speaking. Can we design a cooperative transition to a series of eutopian nations? Can we design new global human group norms? That is, can we incorporate new behaviors into a culture consciously?

Design needs to consider the entire frame of human history, to recognize that anthropogenic environmental change has resulted in catastrophes to some human cultures, and that those cultures disappeared or were radically changed. Design will have to consider the entire global human population, and show ways that the populations can be lowered to those indefinitely supported by ecosystem limits.

Design can present visible limits on the size and consumption rates of the human demomass, as a global phenomenon, then suggest ways for us to respect those limits while still producing enough material food and goods for human needs. Many of these limits will be global as well as local, so the local will have to be defined as a percentage of the global.

We can effect the cultural uses of materials and energy. Design can create soft energy paths to reduce the dependence on fossil fuels, urges Amory Lovins. It might consider the hard technology of nuclear fission or fusion, if standards for safety and continuity can be set and met, urges James Lovelock and others. Certainly soft energy paths can be used to reduce use of fossil fuels. Conservation alone could cut demand by half or more. Otherwise the immense flows of renewable energies will cause more problems. Design can reduce demands through

vernacular building designs. Part of the problem of energy use is that too much energy is put into the system, which did not develop to handle so much energy. Although technical expertise can provide new sources of energy, it has to be combined with limited use. People have to be convinced to forgo doing everything that is wanted or possible. This is a moral consideration, and design has to suggest ways that cultures can convince people to want to limit their use and its impacts on other species.

8.7.2. *Coevolution of Design and Wildness*

Design should coevolve with wild nature or xemes. Regional design has to evolve with the planet. Thinking ecologically makes us aware of interrelationships. Design is recognizing these global and regional processes and contexts. Design is a primary element to stimulate possibilities.

A framework for design can work at any scale, from a small building, at one end of the scale, to preparing an urban design framework or master plan for an entire planet (or possibly solar system) at the other. Models at global scales may be insufficiently realistic. That is why we need a regional and global design skeleton, a framework, to hang the medi- and micro-models on. The Potsdam Institute for Climate Impact Research, for instance, is constructing a unified, global-scale model that is tractable and isomorphic. It employs one set of quantitative functions to describe all human impacts, all human adaptations to environmental changes, and all impacts of environmental change on humans—this is where design is important, to limit or modify those impacts with a framework of design. Within a framework for planning, we need to be able to accommodate the unplanned and the unimaginable. The framework will be incomplete; it will lack detail and definition, but it can be used by all the participants to coordinate actions within physical, ecological and mutual constraints.

8.7.2.1. *Wild Design*

Thoughtful rational design works well with many kinds of tools and buildings at a small scale. It may not work with wild systems on a global scale. Human agency may be limited, but it could incorporate into its design natural processes that could be effective at the planetary level.

Design works out challenges and problems in an artistic way. Art is wild. We cannot control the effects of art, or even anticipate all of them. We cannot anticipate the changes it might make. That artistic way is a wild way of thinking and can mesh with large-scale design better than a simple technical approach. Design needs to become wild. Wild design is not human-centered, as most all design in the past has been human-centered. Wild design is based on radical ecology (Wittbecker 1978)—it is the push, beyond human interests, to consider the character and patterns of ecosystems. Not to subvert or interfere. We can guess what the system wants with reference to its past behavior. Well, we know what it wants: To exist, to regenerate. We need to create the conditions for the system to flourish. And, if we use any of it, it has to be limited to that level of productivity that does not interfere with the survival of the system. We are reintervening in a natural system at different levels rather than using or interfering for human benefit.

The word design is modified in this sense to be power with natural processes, not power over them or control of them. Wild design is a conversation across time. We listen, ask, and contribute. We inscribe human stories on the larger stories of the system. Participating means living in the systems. We can reciprocate by giving our bodies back to the system. It cannot

hurt to give our minds to the shape of the system. It is knowing what not to do, as well as what to do, when to do it, if we do it. The future is already connected with the past through the present. It just gets complex and unpredictable away from the present. Too complex.

Wild design has to be heroic, especially due to the scale of working on a global level. Heroic design and extravagance in life is needed. It is not contradictory or antithetical to frugal lifestyles or restoring a healthy environment. Life is exuberant; energy is used, lives are lived and used, not saved. Wild ideas are needed. For monitoring natural systems. For closing local loops in energy or matter. In closely linked webs. For increasing connections and collaborations. Our cultures, made more intense in cities and by technology, like the web, can be the incubators of new forms.

8.7.2.2. *Restoring Balance*

As the natural balances are upset by human settlements, the settlements also suffer. C.A. Doxiades discusses the need for a global ecological balance. He suggests a scientific analysis of such a balance to replace luck, and trial and error limits (or as Buckminster Fuller states, the “trial and error error error”), of hunters and cultivators. But we cannot wait until we learn.

To achieve a global ecological balance, we need to set goals for each kind of ecological spaces. We need the concept and goals for the overall system, also, to have the local ones make sense. We also need to have a global coordinating body like the UN to design and implement a global ecological balance. And, at a regional level, nations and communities can go further balancing regions and locales.

Design will have to balance the gains and losses on a regional scale. It will have to do it in an equitable manner, with attention to past and current inequities between cultures and peoples, between regions and economies.

Obviously, redesigning regions means redesigning human structures, paths and influences. Trying to change the patterns of consumption to conserve the capital of nature. Trying to limit human influence. Trying to contain human mass to a limited area of the planet. Simple conservation makes the most sense, as we just reduce the flows, and have less to bury or deep-place in the ocean, or to avoid using solar screens or aerosols. Efficiency alone promotes more consumption, therefore conservation must limit quantities and uses.

We can create thought experiments for all these situations. We can create possible scenarios for dealing with them. We can create ways to reduce the possibility of catastrophe. We have had catastrophes. We may always have them. Bacteria and earthquakes are part of the entire system, as are asteroids and irrationality. And, we have adapted to change. We can adapt to almost anything, Rene Dubos worries, from overcrowded slums to a hot desert world. So, we need to balance our ability to adapt with our strength at making goals. These approaches will be the best bet to reduce the patterns that may influence global warming, extinctions, and ecosystem conversions. And, they may lead to better places for human beings as well.

8.8. *Designing Regions Politically*

Humans have never designed regions. They have never designed cultures or nations, either. Basing designs on traditional cultures and on the properties and limits of regions or ecosystems should make such designs useful. Any design also would have to consider political functions at the appropriate levels—global, regional, national, and personal.

8.8.1. *Advancing National Functions*

The nation (or union or federation) is experienced on a smaller frame of reference than global unity or groups of nations; people live on the local level. Local knowledge is knowledge in place, earned in place by generations of inhabitants, through visions and trials, experience, and stories. Knowledge of the regional level is becoming more important. Thus, individuals are preserved in societies that are preserved in places that are preserved by individuals and societies. Laws, politics, architecture, sports are things of place. They are shaped with local and regional knowledge. A local area is limited by the limits of vision, a horizon. As protectors of place, nations have five explicit functions.

8.8.1.1. To Conserve Local Ecosystems and Places & the Region

Nations have the responsibility of keeping their environment healthy. Human activities cannot be isolated from societies or ecosystems. Cultures must adapt to ecosystems or biological regions to survive. All beings modify and exploit the earth to some extent. Humans do. For successful exploitation, power must be limited and density controlled. A human ecology must provide each living human being with a satisfactory environment that must be in equilibrium with the rest of the system.

