AN INTERDISCIPLINARY REVIEW STRUCTURE OF ARCHITECTURAL SUSTAINABILITY

by

Hans Russell Howland

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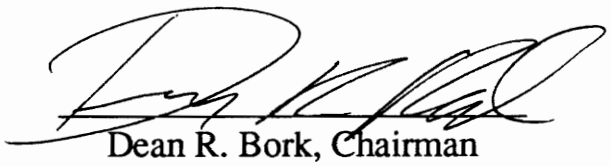
Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF LANDSCAPE ARCHITECTURE

Approved by:



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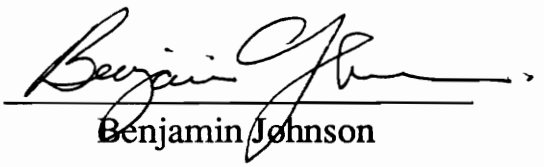

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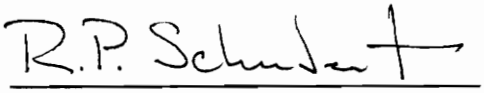

Robert Schubert

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(ABSTRACT)

The production of sustainable architecture has traditionally been inhibited by the inability to formulate a comprehensive scheme of environmental and project review. The environmental constructs(The ways that an environment naturally regulates itself independently from human influences) and the project objectives(The motivations for architectural development) each have aspects that relate to sustainability, some of which are interrelated and dependent on the other aspects for their existence and maintenance.

The interdisciplinary review structure integrates existing evaluative methodologies and concepts into a personal, foundational analysis for sustainable architectural development. The structure integrates the developmental objectives of individual disciplines and professions into a comprehensive evaluation scheme for environments and architectural projects. The combined aspects and systems required for sustainability devise perameters to support a sustainable architecture for a site specific environment.

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I would like to sincerely thank my thesis committee: Dean R. Bork, Benjamin Johnson, and Robert Schubert, for their critique and support throughout the thesis process. It was their guidance which made the investigation manageable, bearable, and enjoyable.

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Table of Contents

Table of Contents: Figures

Landscape Architecture

Part 1: Introduction

Throughout my undergraduate studies in architecture and work experiences in construction and design, I have found very little interest in environmental conservation, mitigation, and preservation. Some of the major concerns(with regards to particular environments) of design and practice have focused on producing temporary structures that 'concur' environmental conditions and limitations for a short period of time. Once the need for such a structure expires, the structure is discarded as a decaying relic of a past purpose.

There are many examples of this principle including the following: Department stores building new structures to house more products and floor space while discarding other structurally sound buildings without a specified function or purpose, cul-de-sac housing constructed for a limited life cycle(many in the range of twenty years), and urban decay visible through the proliferation of slums, the boarding up of buildings, and the removal of a city's historic structural context for new construction space. These types of practices misuse construction materials, disregard existing environmental assets, and degrade the architectural profession by producing structures that will not exist longer than the life of the architect.

The notion of sustainability(as seen through the research within this document) implies that environmental conditions(economic, sociological, and ecological) may be maintained and integrated into human developmental practices for the combined benefits of the environment and the user. The concept of sustainability within architecture incorporates the designed needs of the client with maintaining the status quo within an environment. Sustainable architectural practice could include: the reutilization of existing structures, the preservation/enhancement of existing environmental conditions through architectural design and systems usage, the reduced use, and recycling of, construction materials, controlled land utilization through intense planning practices, and structural design that offers more than one purpose to a structure(Thus increasing it's life cycle).

The interdisciplinary review structure, formulated within this document, describes various relationships within an environment. The review structure first investigates the ecological, economic, and sociological characteristics of a specific environment. The investigation of existing environmental conditions let us understand the positive and negative aspects of said environment and imply interrelationships between the individual facets. An understanding of environmental systems and their interdependency would offer the designer opportunity to sensitively coordinate environmental modifications to enhance the positive aspects and reduce negative aspects of the environment.

The structure would then investigate the intended project or development. Evaluations of a project's intentions and objectives describe the characteristics and systems that will regulate the development's viability. The cross-referencing of developmental concerns and systems that would regulate the development would help describe the needs of said development. By cross referencing the investigations, a comprehensive or synthetic view of the environment and the project may be formulated to fully coincide with the environmental conditions(structure) and meet the intended functions of the development.

This thesis is the culmination of three years of investigation, introspection, and experimentation. The methodological and conceptual structures defined herein are intended as a personal investigation into sustainable theory and practice. The use of the research and investigations by others is encouraged, however with a word of caution: Each person's perception of value and their methods of investigation and practice differ. It is therefore important that each individual format sustainable investigations to match, or enhance, their own perceptions of value, knowledge of sustainability, and architectural practice procedures.

The format of this document is quite unusual. The interdisciplinary review structure will be presented before the research defining the structure. The structure is presented to define the methodological and conceptual aspects required for environmental and developmental investigation. The structure is then applied to a case study, the Boyne River Ecology Centre in Shelbourne, Ontario. This is done in order to examine and compare the theories and techniques to something existing so that the review process may be tested for it's

strengths and weaknesses. This is followed by the conclusions of the case study investigation and the structure's analytical capabilities within the design profession.

The research and development of the structure follows the model, case study, and conclusions. These sections investigate sustainability and it's relationships to different disciplines and professions. Research includes definitions of sustainability as it apples to the different disciplines, the existing theories and methodologies for sustainability evaluation and research within those disciplines, historical precedences related to the sustainable issues within those professions, and the development of sustainable interrelationships between the disciplines. The objective of these investigations was to evaluate how sustainability may be addressed through many perspectives and how one might look at sustainability as a combination of many facets and disciplines, not just as an issue of energy efficiency or material conservation.

Part 2: Interdisciplinary Review Structure of Architectural Sustainability

An interdisciplinary review structure of architectural sustainability is intended to define and organize the primary environmental and developmental concerns of a particular project and environmental context. The study of the various fields suggests that a structured investigation for sustainable architecture could not possibly be a once investigated and applied linear process; the aspects of environmental organization and society are ever changing and too complex to be observed once and related directly to permanent 'solutions' for the questions at hand. The development and/or revitalization of communities may adequately address contemporary issues, but the environment will evolve to create new conditions and issues. The changes made to an area may address the issues of the time, but the society or community will not be capable of developing further than the scope of the designed functions and features. The project theory must evolve along with the changes occurring due to the environmental and sociological stresses within the project scale to remain viable.

An interdisciplinary review structure would provide planners/architects/designers with evaluative environmental information to make design directives for development and then would be utilized as a monitoring device for developmental impacts within environmental constructs. The structure could be used as a monitoring device that would evolve with the environmental and societal development to retain it's viability. Modifications to the natural and human environments would translate to informational alterations within the structure.

An interdisciplinary review structure for sustainable architecture would first investigate and evaluate the conditions and issues of the existing site, community, and/or region. The existing conditions of the site include: The constraints of local environmental constructs, environmental opportunities for modification and development, and scalar environmental processes that development would affect or alter. The structure would then investigate the developmental conditions within the environment. The predominant developmental conditions and issues affecting the area would help dictate the priorities and directives for the project.

By revealing the dominant issues of the locale, the designer can better evaluate the possible means for development.

The interdisciplinary review structure that follows is a combination concepts and methodologies that have been integrated and synthesized to formulate a larger, more comprehensive, investigative scheme for the designer. A series of environmental evaluations offer ecosystem and sociological developmental directives for the designer. The structure then focuses on sustainability within architectural development. Evaluations of existing and proposed projects derive the levels of efficiency, or sustainability, within site and community designs.

Once the designer derives the constructs of the environment and the architectural objectives of the project, the structure suggests developmental directives to attain sustainability within the project. Utilizing some of the many resources available, such as Mechanical and Electrical Equipment for Buildings, 8th ed., and The Solar Living Sourcebook, 8th ed., the structure suggests example systems and methods that lead to a development that is sensitive and supportive to a specific environment. The combinations of, and utilization of, such types of systems would help support sustainable development for that individual environment.

This structure is intended as an investigative and directive perspective. The information provided within this structure considers the contemporary theories, evaluative methodologies, and alternative systems technologies available during the time of investigation. The designer must continue to investigate systems and methodologies for increased efficiency and reduced environmental impact and then integrate them into this foundational model. As stated previously, the viability of this structure is directly related to it's implementation and evolution within environmental constructs of the time.

Within the structure, each investigation has written and visual references for ease of understanding. It is accepted that each of the sections within the structure has it's own process, however document layout has allowed for all of the structural sections to have similar

visual orders. Along with the visual references, each division of investigations has written descriptions of the processes involved.

Each section of the structure starts with an existing or current status area. That area is located, or visually defined, by a solid line box. Although each type of investigation varies, the visual referencing system allows for simple referencing of the approximate stages of investigation. These investigations lead to the dotted developmental directives or conclusions of the investigation. A graphic example is below:

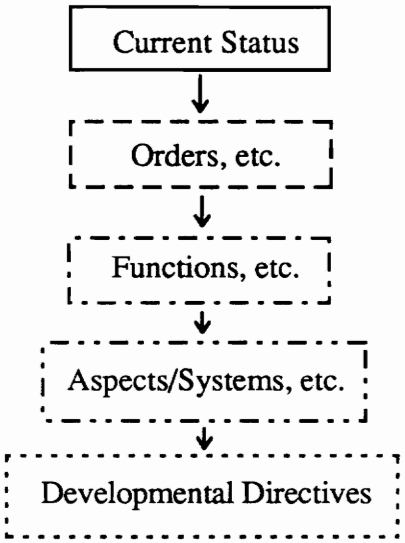
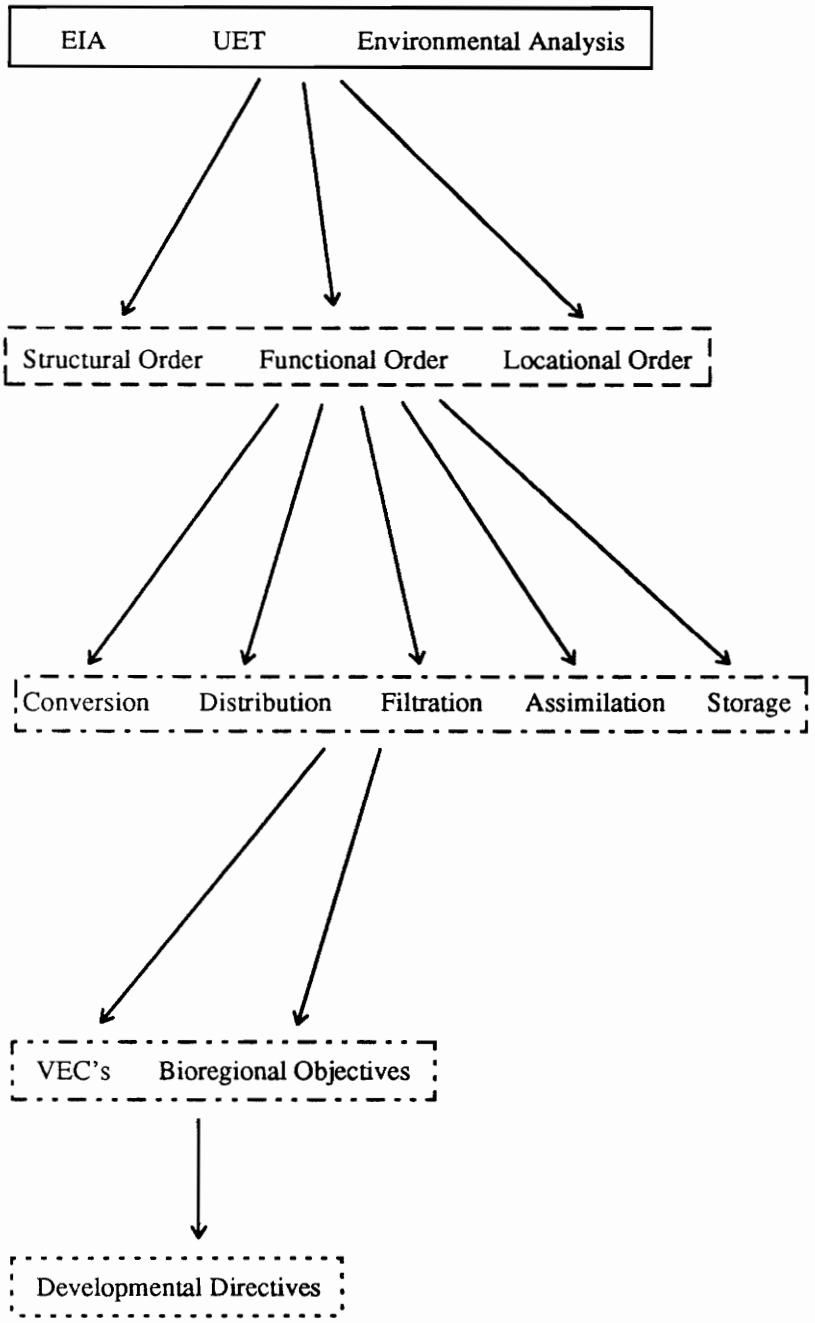


Fig. 1. Structure Graphic Layout

Note: At the end of the structure is a series of pages containing the methodological and conceptual techniques utilized within the structure. Each type of process mentioned has an easy reference short definition, and it's location noted within the thesis body.