8.8.1.2. To Manage Local Resources with Appropriate Technology

Every nation has the power to use its local sources in any manner, within the limits of regional and global damage and pollution set by the United Nations. Every nation has the duty to conduct activities in a manner respectful of their effects. With information available now, from a more extended resource inventory and with optimal ideas about renewal, climatic conditions, traditional land-use patterns, local cycles, and ecological requirements (limits), conservation is more effective. Its goal is to support a steady state economy within satisfactory ranges based on natural and human limits. Every nation that claims sovereignty accepts responsibility for keeping its population within the limits of its place—that is, the ecological and cultural carrying capacity.

Technology can be used to increase carrying capacity to some extent, but not infinitely. Although, technologies tend to homogenize people and places, the same technologies may be used in different ways, especially adapted to local requirements, for instance, the use of tin cans as cases for radios. Heterogeneity is beneficial to all countries; it enriches the cultural resources, provides niches for individuals, and supplies many patterns that may be adapted. It also increases the speed of cultural evolution or the richness of exchange. A nation could promote appropriate technology for its region. Dangerous technologies would be reduced through wholesale substitution, if not of materials, than by labor-intensive solutions. Traditional housing, for instance would be preferred; its form and design are integrated into the culture, it

is adapted to the local climate and is usually less expensive, due to use of local materials. Much traditional architecture is authentic and unselfconscious; its forms fit the context of place and develop in response to place. With arcologies (the urban ecologies designed by Paolo Soleri), the city can change its relationship with nature; an arcology is a good solution for an urban culture, as it solves the problems of waste, resource-use, scale, obsolescence, and segregation.

8.8.1.3. To Maintain the Health of Cultures & Individuals

Traditional cultures provide personal security, respect for the individual, responsibility for actions (self-discipline), social integration, concern for others, and reverence for nature. Traditional social structures, with networks of marital relations, inheritance, and rationalizing myths, are closely adapted to the local environment. Preservation of identity appeals to qualities inherent in established ways and to people's desire to maintain their distinctive customs against change. There are also esthetic reasons for preservation: To preserve styles, merit, and achievement. Ethnic identity and consciousness of gender make finer grids of groups. Devotion to groups, clubs, corporations, teams, co-ops, can provide a better individual identity. Distinct cultures allow different frames of accomplishment. The sum of cultures provides a greater sum of accomplishments. Cultural identity is necessary to the benefit of places. Nations educate their members; they are responsible for the ecology, numeracy, and literacy necessary for individual survival and actualization within the culture. The emphasis would be local: Local culture, history, geology, botany, and economics. Cultural education may not emphasize competition or excellence for economic or political purposes, as is so often done in industrial cultures.

8.8.1.4. To Provide Power for Individuals (Political Self-rule)

Politics can start at the community, over community issues, like housing, transportation, or pollution. People need to save their own identities and places first from corruption and degradation. Power can be shifted to local levels through self-reliance and participation. The function of politics is to ensure that decisions are taken at the right level. A nation protects individual freedoms, guards regional culture (values and identity), and holds groups accountable for the use of power. The size of nations would be defined by place and culture. There can be no separation of politics and ecology. Every political act has ecological consequences and every ecological decision is a political demand for control over use of the environment. The restriction of freedom, either through tyranny, cultural uniformity, or crowding, results in a decrease of variety, which is created by spontaneous play, which is necessary to flexible and enduring social systems. It is not necessary to prescribe forms of government and administration for peoples.

Many forms of government that are size-specific, such as democracy and communism, could be possible in scaled nations. Although the smallness of cultural units would not guarantee freedom, with a smaller scale tyranny the tyrant is visible and corrective action possible and more likely. In the eutopian approach, groups may pursue anarchistic isolationism or disinterested inter-republicanism. What matters is not perfection, but the basic value orientation of the polity. The developed countries may prefer Jefferson's republican simplicity to Hamilton's national power and commercial complexity; other countries may prefer Gandhi's vision or Marx's communism. China or Greece may provide some alternatives; others may be invented. The logic of individualism creates conditions that require constraints. Politics has

to make them palatable. Although we realize that nothing in nature is without some limit or cost, we may dislike giving up what we now consider (wrongly) as rights. Some nations may have to accept that there are too many people, wanting too much, and that we have to change our wants and ways to achieve them. People may have to expect much less than they want, even though many expectations are rising. Planning and regulation does not necessarily reduce individual freedoms, certainly not as much as poverty and crowding.

8.8.1.5. To Provide for Needs of the Individual (Economic Self-reliance).

One necessary condition for the preservation of finite resources is sovereign power. To share resources without the discipline of power invites a tragedy of the commons. The limit of sharing has to coincide with the limit of sovereignty; otherwise runaway destruction could result. Every nation has the responsibility to conduct its economy without causing damage to its ecological base or to other nations. Environmental risks and damages must be identified and solutions found before economic processes can be implemented.

Every nation strives for self-reliance. Communities can be self-reliant by producing enough food and shelter, by limiting their population to what can be produced, by sharing tools, by recycling and repairing, by using handicrafts rather than manufactures (shoes, furniture), by using local products and raw materials (soil, minerals, plants), by using general and not specialized machines, by having multipurpose factories, by networking with other communities, and by doing without things that are not needed (e.g., bombs, food additives, plastic bottles). Food would be produced and available within local groups, so there would be no reliance on large-scale food production and distribution. Local production would eliminate transportation cost and waste and diminish dependency.

Many leaders of nonindustrial areas have attempted to reduce links with overindustrialized areas. They have attempted to balance population and resources on a local level; they have placed local values before international ones. Julius Nyerere in Tanzania promoted an African socialism. Mao Tse-Tung placed the peasant before the urban dweller in China. For India, Gandhi envisioned a familiarization of society, where property had a common ownership. Each village was a complete nation, independent of its neighbors for vital needs, characterized by self-rule and self-restraint.

National control would mean the regionalization of transportation and communication, the administration of social services by a smaller and more responsive bureaucracy, and the resurgence of more direct forms of economic interaction, such as labor-gift and barter exchange in local neighborhoods. A free market system involving each nation could work; one major difference is that supply would be regulated by the United Nations. Nations could coordinate worker controlled industries and producers cooperatives (forged from kinship or cooperation). Credit unions and mutual insurances could replace big banks and insurance companies. The nature of work could change with a change in scale; it would be self-determining and nonexploitative, resulting in greater harmony between worker and employer.

Traditional cultures often have wealth-leveling properties, absolute property ceilings, fixed wants, and production coupled with need; these can result in a stable economy. Efficiency and productivity are less important than use and appropriateness. Advertising, the creation of desires and needs, is less important in face-to-face economies. In a small state, people can decide how to use scarce resources and how to distribute them. They can decide whether to be conservatively sustainable or to grow and gamble on innovation and substitution.

8.8.2. *Considering a Realistic Argument*

For most people in agrarian countries, even freedom from hunger and sickness is utopian. For most people in industrial countries, the choice of a fulfilling profession is utopian. Grinding poverty, economic dislocation, homelessness, are more painful than a transformation to a new global order would be. Already most cultures have been transformed by cash crops, mining, tourists, highways, high-rise housing, and condominiums.

Industrial cultures have replaced older patterns with great suddenness. A new regional or global government cannot seem more sudden than the loss of a home or place. Industrial cultures have reduced people's control over the means of production and power. A new regional framework would not offer less control. Whole communities have been destroyed by industrial scale. Our social structures are already changing rapidly and impractically. Let us just make the changes conscious and more practical. A framework would offer movement towards common, achievable goals. Its variability would insure that we could reject any of the local visions that fail. There will be questions regarding the breakup into more natural cultural divisions. Some will want to decide boundaries by ecosystem; others through culture, watershed, or political power.