Environmental Constructs

1. Undeveloped Environments



Environmental/Ecosystem Current Status

-An understanding of an environment or ecosystem's status offers insight into the working orders within the environment. The environment's problems, as well as assets, are defined by these investigations and infer as to which of the orders would be affected by certain types of modifications.

Environmental /Ecosystem Orders

-An understanding of environmental or ecosystem orders of Structure, Function, and Location allow for the classification of functional systems within the environment. The functional systems derived from the environmental order investigation offer further systematic description of a specific environment or ecosystem.

Environmental/Ecosystem Functions

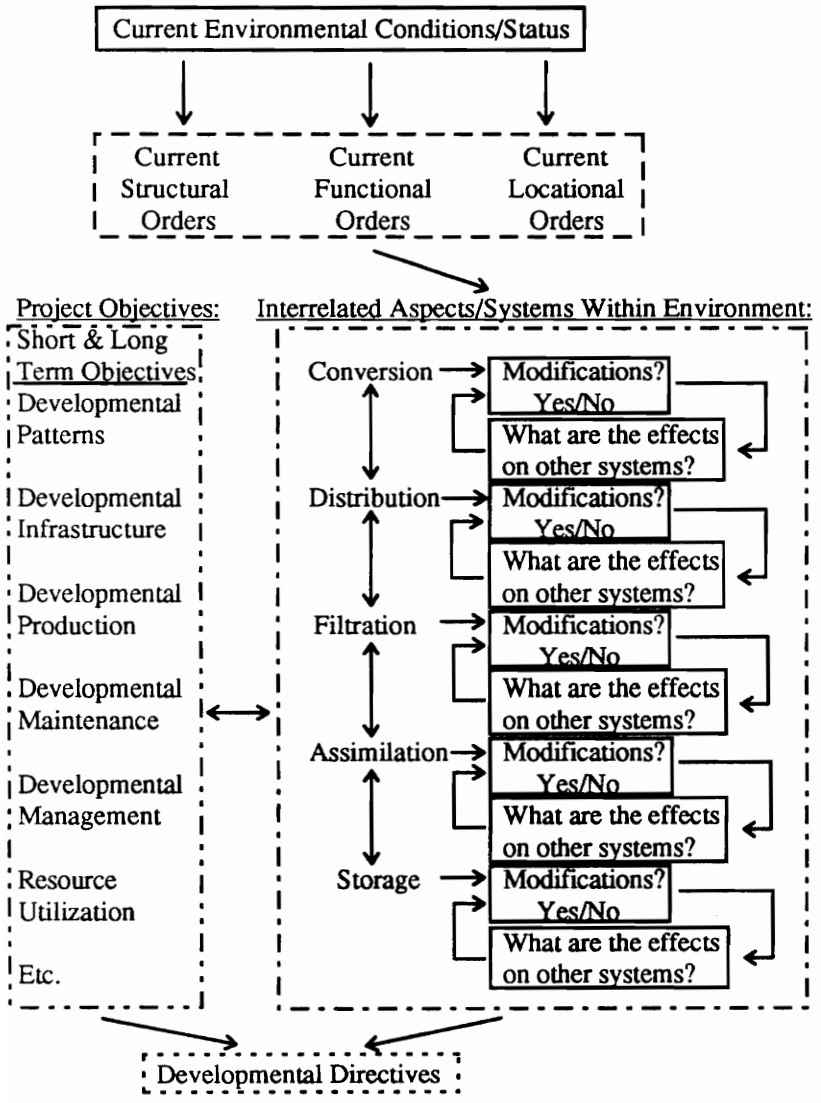
-An understanding of the environmental or ecosystem functions of Conversion, Distribution, Filtration, Assimilation, and Storage offer distinct definitions of the environmental systems that regulate the ecosystem and mitigate ecosystem stresses. These understandings allow for the valuation of aspects and systems within the environment.

Valued Environmental Aspects/Systems

-The delineation of Valued Ecosystem Components and Bioregional Objectives derive the conditions within the environment or ecosystem worth preserving or emphasizing. Directives for development are based on this last step of the environmental constructs evaluation.

Fig. 2. Environmental Constructs(Methodological Analysis): Undeveloped Environments

Another way to look at this environmental evaluation is by describing the concepts behind the evaluative methods just specified. The environmental constructs of an area or region are investigated to inform the designer of the ecological characteristics of said area. An ecological environment is a series of interrelated processes that rely on each other for the viability of it's production and maintenance systems. These systems evolve due to the stresses placed upon the environment by internal(disease, etc.) and external(development, etc.) forces. Once the dynamics of an area are understood, the designer must update their information in order to design future projects for the same area. The primary ecological systems(such as climate or land type) will modify through time and will require an evolutionary investigation to maintain feasibility. Essentially this section of the structure is intended to be utilized to find the following information:



From the Environmental Impact Assessments, Ultimate Environmental Threshold, and Environmental Analysis studies, we find the predominant environmental constructs of the environment. These constructs describe the production and maintenance orders of the environment.

The orders of the environment describe the processes and configurations of systematic functions within the environment. Those functions have interrelationships that may or may not be modifiable for ecological viability through development. Assessment of interrelationships and their ability to be modified are vital to understanding the environment's status.

When compared to the developmental objectives, the environmental systems may require modification to meet project objectives or the project may have to be modified to meet environmental objectives. Either way, or both ways, the process supports a development that is more responsive to environmental conditions and factors.

This process helps derive some of the developmental directives for the project.

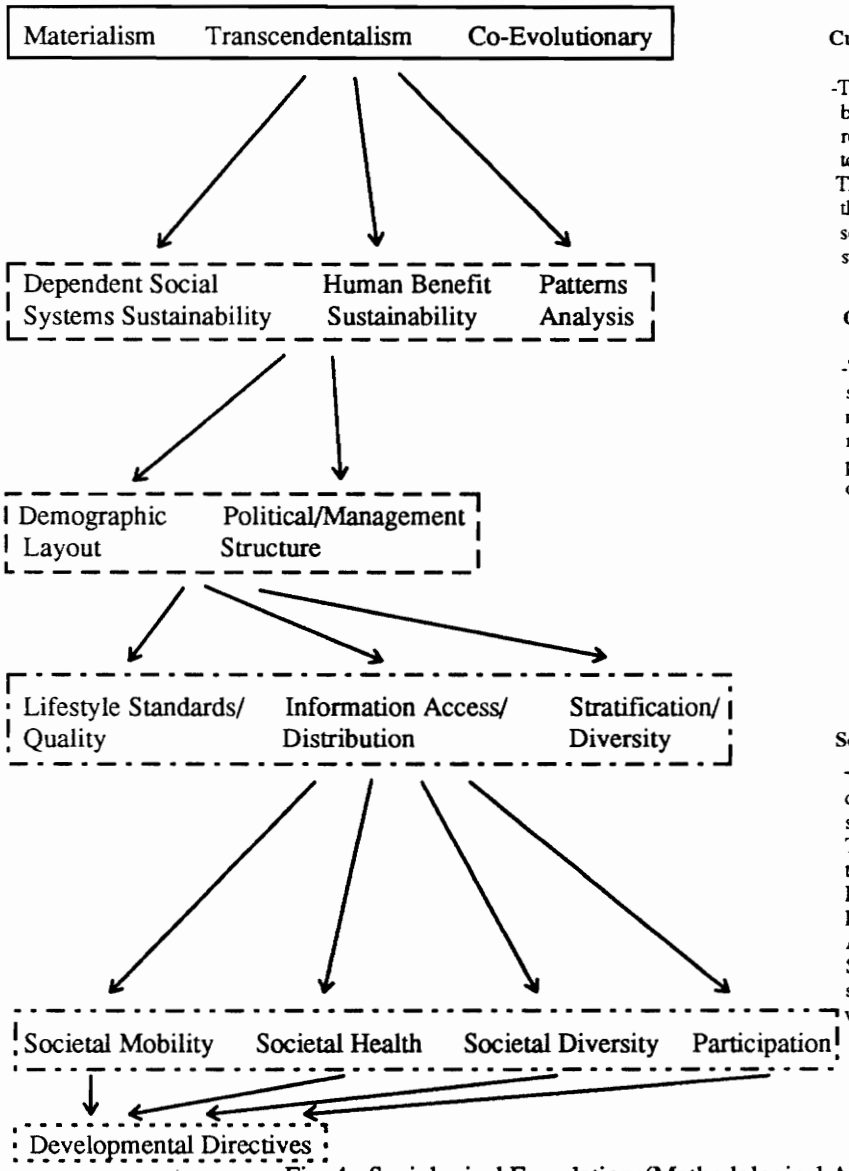
Fig. 3. Environmental Constructs(Conceptual Analysis): Undeveloped Environments

Environmental Constructs

2. Environments Containing Development

Areas containing development also require an understanding of their environmental constructs. This is an extended or complex environment and will require investigations and evaluations of the environmental, social, and economic organizations of the area. The designer will utilize the environmental evaluation described for areas without development, as well as the following analysis methods:

Sociological Foundations



Current Social System Type

-The type of social system currently utilized by a community, region, or country can relate to the ability of that community, etc. to implement developmental programming. The social system may not support many of the modifications for sustainability and the social system itself may require change for sustainability.

Current Social Systems Analysis

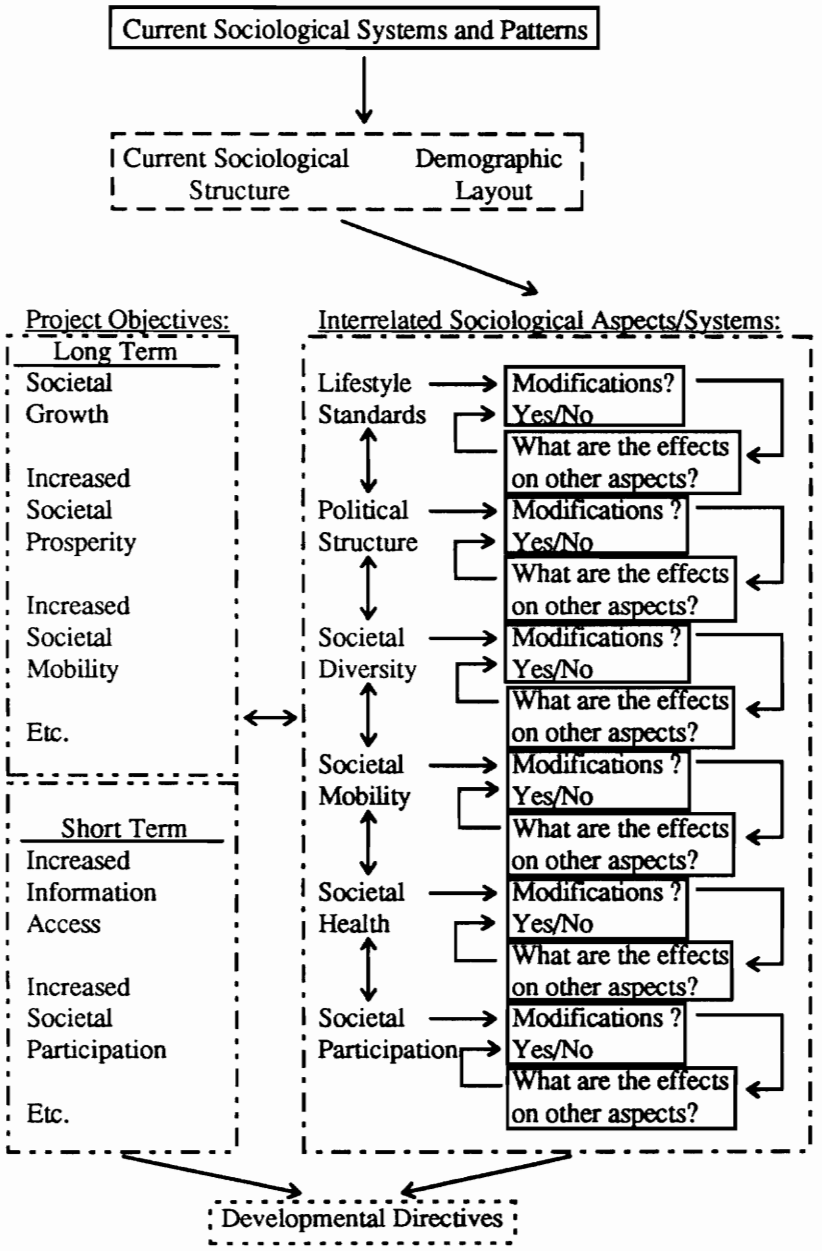
-The systems and patterns required for a society's well being or current status are noted for their patterns and resource requirements. The society's developmental patterns help define the Socio-Structural orders.

Socio-Structural Orders

-The Socio-structural orders of a society define the ways in which the society is systematically organized and managed. The management practices of the society, the Demographic Layout and the Political/Management Structure, define the Lifestyle Standards/Quality, Information Access/Distribution, and Societal Stratification and Diversity. The socio-structural orders help define the aspects of value and the objectives of the society.

Fig. 4. Sociological Foundations(Methodological Analysis)

Within a society, there are many concepts and patterns that show themselves through this evaluation. There are aspects of a society are interrelated and regulate the society's status and viability. The constructs of a society, within a built or developed environment, may or may not address the environmental constructs as they are ecologically. They do, however, help create the constructs of a developed environment. Those constructs are legitimate for the investigation of development and modifications to developed environments. Below is a description of how the sociological evaluations are to help devise developmental directives:



Initial studies of sociological environmental structure, such as Dependent Social Systems Sustainability, Human Benefit Sustianability, and Patterns Analysis lead towards the understanding of sociological patterns of development and demographic structure.

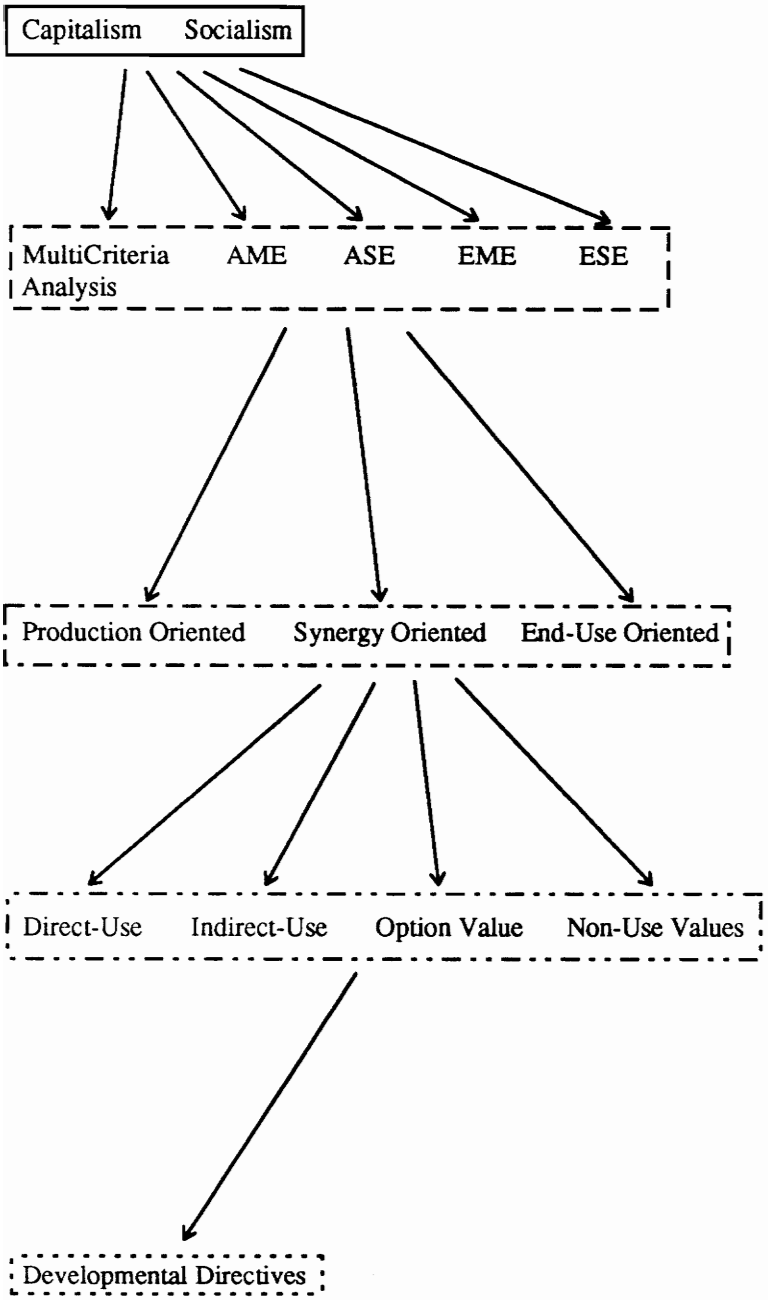
The sociological and demographic layouts of a developed environment describe the processes and configurations maintained within that environment. Those aspect and systems may be easily modified without negative results to other systems, or may be unknowingly a major facet of the sociological structure. It is important to understand the interrelationships within aspects of a society and develop in order to enhance the positive aspects and reduce the negative aspects.

When these aspects are compared to the developmental objectives, each may be modified to create a better 'fit' between the existing societal structure and a sustainable societal structure.

This process of investigation helps derive some of the developmental directives for project implementation.

Fig. 5. Sociological Foundations(Conceptual Analysis)

Economic Foundations



Current Economic System Type

-The type of economic system prevalent in a society formulates the ways that economic reform must be based for a sustainable society. Each system has facets particular to their system and it is unrealistic to associate reforms as pertaining to all existing societies.

Current Economic System Status

-The current conditions of economic systematic status inform the designer as to the economic structural orders within a society. A Multicriteria Analysis will offer a society's position on production status and the AME, ASE, EME, and ESE evaluative methods offer insight into the society's use of materials and resources, the diversity of products, and the ethics involved with product development. These investigations lead to the economic structural orders of the society.

Economic Structural Orders

-The manner in which a society organizes it's resource utilization: As a matter of producing more energy/products to ease burdens of societal needs, the producing of products and systems for compounded gains in utility and resources, or a system of reducing societal burden from the end of the product and energy cycle. The Economic Structural Orders of a society infer as to the economic value systems of the society.

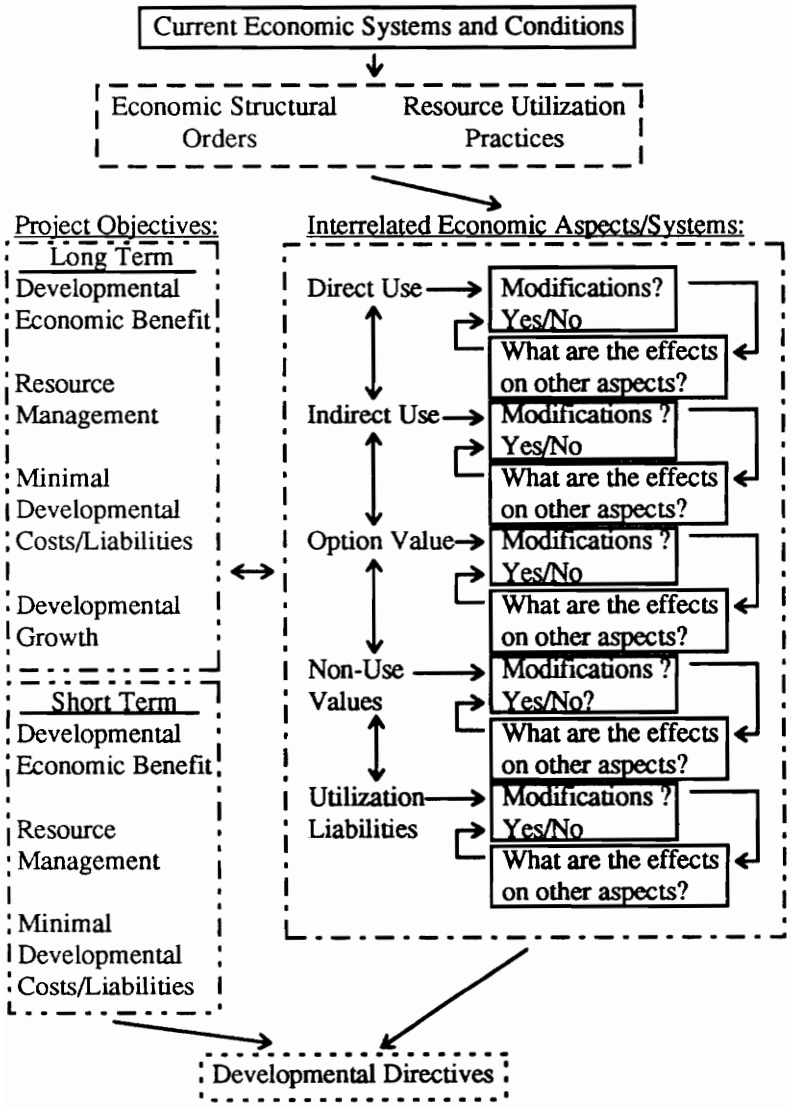
Economic Value Systems

-An investigation into resource or aspect value to the economic status of a society, the economic benefits of ecological functioning and conservation, the preference to avoid resource utilization in order to gain in the future, and the benefits/impediments incurred regardless of intentions offers insight into the underlying values of the society and their tolerance to modification of existing systems. These evaluations lead to developmental directives and increased understanding of economic constructs within a society.

Fig. 6. Economic Foundations(Methodological Analysis)

The economic constructs of a society or developed area are interrelated to form the working orders of a society. The resources and their utilization help define the ways a society can, or can not, produce goods and services for that society or others. The choices made about resource utilization, maintenance, and conservation directly relate to the ability to continue to produce products. The society may choose to utilize a resource for the immediate economic gains from the use, but will have to accept the liabilities of using the resource. Those may be: The non-renewable nature of the material, pollutive properties of the material and it's production, and the economic stresses of resource utilization.

Below is the conceptual framework for the economic evaluative methodology described earlier. It describes the interrelationships of resource utilization, the costs of utilization, and the related liabilities with regards to project development.



Initial studies of economic structure and resource utilization for economic gains, such as AMEs, ASEs, EMEs, ESEs, and Multcriteria Analysis offer insight into the aspects and systems of economic functioning within a society.

The accepted economic systems of production and utilization direct us towards a series of interrelationships. The relationships between resource perception and value, incentives and liabilities of resource utilization, and the short and long term costs of utilizing an environment define the ways a society will utilize materials for it's growth and production. This also defines the economic ethic of a society; that is, how a society values growth as compared to the side effects of production and growth.

When these aspects are compared to the developmental objectives, both may be modified to form a better system of resource utilization for the environmental constructs of an area.

This process of investigation leads to some of the developmental directives of project implementation.

Fig. 7. Economic Foundation(Conceptual Analysis)

Sustainable Architectural Development

The sustainability of an architectural development would depend on the viability of the individual buildings, a development's scalar layouts within the current environmental constructs, and the development's management infrastructure. The review structure for architectural sustainability is comprised of many evaluations and can be utilized for projects varying from site scale to full community development.

Building Sustainability

The sustainability of an individual building relates to it's ability to mediate between the user/occupant's needs and the existing environmental constructs. The building may be sustainable in it's energy use, material/resource use, and it's in it's nature(the ability to be recycled or reutilized past it's contemporary functions). It is therefore necessary to break up the review structure into another series of investigations: The built and the unbuilt/planned building.

Conceptually, an understanding of how a building is to exist within an environment is important to derive before evaluating how the building functions systematically. The sustainability of a building is related to it's associations with an environment and it's effects on the environment. A building's relationship with an environment is a direct representation of it's sustainability. How it is to use environmental features to it's advantage and function, and the byproducts of it's existence(I.E.-Heat produced through environmental controls, etc. and how they effect the environment when released through a heat pump) correlate to a building's ability to exist as an equal member of an environment.

The ability of a building to evolve with changes in ecological conditions and user needs, throughout time, are also associated with it's sustainability. A building is not sustainable if it's uses are limited to a specific set of perameters that may not be permanent. To be sustainable, the building must be planned as evolutionary; it's construction and systems modifiable to meet changing needs. A graphic representation of these concepts follows:

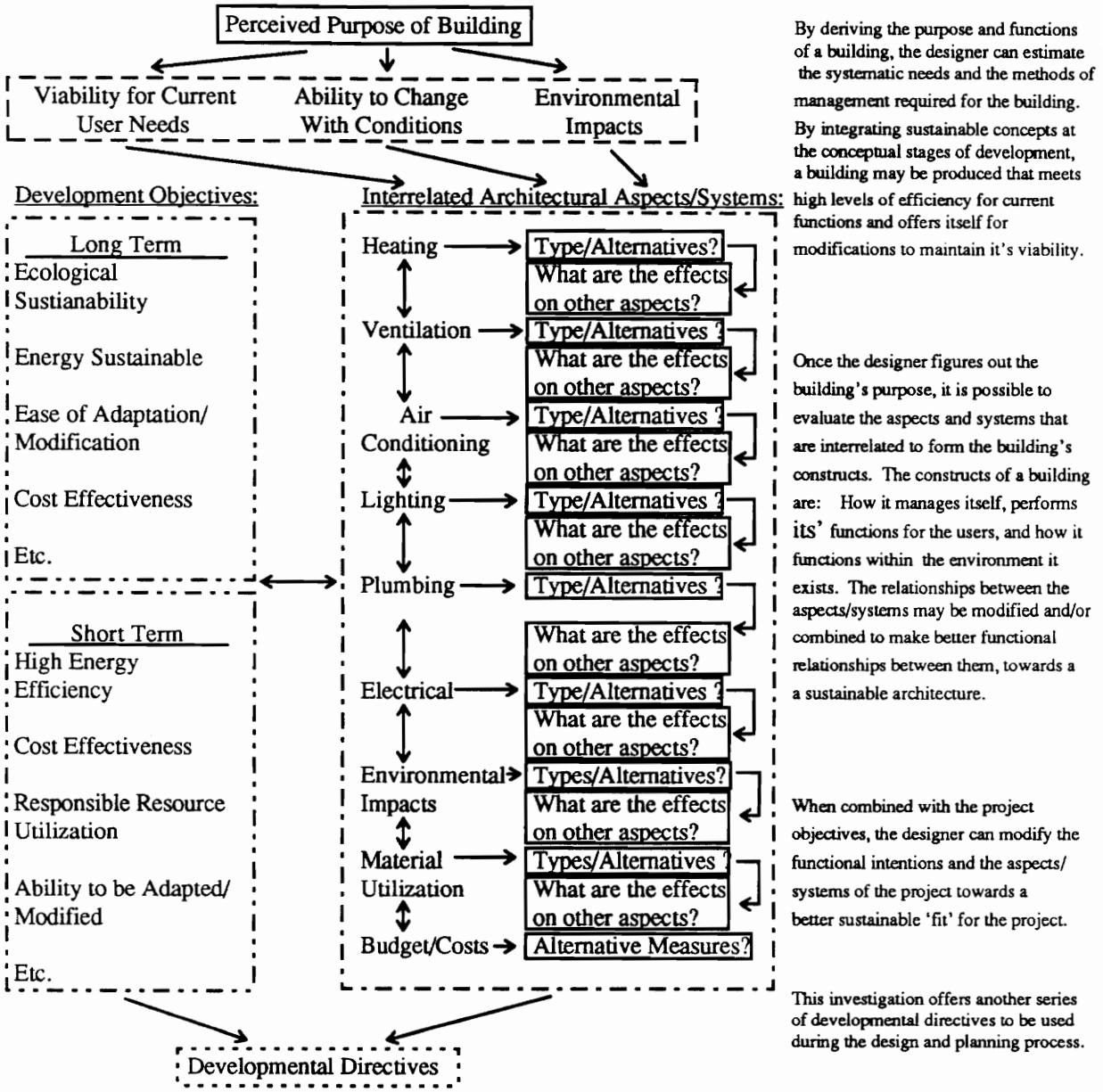


Fig. 8. Building Sustainability(Conceptual Analysis)

The next step towards a sustainable architectural review is to look at architecture by way of evaluative methods. These methods will explain some of the processes and systems initiated, or planned, within project development. The systems and methods available to architects, in coordination with sustainable thinking and techniques, derive methods of design and development towards efficient, and possibly sustainable architecture.

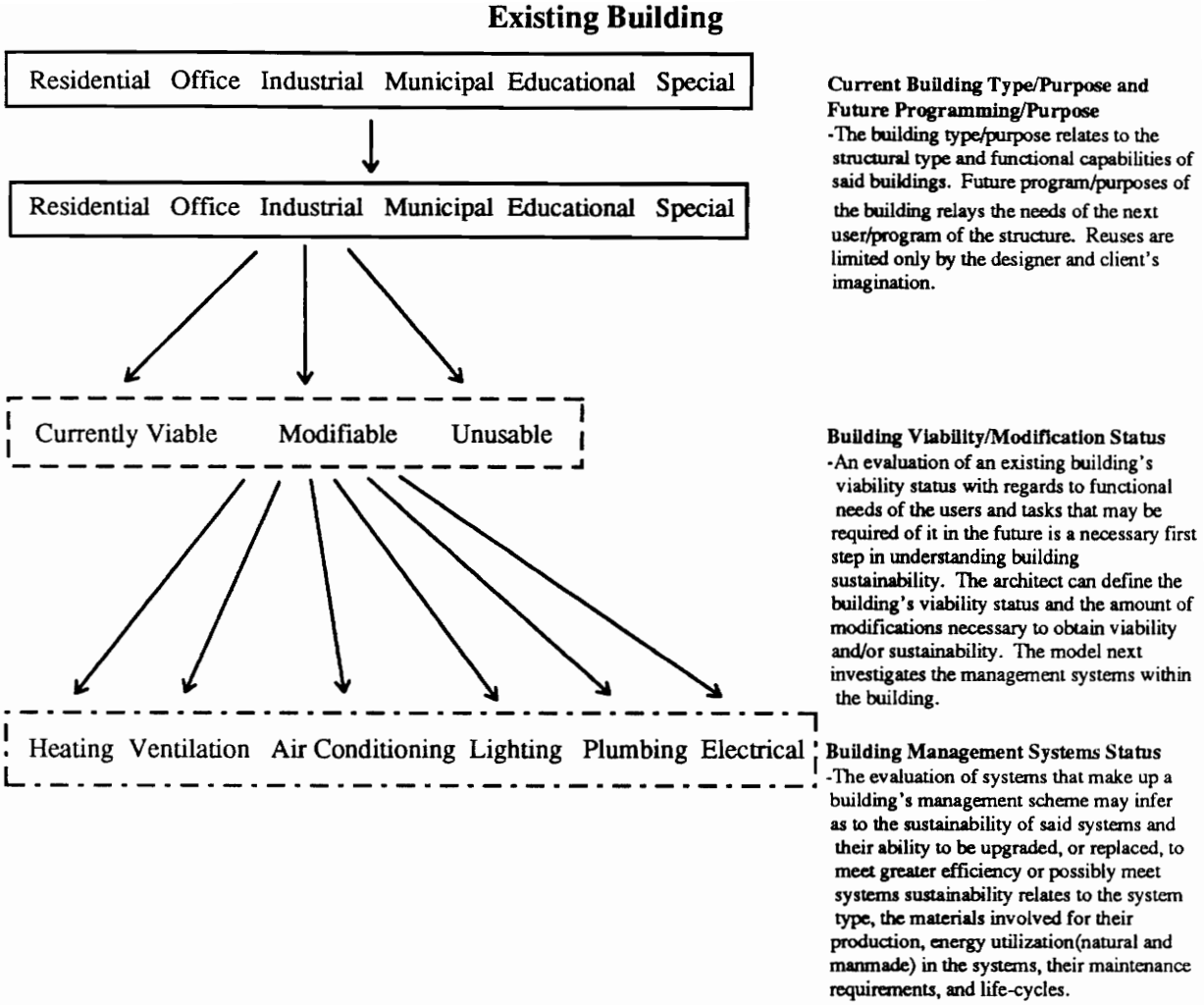


Fig. 9. Existing Building Analysis

Heating

When evaluating the heating system of a building, it is important to understand the current type of system being utilized, it's efficiency(as rated by industry standards), the type of energy source for the heat, and the types of systems that may modify/replace the current system/s to make the building higher in efficiency and/or sustainable. With all heating, ventilation, and air conditioning systems, it is important to maintain air quality and air exchanges to reduce probability of sick building syndrome.

Current System	Material Usage	Energy Utilization	High Efficiency to Sustainable Systems
All Water	Oil	High Efficiency	Passive Solar
Air & Water	Natural Gas	Medium Efficiency	Heat Exchanger
All-to-Air	Coal	Low Efficiency	Cogeneration
Centralized	Electricity		Roof Pond
District	Solar Energy		Earth Sheltering
Localized	Wood		New Higher Efficiency Model of Same
Passive Solar			Phase Change Salt Systems
			In-Floor Hot Water System

Ventilation

The ventilation system may be directly connected to the heating system, but it may also take other forms. It is important to understand how ventilation is being supplied to a building, the materials required to run the system, it's efficiency, and ventilation systems options for higher ventilation efficiency, to sustainability, for the building.

Current System	Material Usage	Energy Efficiency	High Efficiency to Sustainable Systems
Heat Pump	Oil	High Efficiency	Heat Exchangers
Turbine Ventilator	Natural Gas	Medium Efficiency	Wind Gravity Ventilators
Natural/Windows	Electricity	Low Efficiency	Natural Ventilation
Centralized	Wind		"Breathable" Walls w/ Exhaust Air Heat Pump
District			
Localized			

Air Conditioning

An air conditioning unit may also be an aspect of an HVAC system, however it too may be a separate unit or system. Again, it is important to investigate the current system and infer as to improvements to make the system higher in efficiency or sustainable.

Current System	Material Usage	Energy Efficiency	High Efficiency to Sustainable Systems
Evaporative System	Electricity	High Efficiency	Heat Exchangers
Water Cooled System		Medium Efficiency	Heat Pumps
Direct Refrigerant System		Low Efficiency	Higher Efficiency Similar System
Centralized			Unit Sized To Needs, Not Oversized
District			Earth Sheltering
Localized			

Lighting

The lighting systems of a structure create internal loads, utilize mass quantities of energy, as well as create light. It is important to understand the lighting systems being utilized within the structure, it's energy usage, and the consequences of utilizing that system.

Current System/s	Materials Used	Efficiency	High Efficiency to Sustainable Systems
Incandescents	Electricity	High Efficiency	Task Lighting
Fluorescents		Medium Efficiency	Daylighting
Halogen		Low Efficiency	Compact Fluorescents
High Pressure Sodium			Photovoltaic Lighting
Metal-Halide			Dimmers and Control Devices

Plumbing

The plumbing types utilized in a building: The pumps, pipes, fixtures, water sources, and disposal systems are all interrelated and can be modified to bring the system to a higher efficiency or nearer to sustainability.

Current Systems	Materials Used	Efficiency	High Efficiency to Sustainable Systems
Municipal H2O Supply	Electricity	High Efficiency	Cistern Storage of Rain Water
Well Supplied H2O	Oil	Medium Efficiency	Well Supplied Water
Municipal Sewer	Natural Gas	Low Efficiency	Higher Efficiency Pumps
Septic System	Bioligical		Correctly Sized Heating/Storage Systems
Other			Locational Heaters
			Retention Ponds/Natural Filtration
			Solar Water Heaters
			Photovoltaic Water Heaters
			Insulating Heaters/Tanks
			Low-Flow Fixtures

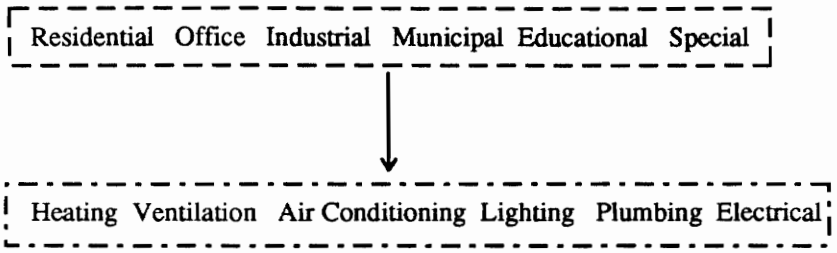
Electrical

A structure has many electrical loads and interrelated systems that consume power from various sources. The electrical systems of a structure must be investigated for their efficiency and alternative measures should be investigated for higher efficiency and sustainability.

Current Systems	Efficiency	High Efficiency to Sustainable Systems
Municipal Power Grid	High Efficiency	Hydroelectric Power
Bulk Power Transfer	Medium Efficiency	Pumped Storage & Coal/Gas Hydroelectric
Independent Power	Low Efficiency	Wind Power
Fusebox		Photovoltaic Power
Circuit Breakers		Higher Efficiency Switches/Transformers
		High Efficiency Appliances(End-Use)
		New Wiring
		Smaller Circuits
		Demand-Side Power Management

Planned Buildings

A building in the planning stages can easily be made more efficient than commonly constructed buildings. The initial expenses of implementing efficient systems may be higher than common systems, but their payback periods may be short and the amenities of efficient systems may far outweigh the economic stresses on the project. It is important to relay the relationships of efficiency and cost effectiveness to the quality of a design and design ethic of sustainable architecture. With increased understanding of systems, their inherent qualities, and possibilities, the designer can integrate many into a comprehensive, sustainable, design.



Building Program/Purpose
-The program for the building type relates the purpose of the structure, the intentions for utilization, and the related modifications that may occur due to changes through time.

Planned Structural Management Systems
-The systems involved in the structure's function and maintenance may be planned as interrelated and supportive in function and resource utilization. It is the designer's ingenuity that dictates the success and variation of these systems options within the structure.

Fig. 10. Planned Building Analysis

Heating

When planning the heating elements of a new building, it is important to investigate ways to maximize the ways in which heat is transferred within the building and optimize the energy consumption. The convection, conduction, and radiation of heat within the building may be the result of many heating systems and relationships.

Examples of Building Heating Options With High Efficiencies and Reduced Resource Consumption	
Passive Solar Heating:	May incorporate phase-change salt systems, trombe walls, water collection systems, etc., within structural mass for heat storage and release.
Earth Sheltering:	A reduction in exposed surface area reduces the escape of heat, as well as, insulates the structure from extremes in summer heat and winter cold.
Roof Pond:	Roof pond systems collect solar energy during the day and release the heat energy into the building during the night. The system also increases roof insulation properties, reducing heat losses.
In-Floor Heating:	The use of a hot water circulation system within concrete flooring produces an ambient heating source. It heats the flooring and the air at a low height. The users notice a comfort zone without producing heated air for non-use areas.
High Efficiency Furnaces	The use of higher efficiency furnaces reduces the needed fuels for heating.
Heat Exchanger:	The exchange of exhaust air from the structure and the introduction of fresh air removes heat from the structure. A heat exchanger transfers heat from exhaust air to the fresh air.
Cogeneration:	The utilization of heat produced through the production of energy, etc., on the site can reduce the need for large heating systems. The production heat of machinery can be utilized for a hot water heat transfer system of other types of cogenerative systems.