There will continue to be problems. Cutting trees in Nepal causes floods in Bangladesh, and floods cause deaths because overcrowding has forced the poorest people to live on flood plains. The poor in the highlands everywhere effect those in lowlands, often adversely. The quest for ecological balance means that some ecosystems must be maintained by systems managers, who often overmanage. The larger the human impact, the more control is necessary.

People cannot be given material equality instantly. But, things can be leveled within a culture; cultures with excess may be taxed by regional or global bodies. Providing work for everyone is one way to narrow income differences. A framework, communities, and families must provide it. Worthwhile work requires imagination. The large work force employed by military contracts in industrial countries will be dislocated at first, but that employment is supported by taxes, which could be reallocated for construction and deconstruction of the many highways, manufacturing plants and abandoned buildings.

Crime and civic unrest will not disappear. A regional rule could reduce many kinds of victimless crimes with new policies. Because most cultures have strong policies regarding drugs, abortion, and prostitution, among other things, any framework would not impose rules on every crime. Dangerous weapons, from automatic guns to tanks, and dangerous products, including nuclear reactors and biocides, would be strictly regulated.

People will still choose badly in a new framework. If a form of government is bad or ineffective, they could alter it. In a new framework, they can learn from mistakes or unintended side-effects—as when doing good causes evil. The scale is small, so the catastrophe is small. There will always be some injustice or unpredictability. Large political and economic institutions have only made it worse. If a regional union or UN turns out not to be the proper framework to solve these problems, it might lead to a better way.

People may object to giving up too much or not gaining enough. Natural environments and human societies are wobbling. Opposite impulses are leading to imbalance; some countries want to consolidate into economic powers and others want to secede into independent units. Human civilization will tear itself apart unless we slow it down and direct it.

The need to maintain our comfortable status for as long as possible, fatalism that

nothing can be done or it is too late, prejudice, ignorance—all are keeping us from moving. There are other unnecessary reasons not to move: Failure of knowledge, failure of communication, failure of imagination, and failure of nerve. Much human suffering is caused by self-deception, which leads to isolation and then anger, reaction, and more suffering. Real change is difficult in this state, but change is more difficult for the starving or oppressed.

To minimize untested conclusions, regional actions should be based on the values and forms of traditional cultures. Rational planning can catch up as it develops. The framework is an open, flexible, and partially-planned global relation, instead of a finished, closed, completely-planned society, as imagined in utopias. We need to accept the imperfect nature of humans and the changing ambiguity of nature. We need to detoxify cultural rivalries. Racism, sexism, ageism, and speciesism should lose their importance in a cooperative society of advanced communication, automation, equality, humane scale, and meaningful preservation.

We need to address the inadequacies of the present system and pursue a drastic system change from the institutional gridlock of elitism, but not so drastic that the feasibility of acceptance is too low. The benefits must be worthwhile to justify the costs. The benefits cannot be vague and unsatisfying when the costs are immediate and painful. Communication and education must prove that the benefits exist, so that the alternative can be called. It must be a participatory movement, and it must appeal to a large segment of the total human society. Since not all interests will be satisfied, there must be opportunities for transformations or for alternate paths.

We have to invest and cultivate our inheritance. We must enlarge our human identity, to include other beings and the earth, to include our own posterity and its image of the future, without which we lose the will and capacity to solve problems. Creating the future is necessary to maintain the present. It is meaningful to construct a world that we will never live to see, to plant trees that take two hundred years to mature, to save some of the forests and soils—not for the oil and timber elite or even for the backpacking elite, not for social abstractions or for personal profit, but for our heirs and the other beings we share the planet with. The best way to accomplish this might be through a regional and global eutopian framework.

8.8.3. Implementing Eutopian Actions at Regional Levels

Utopias are the inventions of great visions; Eutopias are the inventions of small, good actions, local and regional—perhaps later there will be enough time for greatness. Where utopias offer revelations promising a desired future, Eutopias offers limited references for improving our situation now. There is no mechanical prescription for making good places; there is no blueprint or timetable. This work is not a presentation of another utopia—it is a comprehensive vision including political, social, and economic principles, as well as psychological, architectural, and ecological ones, not usually included in utopias. No details of societies are presented here; there is no description of a new consciousness or a new elite. It is an outline of a framework for the creation of good places in times of catastrophe.

8.8.3.1. Acquiring Awareness of Catastrophes

Catastrophe has its own psychology. Humankind possesses incredible scientific evidence of environmental wobble, biological imbalances, and the unfitness of many domestic species, but knowledge moves few to action. Catastrophes, on the other hand, concentrate attention forcefully. When a dam breaks, millions of people mobilize to meet the emergency. When the

earth quakes or volcanoes erupt, the emergencies are met quickly. The psychological effects of a hurricane—fear of suffering and dread of loss, accompanied by exhilaration—have admirable side-effects; the definiteness of danger and the immediacy arouse women, men, and children to great heights of cooperation. People react admirably to catastrophe. They choose sensible directions and agree to practical expedients. War also produces relatively fast, far-sighted—if wrong-headed—policies. War is actually stimulating to many individuals and often produces a national determination and purpose that peacetime does not. War unites whole peoples in a common cause. There are times when human beings face rapid and catastrophic change without chaos. Social systems can adjust if there are popular reasons.

Immediate foreknowledge provokes a greater response than indefinite expectations: hurricanes occur periodically, but not always in the next three hours. Probably nothing will be done until catastrophes become common experiences. As choices become more important, more urgent, errors are more disastrous. It should not take catastrophes to precipitate corrective measures. There are millions of people starving every month in India and Africa, and others in Europe, the Pacific, and the Americas. This is a catastrophe, although it is slow, constant, and distant, and perhaps because of that, it is neglected. Perhaps distance limits the ability of people to react to problems.

Furthermore, whole species are disappearing, and whole ecosystems are wobbling, from exploitation, desertification, and pollution. Environmental deterioration proceeds so slowly that the change is invisible, that is, until a catastrophic threshold is crossed. Those catastrophes, in places from the Tigris and Euphrates to northern Africa, seem to be long-term. The trouble with complex, self-regulating systems is that very small changes have large consequences—shifted rainfall patterns caused whole cultures to disappear. In some cases, where conditions, like drought, are cyclic, in the Sahel region of Africa, humans expand during the good times, only to perish when the drought returns. In other cases, human activities, such as deforestation or overgrazing of herds, can cause rapid climatic changes. The scale and rate makes our situation seem natural, but that is because it has been a slow catastrophe, just now approaching the threshold.

If we could precipitate a disaster psychology for slow environmental catastrophes, then the priorities and motives of people might be changed. But how should everyone be convinced that there is a crisis? The change is so slow: fewer eagles, fewer salmon, more people, more beverage cans. The causes are so complex, and responsibility is so difficult to assign. Unfortunately, a history or theory of catastrophes does not engage us. People need to feel situations before they act, and people will need to feel themselves as part of a delicate web of relationships before they act with ecological wisdom, as once they had to feel that the earth was round by going around it, as lately they had to see that the earth was an oasis in space by leaving it. Random, uncontrollable fate or slow, inexorable degradation causes little anxiety.

Humanity is enormously adaptable and resilient. We can probably survive most physical or social conditions by adjusting to them; for example, overcrowding and smog are acceptable in some areas. But adaptation has its own dangers. We might become less humane, less creative, less concerned with starvation, suffering, crowding, or destruction. Our goal should not be to survive under any conditions, however difficult and unpleasant. Our goal should be to create an optimal life in an optimal environment. We need to adapt consciously to slow catastrophes. The environment is changing too fast for genetic adaptation, so our change will have to be psychological and social. Social changes can occur very rapidly when the time

is right for them. Oil-producing nations, for instance, became financial equals of industrial countries within months. Pressures are building for radical change.

8.8.3.2. Acting Immediately to Implement Measures

A eutopian framework could be implemented immediately. Most global studies state or imply that change cannot be fast, that people cannot adjust, that social disruption would result, and that chaos would finish what ignorance and technology could not. Their most serious drawback is the time of implementation. The first Club of Rome report claims a 20-year feedback lag. *The Ecologist* plan cites a social inability to adapt to rapid change; the attempt would be self-defeating. Everyone assumes the time scale remaining before collapse will be long enough for their plans to be implemented. But these studies also propose slow, long-range plans, while warning at the same time that the earth is facing imminent, drastic change. If their plans are implemented too slowly, and if the population or pollution doubles again, surpassing some unrecognized critical level, there would be worse disruption.

A long view seems meaningless when so much suffering or destruction already exists. An immediate, realistic, coordinated program of action is needed, capable of being implemented by communities and global agencies. We must face our responsibilities directly, declaring that there is no place in a eutopian society for monopolistic and multinational corporations, for the maniacal religion of merchandise, for genocidal military establishments, for urban explosion, for state socialism, for overbearing bureaucracies, or for technocratic politics, we must act to end them. The declaration must be political, through cooperative networks or leaderless consensus, by persuasion and example. The problem of human existence on the planet must be approached without deference to artificial boundaries of states, races, or castes. Poverty, pollution, repression, are concerns of every human community. We must stand and state that nature has limits, that we cannot have all we want.

The application must be immediate. The crisis of exponential growth and destruction cannot be solved just after some final limit is approached or passed, or before a final exponential doubling. The crisis of ignorance cannot be solved by hurrying ahead and creating more problems. Paradoxically, the best thing to do is stop—stop growing, stop producing, stop running; suspend the race and contemplate a direction. We have been asking how the earth will survive its human populations and how they can be lowered. Let us just freeze growth and see what happens. Let us just freeze the populations—a year or decade of no births. We know that whole countries have lost a generation and continued. We know they have rebuilt again from ruins. We could build from recycled materials alone, so there is nothing to fear from stopping. Immediate social reforms, the reallocation of resources, and the preservation of wilderness are necessary, because of the nature of the problem; we cannot predict global climatic or ecosystemic catastrophes. Substantive change and research cannot be delayed until academic controversies are resolved.

Earth parks, in the Antarctic, Amazon, Arctic, and Oceanic areas would be declared immediately. Ecosystem restoration would begin; massive planting efforts would be undertaken. No further expansions would be permitted for development in wetlands or other sensitive areas. Destructive searches for resources would be suspended, in favor of substitution and recycling. No new building would be encouraged until uninhabited ones are restored. Then everyone would have time to participate in design.

8.8.3.3. Accomplishing it Everywhere All at Once

The transformation must be complete; it cannot be done partially. Global political and economic institutions have to change, as do regional ones. A global organization must have authority for the preservation of nature and human cultures. Holistic change will permit the reorientation and balance of local institutions. For example, air pollution is not independent of industrial processes, transportation, and employment patterns. Communities must be of a size that their members can feel responsible for them. These changes are demanded by new situations, ecological balance primarily among them. New institutions must be compatible with these new values.

The approach must be pragmatic and flexible. By its nature, the eutopian frame could reduce some of the stresses of transition, the uncertainty, ambivalence, or reversion. The readjustment to the realities of our new intricate involvement in the whole order of nature and her ecological balance will cause social swains. Some capital of energy and materials may be wasted. Population will be matched to solar budgets or net ecosystem productivities. Production will be redirected to communal needs in transportation, housing, food, and recreation.

For most people in agrarian countries, even freedom from hunger and sickness is utopian. For most people in industrial countries, the choice of a fulfilling profession is utopian. Grinding poverty, economic dislocation, homelessness, are more painful than a transformation to a eutopian framework. Already most cultures have been transformed by cash crops, mining, tourists, highways, high-rise housing, and condominiums. Physical disruption has been more extensive than the transition to the framework could cause.

Industrial cultures have replaced older patterns with great suddenness. Eutopias cannot seem more sudden than the loss of a home or place. Industrial cultures have reduced people's control over the means of production and power. Eutopias does not offer less control. Whole communities have been destroyed by industrial scale. Our social structures are already changing rapidly and impractically. Let us just make the changes conscious and more practical. Eutopias offers movement towards common, achievable goals. Eutopias would be a framework for cultures and regions, where different human experiments are tried. Its variability would insure that we could reject any of the local visions that fail. Eutopias may be called anti-human, anti-progress, anti-scientific, anti-technological, or anti-educational, but it is merely a new framework for conducting traditional human activities.

8.8.4. *Working All Together*

Taking these steps would solve many of the problems addressed earlier. The satisfaction of physical and cultural needs, as a result of living in stable and small societies, would contribute to the health of people. Fitting economic costs and needs to the limits of ecosystems and monitoring the economic process would reduce wastes and pressures on natural processes. The coupling of agricultural productivity to a solar budget, and the conscious restoration of degraded systems, would contribute to the health of ecosystems. Sufficient wilderness would allow the self-maintenance of global cycles. With the increase in security, wealth, and self-esteem, human populations could be dependent on ecosystem productivities and still be diverse and unique.

With the removal of war capabilities and the equalization of wealth, the remaining issues are not the kind to incite violent passions. Disagreements over the best way to raise wheat or

maintain a forest may be more easily resolved than deciding the best nation or truest religion. The death of large-scale dogmatic ideology and national idolatry could also mean the end of organized slaughter. We have to perfect the art of resolving conflict. Mastering it through social debate would free unprecedented resources to satisfy social needs. Perhaps a planetary electronic referendum would open communication. In designing the planet, everyone can participate. We can reduce the violence to nature and ourselves and transmute it to debate. That which has been hitherto left unsaid—what we want to become, what we could become—could become explicit.

Human ills cannot be cured by a return to idyllic hunting and gathering groups or to a quasi-agricultural, ecologically-caring society. There is no possibility of complete return. Most industrial nations are urban; agricultural countries pack their surplus peoples in cities. Nor can there be a return to 4th century B.C. Greece, or to 17th century China, or to 1910 France, or to any time. Many traditional cultures no longer exist; others are disintegrating under pressure from industrial cultures. Nor can there be a jump to a complete technological future, where technology transforms hydrogen into wealth for everyone. Eutopias works with traditional cultures and realistic planning.

Detailed designing and planning of complex open systems is not necessary. Designers or planners are not in a position to attempt detailed models of future situations because many relevant parameters remain unidentified, and many of those known cannot be quantified. Plans can be made within the limits of variables, although it is not safe to be limited by lethal variables, as Gregory Bateson recognized; closeness to limits reduces flexibility, that is, uncommitted potential for change. To minimize untested conclusions, Eutopias is based on the values and forms of traditional cultures. This could allow rational planning to catch up.