Ventilation

Ventilation systems within a building control heat and cooling losses, as well as, maintain a healthy atmosphere by regenerating fresh air into the system. When designing a high efficiency to sustainable structure, the designer should utilize many low maintenance, high efficiency systems.

Examples of Building Ventilation Options With High Efficiency and Reduced Resource Consumption	
Natural Ventilation:	The utilization of natural ventilation systems, such as movable window systems, allows for increased personal modification of user comfort zones and varying degrees of air exchanges.
Wind Gravity Ventilators:	This type of system utilizes a tower-like structure that "pulls" wind down into the building, thus creating air pressure differences within the building. The differences in pressure constitute changes in air circulation.
"Breathable" Walls w/ Exhaust Air Heat Pump:	Utilizing walls with inherent air passing properties offers another method of changing the air within a structure without inducing large duct systems. A heat pump is utilized to remove heat, cold from the air for higher heating/cooling efficiency.
Heat Exchangers:	While allowing fresh air into the air systems of the structure, the exchanger is maintaining the air temperature.

Air Conditioning

The air conditioning systems of the building can utilize natural processes and reduced utilization of resources for air temperature control. The highly efficient or sustainable building can utilize aggregates of systems to maximize air control at a reduced stress on resources.

Examples of Building Air Conditioning Options With High Efficiency and Reduced Resource Consumption	
Earth Sheltering:	The utilization of earthen insulation reduces the heat exposure of the structure while utilizing the earth's temperatures to help cool the structure.
Heat Exchangers:	The heat exchanger removes warmer, exhaust air from the structure and introduces fresh, cool air into the system. It maintains the interior temperature while maintaining the fresh air status of the interior environment.
High Efficiency Air Conditioners:	The use of high efficiency air conditioning systems reduces the energy consumption of the building for cool air needs. A centralized system would reduce resource utilization that many zone conditioners would require through their production. Correct sizing of air conditioning systems would reduce resource consumption through reducing the resources for larger systems production.
Heat Pumps:	A heat pump would reduce the interior air temperature through the removal of hot air by force(high power fans). This method does, however, increase the ambient temperature outside through the release of hot air into the atmosphere. This type of temperature change may 'feel' like it is hotter outside, requiring more air conditioning for comfort.

Lighting

The lighting systems of a building, while consuming some of the largest quantities of energy within a structure, also release a lot of heat through their burning process. The sustainable building would utilize the most efficient systems, mechanically and naturally, for optimum light and minimal resource utilization.

Examples of Building Lighting Systems With High Efficiency and Reduced Resource Consumption	
Daylighting:	The utilization of natural sources and the manipulation of said sources allows for maximum light under current conditions while having minimal resource utilization for implementation. These systems may include sun spaces, skylighting, large patterns of glazing, etc..
Compact Fluorescents:	These lighting systems allow for the high intensities of incandescent lighting, but in a reduced energy consuming format like the tube fluorescent units. The small units have greater lifecycles than incandescents and produce less heat than incandescent units.
Photovoltaic Lighting:	The utilization of solar energy storage devices allows the structure to collect the available solar energy of the day and then transfer it into an evening use system.
Dimmers and Controls:	The utilization of efficient control devices within a lighting system reduces the unnecessary consumption of energy while the space is not being utilized. Motion sensors, dimmer switches, etc. are examples of control devices.
Task Lighting:	The utilization of lighting for specific and focused purposes reduces the need for large expanses of energy consuming lighting. Focused high intensity lighting reduces the number of units needed to supply task specific purposes.

Plumbing

The plumbing aspects of the building may have more environmental impact than many of the other systems within the building. The disturbances created by building placement and the waste removal systems from the building create large concentrations of water removal that are unnatural to the site. In the designing of sustainable architecture, the architect/designer must account for the sources of water to the building and site, the devices of water use and control, and the treatment and removal of water from the building and site. Ideally, the building and project could obtain and maintain it's own water systems for consistent, ecologically sound, water utilization.

Examples of Building Plumbing Systems With High Efficiency and Reduced Resource Utilization	
Cistern Collection System:	The collection of water from the runoff and guttering systems can be stored and utilized for landscaping purposes. This system reduces the stresses on municipal water systems or the aquifer supplying the project with water.
Microbiotic Filtration:	Microbiological organisms can be utilized for the break down and filtration of sewage and gray water materials from the structure. The transfer of said materials to tank and pond storage for landscaping purposes reduces the needed water on the site, reduces impacts on municipal sewage treatment systems, and reduces the need for the creation of septic and leaching systems.
Site Supplied Water Systems:	The utilization of aquifers, ponds, and well systems for structural water supply reduces the need for expansion of municipal water systems.
Solar Water Heaters:	The utilization of solar collection devices to heat the building's water supply reduces the energy required for heat maintenance and may be stored for around the clock utilization.

Example Building Plumbing Systems Cont.	
High Efficiency Pumps:	The implementation of high efficiency pumps within the structure's plumbing system reduces the energy needed for water movement.
Locational Water Heaters:	The use of smaller water heater "boosters" reduces the heat lost to the piping systems of the house and reduce the energy required to maintain a consistent water temperature.
Low-Flow Fixtures:	The use of fixtures and devices that require less water for functioning(I.E.- Toilets) helps reduce the wasting of water within the structure. Tighter control devices(I.E.- Efficient valves) reduce the wasted water during the movement of water from and through devices.
Insulating Heaters/Tanks/Pipes:	The reduction of heat loss through the walls of tanks, heaters, and pipes reduces the needed energy for water heating and temperature consistency.
Geothermal Heat Storage	The utilization of the Earth's insulative properties to maintain higher water temperatures. Hot water is pumped into subgrade tanks.
Hydronic Heat Storage	The utilization of pumps to force water down into the Earth's crust to produce super heated water. The hot water may stored for later uses.

Electrical

The electrical systems within the building are some of the most resource consuming aspects of the building. The production and consumption of energy are some of the largest problems within society today. The sustainable building would utilize minimal maintenance, high efficiency systems for energy production and consumption on the site.

Examples of Building Electrical Systems With High Efficiency and Reduced Resource Consumption	
Hydroelectric Power:	The utilization of water resources on the site to produce power for the structure/s reduces the need for hookup onto municipal power grids. Excess power may be sold back to power supplier for profit.
Wind Power:	The utilization of wind resources on the site can produce electricity for the structure and possibly eliminate the need for hookup to the power grid. Excess electricity may be sold back to the supplier.
Photovoltaic Power:	The collection and storage of solar energy can supply electrical power to the structure during evening/night hours. The reduction of power need from utilities saves the project money and excess stored energy may be sold to utilities at peak hours for the highest resale rates available.
Higher Efficiency Switches: and Transformers:	The use of efficient transformers and switching devices can reduce the waste of energy within the structure.
High Efficiency Appliances:	The utilization of efficient end-use products can reduce the energy needs of the structure. Lower voltage appliances and structural maintenance devices can dramatically reduce the consumption of energy within the structure.
New Wiring/Smaller Circuits:	The utilization of efficient wires and smaller circuits can reduce the waste of electricity within the electrical systems within the structure.

The planning and utilization of efficient management systems within the building offers high efficiency to sustainability during the initial stages. The greatest costs would be related to the installation of systems. The possibility of creating sustainable architecture is directly related to the individual building's presence within it's environment. The ability, or inability, of a building to exist within the series of systems controlling the ecosystem defines the sustainability of it's presence.

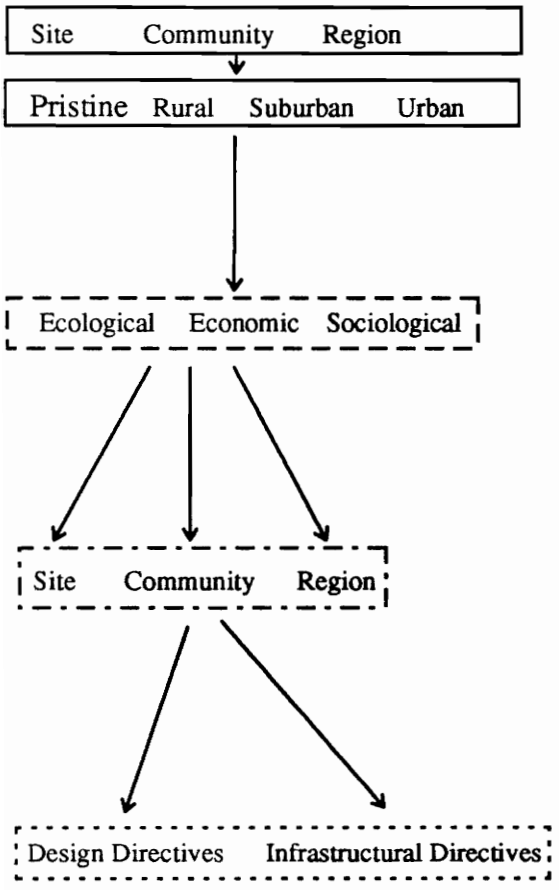
Site and Scalar Development

Sustainability of the individual building or project leads to questions of developmental scales. It is important to address the site placement for the building/s, projects, and communities within environmental constructs for architectural sustainability.

In a site scale project it is important to establish the locational factors of site development and architectural sustainability. The construction issues of sustainability must be applied in a manner appropriate to the site and environmental constructs. The designer should establish the environmental constructs, as evaluated in the first part of the model, and then orient the building and site development to fit those conditions.

Community development is similar in the way the smaller scale sustainability issues are configured into larger, extensive developmental models. The infrastructure of the community dictates it's ability to be sustainably viable. The direct correlation of community design and sustainability can be exercised as a progressive model for sustainability throughout time.

Regional development must address the community issues of sustainability as a series of constructs within a larger environmental construct. The series of community models can be addressed in an extensive, and cohesive, model for the region's sustainability throughout time. See figure 11 below:

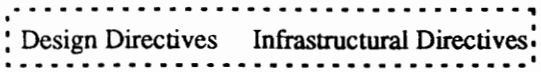


Current Environmental and Developmental Context/Status
-The current developmental status of an environment may dictate the ability, and methods, the architect/designer may utilize to modify the environment to support sustainability.

Current Environmental Constructs
-The current environmental status of the development area and surroundings dictates the predominant conditions that relate to the possibility of architectural sustainability within that environment. These constructs lead to the dealing with developmental issues with sensitivity specific to the given location.

Proposed Developmental Scale
-Assessing the intended scale of development within an environment derives the scalar issues of sustainability and the developmental aspects that can be established to support sustainability. The relationships of environmental constructs and proposed development lead to infrastructural and design directives to support the specific environment.

Design/Infastructural Directives
-The developmental intentions of the project, when combined with the



environmental and developmental constraints, derive the systems and ways

to obtain sustainability within the project. The sustainable design and infrastructural directives of the site, community, and region lay the foundations for the project's viability.

Fig. 11. Site and Scalar Development

Examples of Possible Design and Infrastructural Issues and Directives
Orientation of Individual Structures and Structural Groupings to Optimize Natural Feature Amenities
Structural Placement Within Site Environmental Constructs
Site Development for Optimum Energy Consumption/Conservation
Infrastructural Location Directives for Community Development To Optimize Land Use/Utilization
Developing Sustainable Community and Regional Utilities Such as Power and Waste Management
Developing Manageable/Minimal/Sustainable Community and Regional Transportation Systems
Development of Community and Regional Supportive Food Production and Distribution Systems
Development of Community and Regional Supportive Systems of Resource Utilization and Replacement
Development of Community and Regional Supportive Environmental Sustainability Monitoring
Development of Community and Regional Supportive Developmental Sustainability Monitoring

Structural Symbol Legend

Symbol	Quick Definition	Page/s
EIA	Environmental Impact Assessment- A strategy designed to appraise the environmental conditions of an area and the impacts that development may have on that environment's status.	p. 88-89
UET	Ultimate Environmental Threshold- A strategy designed to assess the limitations of the existing environment and devise limits for developmental influence on that environment. The development would be limited to avoid irreversible environmental damage.	p. 90-91
Environmental Analysis	This symbol was intended to imply that if the project budget could not support extensive analysis, such as the EIA and UET, that it is important that the designer should investigate the existing environmental constructs as best as possible.	
Structural Order	The structural orders of the environment: The composition of living and non-living elements within the environment and their interactions.	p. 114
Functional Order	The flow of energy throughout the environment: The ways in which energy is transferred through an environment. This includes plant and animal growth, death, and decay.	p. 114
Locational Order	The type and number of species that an environment can feasibly support as it exists.	p. 114
Conversion	The organized transfer of solar energy within the environment.	p. 114
Distribution	The movement of environmental materials and processes to support environmental maturation.	p. 115
Filtration	The filtering of environmental nutrients that are relocated by weather, etc..	p. 115
Assimilation	The process of death, decomposition, and enrichment within the environment.	p. 115
Storage	The storage process of resources and energy that maintain the environment. The process occurs in water, soil, and plants.	p. 115
VEC's	Valued Ecosystem Components- The aspects of an environment that have direct influence on the quality of ecosystem and/or human status and maturation.	p. 61-62

Bioregional Objectives	The supporting of certain ecological attributes for the preservation of bioregional integrity. The characteristics of an environment, ecological and human, that must be maintained for environmental viability.	p. 61
Materialism	The sociological construct where emphasis is directed towards the obtaining of products and physical goods for prosperity.	p. 71
Transcendentalism	The sociological construct where emphasis is directed towards increased consciousness of the individual.	p.71
Co-Evolutionary	The sociological construct where emphasis is directed towards the increasing of both material goods and consciousness for the individual.	p. 71
Dependent Social Systems Sustainability	The organizational systems of a society that depend on the ecosystems that the society interacts with.	p. 72
Human Benefit Sustainability	The maintenance of systems diversity within a society for it's viability.	p. 73
Patterns Analysis	This symbol is intended to imply the need to investigate a society's developmental patterns and the participation patterns within a society to describe it's status.	
Demographic Layout	The developmental layout of a community, or society, within it's environment.	p. 76
Political/Management Structure	The manners in which a society manages itself for equity and viability.	p. 76
Lifestyle Standards/ Quality	The living conditions and standards within society that the population with or at; the norm of living within the society.	p. 76
Information Access/ Distribution	The types of information available and the societal players that have access to the information.	p. 76
Stratification/ Diversity	The diversity of individual status and occupation within the society.	p. 76
Societal Mobility	The ability of the individual to dictate their position within society.	
Societal Health	The ways that a society maintains itself for the optimum interactions of participants and features.	
Societal Diversity	The combinations of features, participants, and interactions that provide mobility and diversity within the society.	
Participation	The ability of the individual to utilize and feel "closeness" to the features within their environment.	

Capitalism	The societal economic structure that emphasizes the individual accumulation of wealth.	
Socialism	The societal economic structure that emphasizes the development of societal wealth to be distributed equally between the participants. The economic structure would be maintained by a few politicians and/or leaders.	
Multicriteria Analysis	A model for development based on the economic, sociological, and ecological functions of an environment.	p. 47
AME	Artifact Maintenance Efficiency- The length of time a product or artifact is utilized.	p. 50
ASE	Artifact Service Efficiency- The effectiveness of a mixture of products to satisfy a society's needs.	p. 50
EME	Ecosystem Maintenance Efficiency- The ability of an ecosystem to support a series of uses without long-term harm.	p. 50
ESE	Ecosystem Service Efficiency- The allocation of the negative aspects of economic activities throughout an environment.	p. 51
Production Oriented	The resource utilization of a society as oriented towards the creating of new products and technologies for participant use.	p. 49
Synergy Oriented	The utilization of resources and technologies for a combined, positive, influence on society.	p. 49
End-Use Oriented	The utilization of technological advances to produce end-use product, such as appliances, that have high efficiency and low maintenance.	p. 49
Direct-Use	The contributions an environmental feature or factor has to production or consumption.	p. 46
Indirect-Use	The benefits from the environmental functions as they pertain to production or consumption.	p. 46-47
Option Value	The willingness to pay now for future benefits expected from an existing asset.	p. 47
Non-Use Value	The impediments or benefits which occur regardless of user intentions.	p. 47
Residential	A structure utilized for living functions of individuals and families. Scale may vary from the small studio apartment to the luxury estate.	
Office	A structure utilized for business and service practices.	

Industrial	A structure utilized for production of products and systems.
Municipal	A structure utilized for a community's organizational and maintenance coordination divisions.
Educational	A structure utilized for the education of the general public. These structures may include science museums, etc..
Special	A structure utilized for special purposes, such as art galleries, convention centers, etc..

Part 3: Structure Application: Boyne River Ecology Centre, Shelbourne, Ontario, Canada

The interdisciplinary review structure has provided a theoretical and methodological framework for investigation into architectural sustainability. It would be appropriate to apply the structure to an existing example of architecture in order to evaluate how the structure is utilized as a tool for evaluation. It would be expected that an architect would utilize the structure in coordination with the architect's array of analytical tools and experiences that support their style of design and process. The structure will be applied to an example of "sustainable" architecture, the Boyne River Ecology Centre in Shelburne, Ontario. The complex was designed and implemented as a piece of ecologically sound architecture, therefore the project would be a good assessment of the review structure: If the theories presented support the formulation of sustainable architecture and if the structure applies analytical methodologies in an evaluative manner that reveals important issues and concerns of the environment and the project's objectives.

The Boyne River Ecology Centre

In the early 1990's, the Boyne River Natural Science School in Shelbourne, Ontario, decided that they required more classroom space for it's students. As published in The Canadian Architect, environmental engineer Greg Allen was consulted to figure out how to attain the needed space. He requested that the school "seek sponsorship and turn the project into a demonstration of how it is possible to build a public building with near zero impact on the environment."(The Canadian Architect) Located outside of Toronto, the school could be utilized to teach the "principles of sustainability, low environmental impact, energy conservation, energy renewal, and healthy construction"(Mays, 1993) to approximately 200 students per week.(Crosbie, 1994) The concept was accepted by the Toronto Board of Education and sponsorship was gained from the Metropolitan Toronto Board of Education, the Ontario Ministry of Energy and Environment, and Ontario Hydro.

The architectural firm of Douglas B. Pollard Architects was contacted to undertake the project. The result was a 6,000 square foot, sixteen sided structure that was to utilize solar, wind, geothermal, and hydro properties to support and maintain itself. The project was designed and produced for $1,230,000(Canadian) after a late budget cut, the original budget was $1.5 million(Canadian). It was opened on the summer solstice of 1993.(The Canadian Architect) See figure 12:

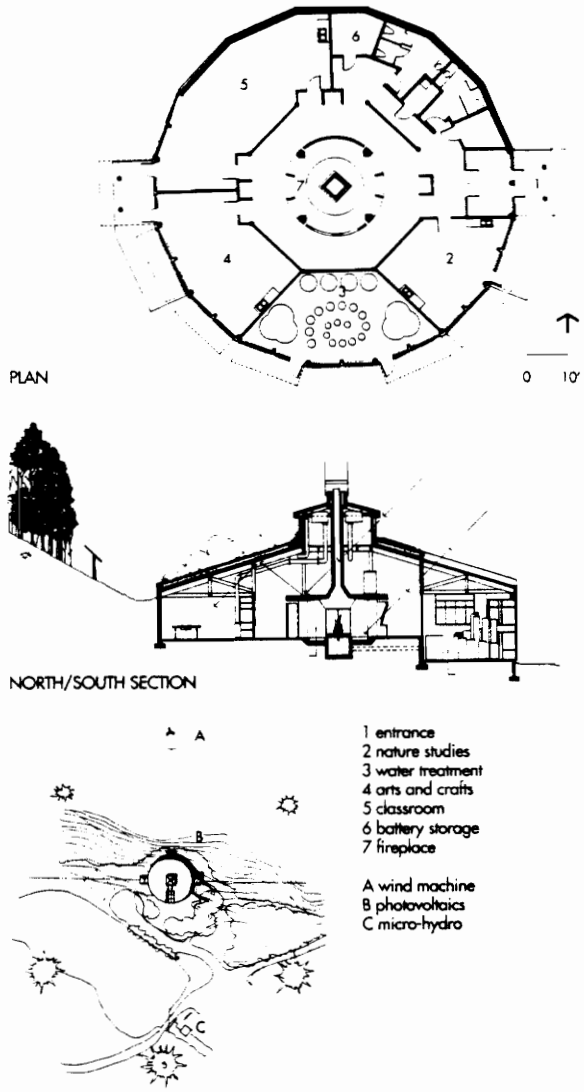


Fig. 12. The Boyne River Ecology Centre
From The Canadian Architect, June 1994, vol. 39, no. 6

In the beginning, the project would fall into the realm of the existing building when applied to the structure. It would be represented as the following:

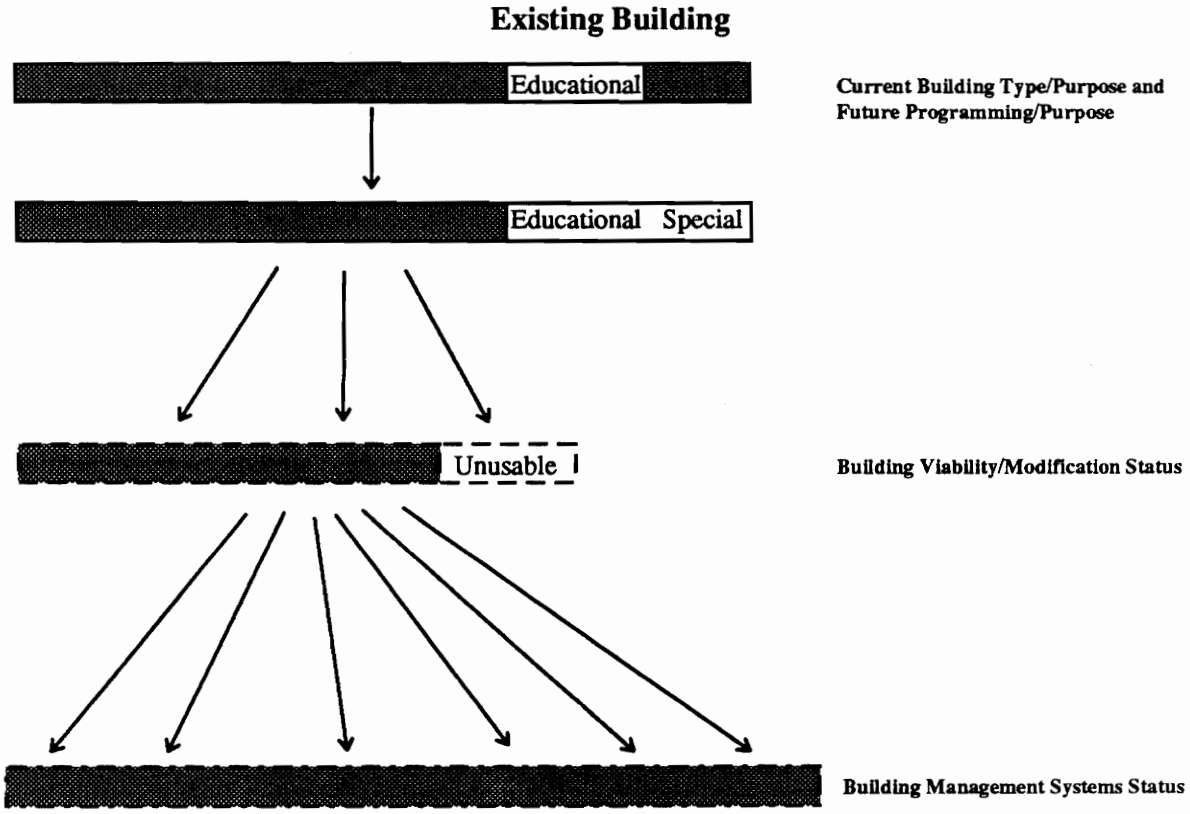


Fig. 13. Existing Building(Case Study)

Because the designer/consultant deemed the building unusable or unsatisfactory, the structure reflects the building this way. The project is then developed as a new building and evaluated within the **Site and Scalar Development** analysis structure. In this evaluation, the project is perceived as the following:

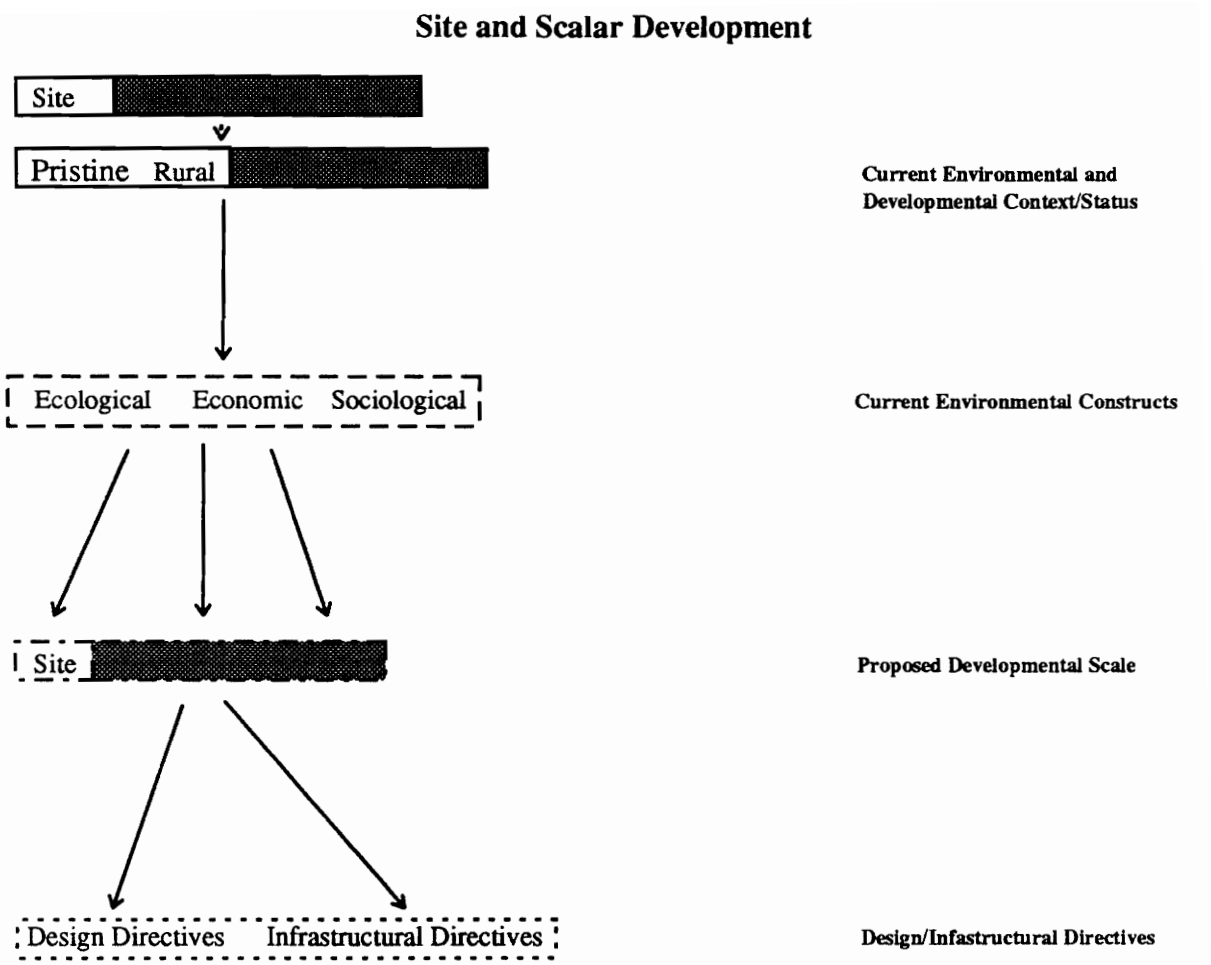


Fig. 14. Site and Scalar Development(Case Study)

The project was intended as a site scaled project. The site is in a rural area Northwest of Toronto, with minimal to no environmental influence besides the existing structure. We may describe it as pristine/rural. At this point, it would be appropriate to input the results of the current environmental constructs evaluations of the project area. Due to our lack of contact with the site and project aspects, we are simply not capable of performing adequate evaluations of the environmental conditions and constructs. I will simply describe the environmental constructs as they are described by my resources: An article in The Canadian Architect, an article in Architecture magazine, and in the book Green Architecture.

The site is located on a hill next to a naturally fed pond and stream. The site that is suitable for construction is a small meadow facing South(from the hill towards the pond) was

cleared naturally by beavers. There is a consistent wind from the West, average wind speed unknown but evaluated as suitable for a wind generator. Temperatures in the region range from approximately -20 degrees Celsius(-34 degrees Fahrenheit) to 36 degrees Celsius(97 degrees Fahrenheit).

The conversion systems that are the usable in the project are active and passive solar energy. A building may utilize solar energy for heat gain into the structure and in PV arrays for energy production. The distribution systems that may be utilized within the project are water movement from the stream and wind movement. The movement of air and water can be utilized for power production and waste management. The filtration systems on site are the ponds, stream, and winds. They may be integrated into waste management systems. The composting of waste materials and combustion wastes of fuels(I.E.-wood) into soils are available forms of assimilation on site. Natural storage systems on site are the pond, woods, and other plant growth. The stored energy from water and wood may be utilized for project energy needs. Important ecological features(VEC's) of the site include the following:

1. The natural vegetation around the pond and stream. The plant material perform many filtration and purification processes on site and are therefore important to the sustainability of the environment.
2. The woodlands around the meadow. These areas provide protection from the winds of winter, the sun of summer, provide habitat for wildlife, and produce resources that may be utilized for construction and energy needs.
3. The view from the site. By maintaining the viewshed, the project visually re-emphasizes the value of the land.

The project is regulated by a bureaucratic system. The Board of Education and other sponsors devise the allocation of funds based on group decisions of valued project aspects. Their decisions lead to programmatic changes within the project. The sociological and economic values of the project are delegated by these groups and therefore the developmental options are regulated by many different interests. The major project functions are considered to be the educational support of students, information access, end-use systems.

The demographic layout of the area is rural and relatively restrictive. The project is off of public and mass transportation routes(70 miles from Toronto). Transportation of

materials and students must be carried out by smaller vehicles. Materials for construction will require long transportation times and energy for implementation. Electric utility connections to the site are long, environmentally disruptive, and expensive. A major project concern will be how to regulate waste of energy and the management of resources to achieve sustainability.

Once the environmental constructs are derived and the motives for development are elaborated into perameters for development, the designer/architect applies them into the conceptual framework evaluation for the architecture of the project.

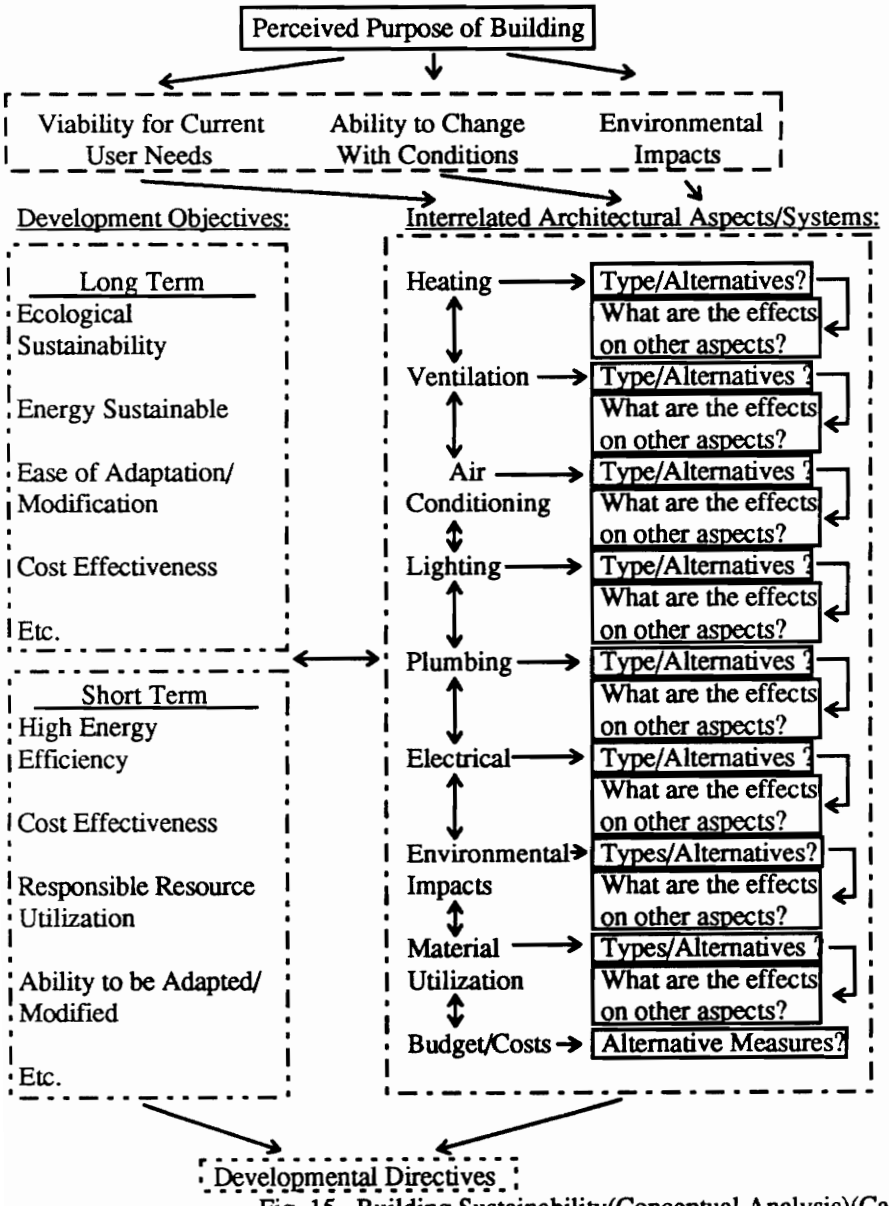


Fig. 15. Building Sustainability(Conceptual Analysis)(Case Study)

The developmental directives for the architecture are then cross referenced with site and scalar developmental directives to establish a comprehensive set of issues and perameters to achieve architectural and ecological sustainability within existing environmental constructs. The directives are then applied to the **Unbuilt/Planned Building** structure and the options for production and maintenance systems are described and evaluated. After the alternatives are discussed, the most appropriate combinations of systems and techniques are applied to the project. This should lead towards a sustainable architecture.

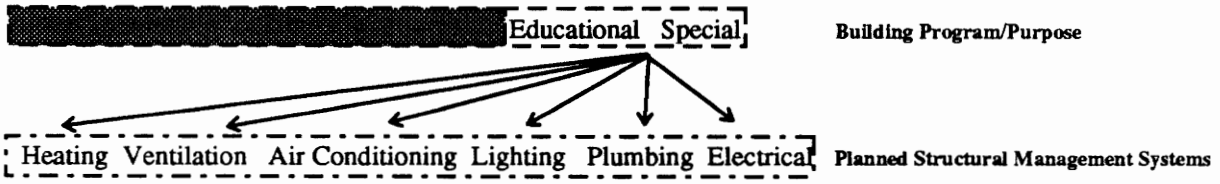


Fig. 16. Planned Building Analysis(Case Study)

The systems selected by the Boyne River Ecology Centre are listed and described below:

Heating

Passive Solar Heating:	The centre utilizes 1,020 square feet of windows and 308 square feet of skylights for light and heat gains to the structure. Windows are triple-glazed, low-E coated and have low thermal conductive silicon foam edge spacers. The concrete slab floor acts as a heat sink and releases heat at night.(The Canadian Architect)
Earth Roof:	The centre's roof utilizes biomass for insulation and heat storage. The roof has approximately an R-30(when combined with layers of styrofoam insulation) insulation value and has a dual function of retaining heat in the winter and blocking heat in the summer.(The Canadian Architect)
Earth Sheltering:	The North facade is recessed into the earth for increased insulation and reduced surface area for wind heat losses. The earth supplies a consistent temperature to the structure(about 54 degrees Fahrenheit) and releases slab collected heat back to the structure in winter evenings.(Mays, 1993)
Fireplace:	A backup heating device, the fireplace provides heat energy from on-site resources. Combustion air is supplied through in-floor pipes.(Mays, 1993)
Vestibules:	Vestibules are utilized to reduce heat losses through users entrancing or exiting the building.
Heat Recovery Ventilator:	A heat recovery ventilator, not unlike a heat exchanger, replenishes fresh air into the structure, while transferring the heat/cool to incoming air.

Ventilation

Natural Ventilation:	The central cupola draws air upward into the structure when the windows are opened. Other natural ventilation sources are operable windows throughout the structure.(The Canadian Architect)
Heat Recovery Ventilator:	As mentioned above, the ventilator replaces "stale" air with fresh while transferring heat/cool to the fresh air.(The Canadian Architect)
10-watt Fans:	Four ten watt fans are utilized in air circulation in extreme conditions, such as in severe winter cold. The fans move air(and heat/cold) around the structure for increased comfort and air changes.

Air Conditioning

Earth Sheltering:	As mentioned in heating, earth sheltering provides mass that transfers heat/cool to the structure depending upon the season.
Earth Roof:	The roof provides insulation from summer heat and the mass cools the internal air.
Heat Recovery Ventilator:	As with hot air, the ventilators provide cooling to incoming air, thus saving energy and temperature of air.

Lighting

Daylighting:	Use of natural lighting and louvers, etc. provide controllable sources of light during the daytime. Daylighting systems include: Clerestories, light shelves, glass transoms, and translucent fiberglass ceilings.(Mays, 1993)
Fluorescents:	Provide more efficient lighting to classrooms than incandescent lamps.(Mays, 1993)
Low-Voltage Halogen Lamps:	Low voltage halogen lamps provide circulation lighting at night without the energy consumption of other lamps.(Mays, 1993)
Motion Controls:	Devices that monitor user movements control lighting for higher energy efficiency.(Mays, 1993)

Plumbing

Solar Waste Treatment System:	A solar waste treatment system utilizes plants, microbiologic organisms, and solar energy to purify waste waters, including raw sewage. Water is stored and reutilized in the building.(The Canadian Architect)
Solar Hot Water Heaters:	Solar collectors utilize solar energy to heat water for most uses on site.(Mays, 1993)
Fireplace Water Heating:	Pipes under the fireplace collect some of the heat of fire and transfer it to piped water.(Mays, 1993)

Electrical

Photovoltaic Power:	A series of PV arrays are located behind the structure on the North side. They provide 2.3kWh/day average.(The Canadian Architect)
Wind Power:	A Bergy BWEC 1500-48 wind machine, mounted on the hill top at North, provides 9.3 kWh/day to the structure. The wind generator is mounted on a 100' mast.(The Canadian Architect)
Hydroelectric Power:	A micro-hydro generator is located at the base of the pond entering the stream. A waterfall supplies head to two pelton wheel generators. The system produces about 3.7kWh/day for the structure.(The Canadian Architect)
Battery Storage:	A bank of lead antimony batteries produce 48v DC and store excess produced energy.(The Canadian Architect)

The centre requires about 5kWh/day for lighting and other small base loads, while the electrical systems can produce upto 15kWh/day at optimal conditions. This excess power could conceivably be stored in batteries and sold back to a utility company during peak periods for a profit. Sales would reduce the payback period of the systems, pay for maintenance to the systems, and eventually provide an added income to the centre.