The eutopian framework is an open, flexible, and partially-planned global relation, instead of a finished, closed, completely-planned society, as imagined in utopias. Eutopias accepts the imperfect nature of humans and the changing ambiguity of nature. Eutopias detoxifies cultural rivalries. Racism, sexism, ageism, and speciesism lose their importance in a cooperative society of advanced communication, automation, equality, humane scale, and meaningful preservation.

Now is the time to define goals in terms of population, quality of life, and preservation of biomes. Resolving conflict through social debate would free unprecedented resources to satisfy social needs. That which has been hitherto left unsaid—the goals of humanity—could become explicit. Goals are not some final state reached once and for all time, but a horizon. Eutopias offers continuity between goals, designs, and practical implementations.

Science presents us with too many facts, yet we crave to have more. Philosophy presents us with too many values, but we hold too few. Technology presents us with too many things, but we do not know what we really need. There may be too many futures to choose from, but we can limit them to three possibilities: The fake ones, with amenities for some and cute lodges in tame wildernesses surrounded by wastes; the technical ones, with maybe a real fenced-in wilderness, and some kind of technological scheme of a world city; and a eutopian one, based on cultural wisdom, traditional forms and an ecological sensitivity.

We should not underestimate the evolutionary potential of small cultures. We can afford to 'lose control' of other cultures, to allow their variability and experimentation. We do not need more information or rules, but we need meaningful ideas. Our attitudes and feelings toward nature need to be revitalized with evocative metaphors that let us accept responsibility

for the part of the earth that we build, namely human culture and human landscapes. In order to know what is important and what is valuable, we need wisdom. We can start by listening to the pragmatic wisdom of the whole planetary system, with its billions of years of running itself. We can let it organize and evolve itself to create diversity and uniformity, work and beauty.

Wisdom begins with knowledge of the larger interactive system, which if disturbed, can generate exponential curves of change. Wisdom is the recognition of and guidance by a knowledge of the total system. Lacking wisdom, we must behave “as if” we were wise, as if we had good sense (after the ideas of Hans Vaihinger and Jonas Salk). Humans have no choice but to live by fictions, as if this world is the ultimate reality, as if we are responsible for our actions. Humanity must plan for its future as if its days were not counted (or at least for several thousand years). Wisdom is a new kind of fitness. To survive, we must accommodate ourselves to the conditions of the earth.

Wisdom can be redefined as the disciplined use of the imagination with respect to alternatives, exercised at the right time and in the right measure. But we need practical wisdom, prudence, and intellectual control in virtue, in place of the theoretical wisdom taught by schools. The truths of our unique cultures and the wild earth are apprehended through myths. The poetic language of mythology can fit all the facts and values, things and images, into our hearts so that we can feel them and act upon them—so that we can make good places in regions and in the planet.

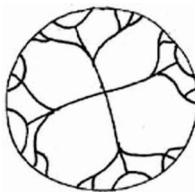


Figure 884-1. Trademark of the G.P. Marsh Institute 1976

8.9. *Wisdom & Action: Do Wisely, Do Now!*

Historically, we humans have used our skills and images to improve our lives and places. We have used our inventiveness to increase our ability to survive and to reproduce, as well as for our comfort and wealth. We have persevered despite many challenges and problems that have killed or impoverished many people or whole cultures at times. We have survived ecosystem collapses and cultural collapses. We have survived droughts and freezes. We have survived diseases and our own self-directed wars of conquest.

We have used tools to change places and some of the processes of nature. We have used technologies to protect our plants from insects and our towns from invasion. We have created the possibilities of unprecedented luxuries and wealth. We have made designs for stimulation or profit, more than for safety or elegance.

But, we have failed to understand much of the detail and scale of nature. We have failed to use our imaginations for things beyond luxury or excitement. We have failed to share new wealth with most others or to share much of the planet with ultrahuman beings. We have failed to create designs that would incorporate us within the limits and cycles of ecological processes. We have failed to have the nerve or courage to try, since it would inconvenience some or disrupt the wealth of a few.

We have the conceptual tools. We have religions that bind us to cultures and places—that teach us simplicity and charity. We have sciences that allow us to learn ever more about ourselves and nature—that teach us humility and resourcefulness. We have words and metaphors that can produce strong flexible images to guide our learning and decisions. We have the ability to create thought experiments and fundamental analyses of problems and catastrophic situations. We have the creativity to make ecological designs on a regional and global scale, to protect the supportive flows that result from a living planet. We have the ability to expand our consciousness to include an ecological perspective of our situation. We have the possibility to share and open ourselves in a eutopian effort to balance the use of a common planet.

But, we have been seduced by our brilliance. We have become trapped by the changes we made to eating and living—by our close adaptations to agriculture and cities. We have become too comfortable in our habits and pleasures. We have allowed growth and inequity, dominance and slavery, to continue because it has become part of our perceived patterns of economic success. We have allowed intolerance, conflict and war to continue because they are perceived as unavoidable products of our success.

8.9.1. *Humility & Wildness*

Now, we are beginning to recognize that the scale of problems has become regional and global. We intuit that our economic styles, expanded to a global level, may not be healthy or sustainable. We allow corporations to enjoy unprecedented benefits from a minimum of regulations, because we think that they are necessary to continue the growth we think we need to be prosperous and happy. We start to question whether our modern cosmology—in the image of a machine—is appropriate to understand or relate to living beings, systems, and cycles. We are starting to realize that traditional and archaic cultures were more attuned to their ecological places, and to suggested limits that allowed them to fit into their

surrounding ecosystems. We are beginning to realize that the scale of our changes is affecting the atmosphere and oceans, that we are making things change out of the range of desirable conditions. We worry that every region and the entire planet is wobbling and fragile and could change into a configuration that is not pleasant for us or for the large charismatic mammals we love—from polar bears and whales to tigers and wolves. Maybe, Gaia will turn out to be the kind of wicked mother who may not favor human children above other children, or mammals above insects or reptiles.

We have started to save animals and plants, species and habitats. We have started to design ecovillages and more efficient automobiles. We have started to create standards for more intelligent buildings and roads. We have started to talk about and sketch whole communities or cities that may fit into specific places.

But, we are not thinking about all cities or all roads, not the planetary patterns that overwhelm places and movements of species. We are not paying attention to changes in scale or meaning. We are not considering some kind of economic equalization or the limits to our economic growth. We are not saving entire systems.

We need to understand the spheres and cycles of a living planet. Then we need to start to redesign our activities so that they are in line with these cycles. We need to identify areas to preserve or restore as wilderness, by making sure that they are the right shape and size to continue as self-making entities. We especially need to consider forests and many kinds of animals. We need to understand the factors that may act as triggers of change: Our conversion of ecosystems into domestic lands, the use of commons, or the scale of industrial manufacturing. We need to analyze our adaptive patterns, from agriculture and technology to urbanization and industrialization, and then understand how they developed and became dominant forms of exploitation of places and systems. Then we need to redesign them for the appropriate local or global scales. We need to design ecological cultures based on archaic one, without giving up the benefits of some urban civilizations.

We need to rethink design, to make it ecological and regional. We need to apply ecological design to local ecosystems, whether forests and streams or cities and fields. We need to consider the design of regional areas, from common areas that are used for many cultures, and where natural processes, migrations, and exploitations are allowed to continue. We need to design areas that are independent of national boundaries, where animals and plants can migrate or move freely.

We need to rethink culture, to analyze the weaknesses and strengths of traditional cultures. We need to create a framework to fit cultures with the limits of human activity as well as within the limits of ecosystems and regions. We need to redesign economics and politics through an understanding of what their functions and goals really are. We need to create adequate legal forms for nations and nonhuman nations and the planet. We need to approach the planet through one framework of decisions, a framework based on understanding and shared goals.

We need a wild design to solve these large global wicked problems. We need to be surveying and monitoring so we know enough to design and act. We need to be preserving and restoring as much as we think the planet needs. We need a wild design that is based on traditional wisdom and known operating limits to address these problems all at once. We need a wild design to actually try to create good places using all of our geniuses and strategies over the whole of the planet. We need to do it together and we need to do it now!

8.9.2. *Advertising & Excitement*

Most of all, we need to make design and ecology exciting. The other day, tired of writing, I went to visit friends, who were watching a football game. They were drinking, shouting and throwing things to each other. It was nice; I got to play for a while, too. It occurred to me that only with entertainment industries is there so much technical fireworks and coordinated enthusiastic teamwork. Imagine all that energy and enthusiasm directed to appropriate technology for reforestation or the proper use of fossil fuels. Imagine television coverage of wetland restoration work with the same amount of attention and detail. Why not have a competition for the most beautiful productive forest or teams working to restore devastated city areas—broadcast by a major network as an important event?

Some people have noticed that this remorseless entertainment is an anesthetic against fear, emptiness, self-searching, or death. Continuous entertainment is a kind of guarantee of health, riches, and long-life. Everything that is pleasurable, thought George Orwell, seems to be an attempt to destroy consciousness. Television seems intent on proving him correct. Ecology or design cannot ever compete with entertainment if it raises troubling questions or difficult expectations. As long as the industry can guarantee many happiness and wealth through the arithmetic of fantasy, others of us will always seem to be complainers and false prophets—until it's too late, then we will be blamed for not avoiding the catastrophes.

Good design, good ecology, ecological design, and global design require new images and new language. Getting new images and new language to engineers, politicians, financiers, and landowners, as well as to scientists and industrialists, is problematic. Perhaps poetry, art and design can help, although they are undervalued as forms of communication, not to mention as ways of shaping and making. Business has transformed much of art and poetry into advertising, to match the style and attention span of the people in industrial cultures. Advertising, quite literally from the Wall Street Journal to college textbooks, refers to its activities as “shaping the American dream” or the World Dream. Like art, advertising creates an image of a way of experiencing. Unlike art, it limits its focus for a specific goal—profit. Like art, it mirrors us. Unlike art, it intensifies and glorifies only the positive aspects of culture, ignoring the dark, negative aspects or the complex nonhuman framework.

The simplicity of advertising is irresistible. Our environment deteriorates according to ecologists, but always improves according to economists (who require it to improve to make a profit). And their pictures are much prettier. People want to hear that it is getting better. Advertising tells them it is. People want to act stupid, greedy, and selfish, and spend the inheritance of their children on themselves. Advertising tells them these actions are normal and rewarded. The real issues of life and death, destruction and hope, make people feel helpless and anxious, so advertising draws their consciousness to comfortable trivia.

Despite the limits of the dreams of progress and growth, of waste and stylistic frenzy, advertising, using sophisticated techniques and narrowing the focus out of context, makes the dreams desirable and irresistible. People in agricultural and hunting cultures interiorize the abstract industrial vision. African farmers are convinced to buy inorganic fertilizers, even though it degrades the soil; women to buy powdered milk for their children, even if it kills them; tractors replace draft animals in the paddies in the Philippines, even though they are costly and less energy-efficient; French winter fashions are found desirable in tropical Brazil, even if they can only be worn in air-conditioned villas. People in industrial societies are

convinced that their children will be ruined without personal computers, even if they become isolated game-players, unconcerned with wildness in remote locations.

Advertising has been serving the dream of progress, but progress is leading to catastrophe, a long, slow, global catastrophe. When people experience local, sudden catastrophe, they usually respond immediately, with heroism and sacrifice, aiding the victims of earthquakes or floods, or sometimes famines. Advertising could bring to consciousness the slow catastrophes of erosion and the destruction of entire forests, and, perhaps, invoke the same altruistic responses to them.

Advertising may be the most effective means to reshape desires and reform buying habits, as well as where and how we live. Advertising presents the symbols of modern experience effectively, even if they are just the trivial ones. It could present healthy symbols equally well. Advertising does incorporate traditional values, like family, friendship, and love, although to sell beer and cereal and, sometimes, churches and hospitals. And, like art, advertising lies, although Jules Henry thought it might be a new kind of truth—"pecuniary pseudo-truth"—not intended to be believed, or certainly, proved.

Advertising is beginning to support more informational functions, such as the dangers of drug abuse and smoking. Advertising also can create values—fur coats, fast cars, dark beer, slim cigarettes are certainly recent and artificial values—but it could be used to create positive ecological values and new identities that show that our needs for prestige, esteem, and belonging can be met without stylistic waste at mindless speeds. Advertising could promote new attitudes about appropriate technology, the rights of other cultures, and the place of people in nature. Good advertising could be as subversive and conservative as design or ecology (Pablo Picasso said art was subversive; Paul Shepard called ecology subversive). Good ecological advertising could avoid confrontation with people's values and emphasize positive aspects without negative ones. A good ad could capture and carry the most self-indulgent viewer—after all, for the most part, ads don't require effort or literacy, just attention.

Maybe we can present images that rival the industry images. Maybe we too can speak the languages of euphemism that large corporations use to conduct their businesses of larceny and fraud. Positive images and pleasing language skills are everything these days; no one really looks for substance. The devotion to money, beauty and youth is the old focus. Maybe that could be subverted with the beauty and wealth of nature.

To work towards this goal, ecological design groups, with conservation groups, preservationists, sportspersons, politicians, and actors, could define and promote an integrative mythology as the basis for the framework of diverse efforts to protect life and the environment in the whole planet. Ecological organizations could provide a meaningful philosophical foundation, as well as coordination for other humane, social, and conservation programs. But, the approach must be egalitarian: Respect for life cannot neglect human life and suffering. The approach must be eutopian: A new cosmology cannot ignore adaptive cultural traditions that arose in place over centuries. Furthermore, in addition to formal education, groups could fund and provide re-education through the most effective means, such as advertising. Wildlife groups could spend money advertising "humane consciousness," moderation, and the joy of living—instead of just consuming or winning. Ecological design ads would be unique and compelling, simple and effective. They could present our goals and successes, the importance of our efforts to redesign out human structures to protect and restore the planet. They would advertise not a product, but a way, not for a profit, but for a dream. We have to start *now*!

8.9.3. *Can One Form an Attachment to a Region?*

Do we start by loving the region around us? Obviously, we can love ourselves and families and friends, even other animals and plants, but is it meaningful to say that we love our region, much less the planet? Is it some sense of topophilia, or biophilia, or ecophilia? Are those labels too abstract? Perhaps we can understand them philosophically, historically or ecologically.

At a personal level, early foragers became one with the animal hunted or seeds collected, to realize that they became part of you, living through you. On the other hand, when the relevant social unit was the tribe or nation, it was possible for the local mythology to represent others outside the bounds as inferior and its local inflection of the universal heritage of mythical imagery as the one, true, supreme image. The young of the group would be trained to love home and hate outsiders. Xenophobia was once adaptive; now it is anachronistic. There are no outsiders, we are all passengers, inhabitants. All dividing gateways on the planet have been opened. We cannot hold our loves at home and project hatred outward.

The concept of tribe and state is growing toward an ecumene, an inhabited earth. Today, there is no outward on earth. Our mythology has to grow also, to include the whole planet. There is no practical elsewhere anymore. A global mythology cannot afford to teach of elsewheres. It must teach of a multiplicity of cosmologies. The difference between cosmologies is not due to the number of phenomena taken into account; it is due to the difference in basic postulates of thought. The difference is not a matter of truth or falsity. Truth and falsity are meaningless for cosmologies. Primordial water is no less true than six-dimensional phase space or primordial ylem. No one group's image is more true or accurate than any other's. Each group views and reconstructs the world through their experiences and values.

During the Renaissance, Christianity became affected by the spirit of affirmation, especially with the discovery and popularization of the teachings of the Stoic and Epicurean schools: Love of man was the virtue above all virtues.

Albert Schweitzer believed that even if we despaired of comprehending the phenomenal world or the plans of God, we would not need to confront the problem of life with utter perplexity, because the ethics of Jesus, reinforced by reason, lead to the reverence for life, whose edict is the rule of universal love. This same reason would find the bridge between love for God, love for man and love for all creatures, and express reverence for all being, however dissimilar to our own, reverence and compassion for all that is called life. Such a foundation for morality forces the realization that when we establish gradations of values between lives, we only judge them in relation to ourselves and that is wholly subjective. How are we to know the importance of each? The principle of reverence for life rejects relativism— "it recognizes as good only the preserving and benefiting of life." Individuals must transform themselves from blind men into seeing ones by following the new commandment: Revere life. The quality of personal existence depends more on it than on laws and prophets; it comprises the whole ethic of love in the deepest sense; it is the source of constant renewal for humanity.

Schweitzer's love was abstract, yet he did not love nature. Part of Schweitzer's dilemma came from the prevailing myth of the opposition of life and death, strife and love. Opposites are necessary conditions for each other.

Leopold has proposed a conservation ethic, dealing with the human relationships to land, plants and animals. The land ethic Leopold had in mind was a sense of ecological community between human and other species. When we see land as community to which we

belong, we will use it with love and respect. Such an ethic would change the human role from master of earth to plain member of it. Predators are members of the community; no special interest has the right to exterminate them for the sake of benefit for itself.

The aim of an ethic must be harmonious with the world's population of living beings. Michael W. Fox proposes a biospiritual ethic as a unifying set of principles, ethics and values that will bring about a nonconflicting state of one earth, one mind. The ethic is based on the biological fact that all humans and living beings are kin and that life is spiritual—love is stronger than violence. It arises from seeing humanity in an ecological perspective (from knowledge of evolution).

Other modes of knowledge must be accommodated along side science. Gnosis is augmentative knowledge (intuition and revelation), in contrast to the reductivity of science. Tillich calls gnosis “knowledge by participation”—and that is what humans need to do—recognize that they automatically participate in everything, and that we cannot unparticipate by choice.

The principle of reciprocity in ecology is that no entity can exist by and for itself; everything is connected to everything else. In religious terms, this is the golden rule (according to Aldous Huxley's *Perennial Philosophy*). Reciprocity is the recognition of mutual obligation. All things are bound in bonds of mutual dependency. Ecology has become a philosophic viewpoint as well as a systematic discipline. The counsel of ecology is caution. Caution is an expression of love. Love is treated as the basis of religious feeling, and even wisdom.

Gregory Bateson defines wisdom as knowledge of the larger interactive system. Wisdom is a perception of relationships and relativity, an awareness of the wholeness of things without losing sight of the unique particularities. It joins the left and right brains in a union of logic, poetry and feeling. It reintegrates knowledge with values. It implies making judgments in advance, infusing elements of older wisdom into a new expression. The wisdom of cultures forms a perennial philosophy of the human race. Gary Snyder discerned an undercurrent in civilization since the late Paleolithic. He considered Buddhist Tantrism to be its finest and most modern statement: “that Mankind's mother is Nature and Nature should be tenderly respected; that man's life and destiny is growth and enlightenment in self-disciplined freedom; that the divine has been made flesh and that flesh is divine; that we not only should but do love one another . . . these values seem almost biologically essential to the survival of humanity” (in his book *Earth House Hold*). Myths (with transformations) and metaphors (with structure of integrated differences) are modes for conveying ecological wisdom; they are less concerned with survival than the survival value of a good fit between the dualisms of life.

Certain elements—care, responsibility, respect, and knowledge, according to Eric Fromm—define a loving relationship. The inexhaustibility of a being or of our relationships constitutes much of the nature of love. Human beings are compelled to seek other beings and love is the only approach. Abraham Maslow presents “love-knowledge” as unlimited. Love creates an openness to experience, without judgment. Beings unfold. Love expands the awareness of the self and other beings. And its intensification of feeling pulls the frame through the focus of the metaphor, yet preserves the original distance. Love binds space and time in miniature. Its intimacy permits distance. Its duration reaches future generations of beings. Love personalizes the universe, but keeps it free to develop.

The regions in the planet are like living symphonic poems. The score does not fully determine the music, the passion and intensity. The present movement gives no clue as to

how it will finish. Each voice fits in with others, but is not limited. We can be aware of the symphony as a whole and the individual voices. When we are attuned to it, control is not a problem. If we can trust ourselves to improvise as the need arises, we can trust nature, and not follow some rigid plan. Every cosmology has limits, of incompleteness, indeterminacy, and of locality. Our new ecological cosmology, expressed through our intentions and designs, recognizes its limits with love, and continues to act.

8.9.4. *Brief Summary of a Regional Ecological Design*

Central to this effort to outline and initiate a participatory framework is the recognition that our catastrophic situation requires immediate emergency actions on a regional (and local and global) scale, from expanding personal consciousness to reforming the very character of human civilization and its coevolution with wild nature. First, an international organization such as the United Nations has to assume control of the planetary commons for limited utilization as well as protection. It would manage the commons in the interests of all living communities. By charging usage, extraction or loss fees for water, fossil carbon and other resources, it would become self-supporting. By international agreement, it would have the largest and only standing army, with some large-scale nonnuclear weapons (nations and communities maintaining police forces for public safety and control). It would allow all nations—even minor landless ones or business/conservation entities like corporations—to join with equal votes. It would protect traditional and modern cultures in a loose framework, encouraging cultural health related to environmental health, stressing economic equity through a variety of measures, and trying to direct the emerging global culture. Through this organization, we could consider incorporating the planet as an interested party.

This international organization, as well as nations, communities and individuals, would start to question things; to learn to apply an ecological perspective to knowledge and processes; to understand and direct trends and gigatrends; to understand fields, systems and limits; to understand flows and connections; to understand the history of the planet, especially spheres and cycles; to learn how elements and materials interact in patterns and how patterns restrain them (and how this produces uniqueness and diversity); and, to understand how communities and ecosystems work. Every person and group needs to understand how challenging events can become problems, especially with water flows on land and air and with atmospheric change; to recognize others, such as cultural collapse, earthquakes, and diseases; to face the global problems of a chaotic changing planet; and, to comprehend the limits and weaknesses of cultures, especially bad images, incomplete cosmologies, maladaptations, drift, and traps. Creating an ecological cosmology, with new metaphors and logic, is an important step.

We need to emphasize science, especially addressing systems and synthetic thought. We need to end the thoughtless, large-scale experiments on ourselves, living communities and the planet, and imagine real thought experiments. We need to reduce our massive interference with ecosystems and landscapes, especially through conversion. We need to reduce and recollect many kinds of pollution, from plastic nurdles to carbon dioxide gas. We need to rethink and rework design at every level, from personal and local to regional and global, through principles and actions, then use design to recover our tremendous losses, to save and restore wild and common areas, especially extents of forests. We need to create surveying programs to inventory places and the planet, then monitoring programs to keep informed as well as to reconnect many plant and animal patterns. Human populations should be related to

ecosystem productivity, as well as to rarity and diversity, even if this means a large reduction in numbers. Failed cities should be removed or refitted. New cities should be built with psychological and ecological prospects (perhaps as arcologies). Technology could be reduced and integrated to fit needs and limits, instead of being automatic. Many predominantly technological problems, such as carbon production, fossil fuel extraction, nitrogen pumping, phosphorus loss, and pollution, can be solved through a combination of conservation and balancing. New smaller scale forms of technology can be designed using precautionary principles. Industry could be reformed as limited artificial ecosystems. Appropriate technology could be directed and certified.

We need to learn to be healthy individuals in living communities, to reduce antibiotic use and unnecessary luxuries. In fact, we need to place health in the context of ecosystems and global cycles. We need to learn to adjust to our own psychological and social limits. This means addressing problems with patterns of wealth, especially growth, inequality, poverty, dominance, and slavery. We need to link economics to ecologies, especially at the global level. We need to redefine the nature and limits of corporations, especially with new goals and community responsibilities. We have to consider the problems of intolerance, conflict and war within a frame of ecological ethics, and to reconsider the goals and responsibilities of individual nations and a global community. Failed nations and communities will have to be rebuilt.

We have to create new surveys, inventories, monitoring and planning, not only of local resources, but of global properties, not just of the atmosphere and ocean, but of bioregions and deep continents. We have to monitor all global threats, from earthquakes to meteors. The design of new forms of human settlements and activities can be accomplished through ecological design. We can design the entire planet as a whole. We can integrate traditional adaptive patterns, from agriculture to technology and cities, to natural processes. We can consider our civilization and planet as part of the solar system and local space. We can strengthen religions with common understanding to bind people to their places and planet. We can make politics conscious and fair, with traditional goals and limits. We can make global designs, mostly to restrain humanity and restore balances of systems, but also to coevolve with the development of natural systems. We can create a planetary framework with clearly delineated functions at each level from personal to planet. And, we can advertise this to everyone so they can participate. Then we, they, all of us can say what else should be done. But, we have to say and do it, *now!*



Figure 894-1. Trademark of SynGeo ArchiGraph LLC 1992

9.0. Appendix

This section contains: Notes from the various chapters are listed by chapter. The glossary contains common words from all chapters. The bibliography combines references from the chapters. Short biographies of the authors have been added by the authors themselves. And, there is a page listing contacts for authors and institutions.

9.1. Notes

- On 0.3. Taken from personal communications from 1982 to 1983 as part of tutorials through International College.
- On 0.4. Taken from Dr. Fox's book *Healing Animals: The Vision of One Health*, published in 2011 by One Health Press.
- On 1.4. Taken from a distance learning class on ecological forestry, 1994. Published in *Ecoforestry*, the Canadian-American journal, 1997.
- On 2.9. Prof. Naess's article was considered for *Pan Ecology*. Published in *The Trumpeter* Volume 21, Number 2 (2005). Reprinted with permission.
- On 4.5. Based on several articles and a public talk at Powell's Bookstore, Portland, Oregon 1998.
- On 4.6. Taken from Dr. Fox's book *Animals and Nature First*, published in 2011 by One Health Press.
- On 5.3.2. Michael W. Fox is the ANIMAL DOCTOR Syndicated Columnist. Dr. Fox maintains websites with pet-owner information on foods and medicines.
- On 5.4. Paolo Soleri wrote this on January 26, 2009, while preparing his book on Lean Linear Cities (excerpted in *Redesigning the Planet: Local Systems*).
- On 6.7.7. From a talk at Claremont, 2010, on the necessity for an ecological civilization, by John B. Cobb Jr.
- On 7.3.5. From submissions and the web page of Doctress Neutopia, with her permission and at her direction.
- On 7.3.8. From a talk by John B. Cobb Jr., hosting a Chinese delegation interested in building ecological cities.
- On 7.6. First published in *DEC Notes* 1989 by Digital Equipment Corporation, in response to a request for new company goals.
- On 7.7. Based on a graduate project in Geography, 1970. Entered in a contest in Ireland 2002. Some of the numbers have been updated to 2010.

9.2. Glossary

(Refer to website: www.syngeo.org)

9.3. Bibliography

(Refer to website: www.syngeo.org)

9.4. Biographies

Michael Barnes is the principal at Cascadia Forest Goods. He was Co-Director of the Ecoforestry Institute from 1993 to 1997.

John B. Cobb, Jr. is Professor Emeritus at Claremont College, where he was the Head of the Center for Process Studies. An author of books on religion, ecology, economics, and politics, he is still contributing to many projects and movements.

Dr. Alan Drengson is Emeritus Professor of Philosophy and Adjunct Professor of Environmental Studies at the University of Victoria, Canada, where he was the former Director of Environmental Studies and also taught philosophy. He has published many articles and books, for example, *The Practice of Technology*. He is the founding editor of a journal dedicated to ecoforestry, *The Trumpeter*.

Dr. Michael W. Fox is a veterinarian with doctoral degrees in ethology/animal behavior and medicine from the University of London, England. Spending most of his professional life in the US as an advocate for animal health, welfare and rights, he has published over 40 books and writes the syndicated newspaper column *Animal Doctor*. Please visit his web site for articles and information.

R. Buckminster Fuller was a designer, systems theorist, architect, and futurist. He worked as a ‘comprehensive anticipatory design scientist’ to solve global problems and create the conditions for a ‘sustainable planet.’ He expanded and popularized the geodesic dome and invented dymaxion buildings and vehicles.

Twila Jacobsen taught Ecological Economics at Oregon colleges. She practices it with the Mountain Grove Community, the Ecoforestry Institute (where she was Co-Director from 1993 to 1997) and Cascadia Forest Goods.

Arne Naess was Professor of Philosophy at the University of Oslo and an enthusiastic mountaineer, who tried to “think like a mountain.” His thinking led him to form his own ecological philosophy, ecosophy, which inspired the movement of Deep Ecology—the belief that our concern is for all of nature equally, including humanity. He was always appreciated for his exuberant playfulness.

Paolo Soleri is the visionary architect of new, intense human spaces that fit in ecological systems. He is the founder of the first arcology, Arcosanti, and of the Cosanti Foundation. He designs Windbells and lectures everywhere in the planet to urge people to build rational, spiritual, ecological cities.

Alan Wittbecker is Senior Design Ecologist with SynGeo ArchiGraph, LLC, where he works on wildlife projects. He is Professor of Environmental Science at Ringling College. He is former editor of *Pan Ecology* and *Ecoforestry* and author of *Eutopias*.

9.5. *Contacts*

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www.ecostery.org
www.lovolution.net
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Dr. Michael W. Fox: ipan@errols.com
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Alan Wittbecker: aw@syngeo.org

9.6. *Index*

(Being prepared for web site: www.syngeo.org)



Figure 77133-1. Ecoforestry Institute Logo 1993

Colophon

Type: Adobe Garamond Pro, 11/14

Hardware: Mac G5, HP3310

Software: Pages, Indesign, Acrobat, Photoshop, Iwork

Design: Rian Garcia Calusa Design

Editing/Graphics: Alan Wittbecker

Place: The house in Tallevast



Figure 98-1. Rian Garcia Calusa Logo 1986 (filled in color)