The resources described minor problems with the fireplace system and a few other "bugs" with the systems. By utilizing the structure as a post-occupancy evaluator, modifications and alternative measures can be examined for the evolution of the project. Modifications may increase the building's efficiency and sustainability within the environmental conditions. A few examples of modifications that may help the centre's efficiency are the following:

1. Replace the relatively inefficient fireplace with a Finnish-type fireplace(they tend to be extremely efficient and utilize mass for thermal storage and release.
2. Utilizing compact fluorescent lighting, instead of larger, less efficient, fluorescent bulbs would reduce energy use and produce comparable light for the project.
3. The utilization of phase-change salt solutions within concrete slabs would retain more heat than conventional slabs. Phase-change salt solutions absorb high amounts of thermal energy to change phases and maintain the changed state. Solar energy collected by the slab would be released during the night hours when there isn't enough energy to maintain the phase change.

By utilizing this structure as an examination of theories and methodologies, the architect can reveal the predominant issues of the environment and the project's goals through

the evaluation process. Through the combining of environmental aspects and the project desires, the architect can define a series of developmental objectives. The integration of concepts and processes offers a more comprehensive scheme for architectural evaluation, designing, and systems selections. The structure formulates supportive combinations that lead towards a sustainable architecture.

Part 4: Findings/Conclusions

The application of the structure has provided me with valuable information as to it's organization and viability. As a conceptual scheme, it appears to have combined enough architectural, landscape architectural, and planning concepts and issues to be manageable, while offering insight into many of the sustainable issues that are in fact effected by the interrelationships of the design professions.

The integration of ecological, sociological, and economic sustainability issues increases the depth of understanding of sustainability as it pertains to the frameworks of an existing environment. Once we are able to understand how an environment currently exists, we may begin to understand how modifications to that environment will effect many aspects of the environment, not only the obvious. An increased understanding of environmental issues and designing with sensitivity in mind is necessary to develop with a chance at sustainability.

The practical application of the structure is possible, however the structure(as mentioned in the structural introduction) must be considered an aspect to an individual's perception of environment and practice procedures. If the structure were accepted as the solution to all problems it would not address the creativity of the firm. The structure is, in fact, a relatively simplistic look at how design must be combined with environmental constructs to formulate sensitive development within various environmental conditions.

The structure offers starting points for investigations that would enhance the analysis of environments and lead to designs for specific locations. Further investigations that would help the structure itself would be:

1. Further development of environmental investigations- Examples of how the structure applies to economics, ecology, and sociology would help validate the structure to more audiences.
2. The evaluation of another type of structure, for example an office building, would note if the investigative structure could be applied easily to a condition other that an optimal investigation, such as the Boyne River Ecology Centre., and,
3. The application of the structure as a tool for an actual investigation and design project. The structure would be applied in a real environment and the strengths and weaknesses could be observed by way of the results and findings.

By observing the structure under different conditions and investigating the structural sections further, it would be interesting, and helpful, to understand the capabilities and weaknesses of the structure. The only way to really understand if the structure is viable is to apply it in a controlled, testing manner.

The investigation itself has introduced me to many aspects of an environment that are not as apparent, or obvious, as the physically notable. Interrelationships within an environment are far more complex than just how the site drains and what the side effects of using a material may imply. They relate to the infrastructure of the environment and the regulators of environmental functions, such as how animals maintain their populations and lives within the environment.

The real test, and possibly the goal, of sustainable design is how the work fulfills the environment's and user's short term needs and how the design allows for the development's future viability within that environment. Once this is conceptually laid out, it will be possible start formulating procedures to approach these goals. Although the environments will continue to change, designers will be able to develop working methodologies that will assess environmental factors, forecast the future of such environments, and lead to architectural applications that will be sensitive to the various constraints for longer periods of time.

I encourage the readers of this document to continue into the research sections. They are the heart of the structure and would offer far more information than the structure itself. The structure is something that I formulated to organize and manage my understanding of sustainable topics. The structure may not, in it's current form, be applicable for anyone that may have alternative interests in the design professions or environmental management. It may require the further elaboration in a few of the investigative sections, and the formulation of other structures to relate to the other interests. It is also important to reiterate that the concepts and methods for these types of evaluations are ever changing and should be thoroughly investigated to support one's own interests and goals.

Part 5: Introduction to Sustainability

The term to sustain is defined as, "to keep in existence; keep up; maintain or prolong."(Webster's New World Dictionary) In Nature, environmental systems maintain or "sustain" themselves by the relationships of the individual flora, and organisms, to the other facets of their environment that relate to the continuation of their existence. These relationships define the environment's behaviors, resources, and limitations. Maintenance systems such as predators, drought, blight, etc. continue the coexistence of the individual members within the ecological system.

Sustainability, "A characteristic of a process or state that can be maintained indefinitely,"(Thayer, p.99) corresponds to those interrelationships within an environment that are able to consistently exist within the constraints of current environmental conditions. In the twentieth century, the concept of sustainability has developed primarily for explanation purposes of economic and scientific systems. Thayer described the evolution of environmental sustainability as possibly relating to 1950's and 1960's forestry practices and the justification of timber yielding methodologies.(p. 235-236) The same types of sustainable explanations have been used by oil companies, energy manufacturers, materials manufacturers, etc. to explain the versatility of their businesses and the justification of increasing their profits through increased production. Scientifically, sustainability has become a heading for the studies of ecological cycles and the explanation of biomes.

The concept of sustainability within the realm of human development has involved everything from the evaluation and referencing of past civilizations to the development of definitions and frameworks for future developmental practices. For example, Thayer described human developmental sustainability in terms of human existence in a primitive world and the evolution of technologies(I.E.- tools) that supported and enhanced the human experience within these conditions.(p.25-29) Sustainability, in this context, relates to the survival of the humans within their environment while developing enhancers to ease their survival struggle. With the advent of greater technologies and civilizations, mankind developed additional

contexts within which sustainability was affected. Cultural aesthetics, scientific explorations, and ideological explanations of the environment formed the frameworks of community development and the ethics of human/environment relations.(Sheldrake, 1990) The main objective of this development was to support an increasing population and to produce adequately for increased societal standards of prosperity. "Modernization" and the advent of the Cold-War Era produced a series of societies based on the need to be at the forefront of technologies and "stronger" than other continents and countries. A separation of the human from the environment became evident in the United States by the evolution of sporadic city planning, mass housing, the highway, and other technologies that "violated the environment."(Thayer, p.83) Increased populations overconsumed the available resources with the belief that prosperity would continue and the resources were endless. The supply shortages of the mid 1970's(I.E.-Gasoline) provided for governmental and citizen distress over the use of non-renewable resources and the lack of provisions being made for future development. It was at this point that literature and research in renewable technologies, alternative systems, and sustainability received governmental funding for investigation and public recognition of the necessity of investigation.

In 1977, Dennis Pirages devised the term and concept of a "sustainable society" in his book, The Sustainable Society. Pirages discussed and debated civilizational growth that couldn't be readily managed and maintained. This publication's discussion of mankind's growth and the development of the environment lead to many other sustainability discussions, conferences, and publications including Worldwatch Reports and the Woodlands Conference proceedings of 1979.(Futures, 1) In 1987, the World Commission on Environment and Development(commonly known as The Brundtland Commission) produced a landmark document, Our Common Future. In this document, the commission defined sustainable development as development that "meets the needs of the present generations without compromising the needs of future generations." The focus of the report was to emphasize on future development with the environment as an imperative factor in the planning process. The commis-

sion's definition of sustainable development has since been accepted by many disciplines as a starting point, or objective, for prospective development.

The United Nations Conference on Environment and Development(UNCED) in 1992 raised the sustainable development issue to an international level. The "Earth Summit", as it was commonly known, invited governments, non-governmental organizations, activists, and environmentalists to come together and discuss sustainability as a future for life on Earth. Issues included universal adoption of rules, equity and trade regulations, funding for technologies transfers, public education, and developmental policy.(ES&T 1) The conference lead to the publication of Agenda 21, a forty chapter document presenting specific program areas for investigation of environmental and developmental issues. The document addressed the legal aspects of program areas, including future international legislation and strategies, for the protection of the world environment.(USDSD, 1992)

After the UNCED conference in 1992, the World Bank discussed the operational implications of sustainability and utilized this as the theme for their World Development Report, 1992. The bank then incorporated a Vice President for Environmentally Sustainable Development into their operations. This Vice President investigated the underlying conceptual issues of sustainability within international trade and developmental constructs. He related the fate of sustainability to the theoretical integration of three disciplines: Economics, Ecology, and Sociology. The position of Economics was investigated for a methodology pertaining to the maximizing of human welfare and interests within the constraints of existing capitol stock and technologies. An ecological position was important for the preservation of critical ecological subsystems for global ecosystem stability. Finally, a sociological position was investigated to formulate patterns of social organization as they pertain to the viability of sustainable development options.(F&D,1) The Vice President then organized the disciplinary positions into a graphic representation so that each discipline would understand the other's major objectives and agree that their positions were justified within the study of sustainability.(See figure 17)

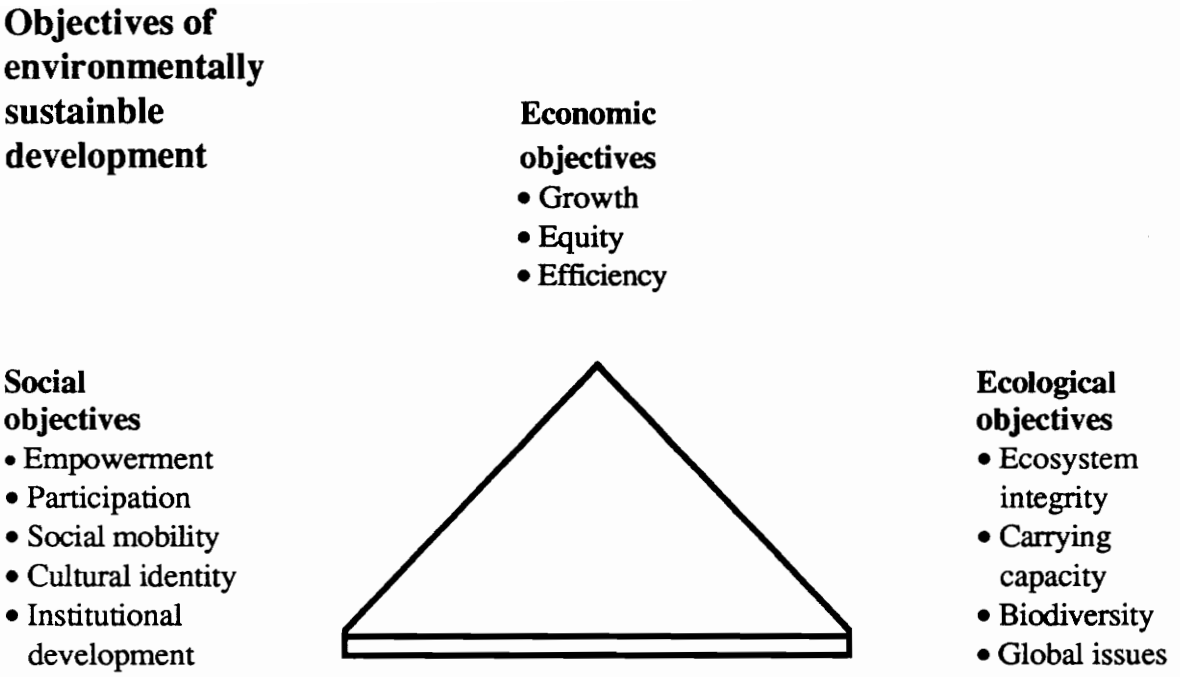


Fig. 17. Objectives of Environmentally Sustainable Development
From Finance and Development, December, 1993, p.7

Although the Vice President addressed the topical diversity of sustainability, and raised the issue of interdependency, he failed to address the perspectives of each of the disciplines as they relate to each other directly. An example, as was stated in Finance & Development, would be the way an economist would address ecological and sociological objectives and perspectives in economic terms. Sociological issues would be addressed under the guise of poverty reduction, etc. and ecological issues would be addressed in terms of resource management for economic gains, not for ecosystem biodiversity reasons.

The Vice President's interdisciplinary classification was sound and has since been utilized by many scholars as the defining principles of sustainability. D. Scott Slocombe, for example, utilized this classification as the basis for a developmental study into ecosystem regional planning and management. He applied the model as a foundation for the scale of systems, and their inherent characteristics, within the world.(See figure 18)

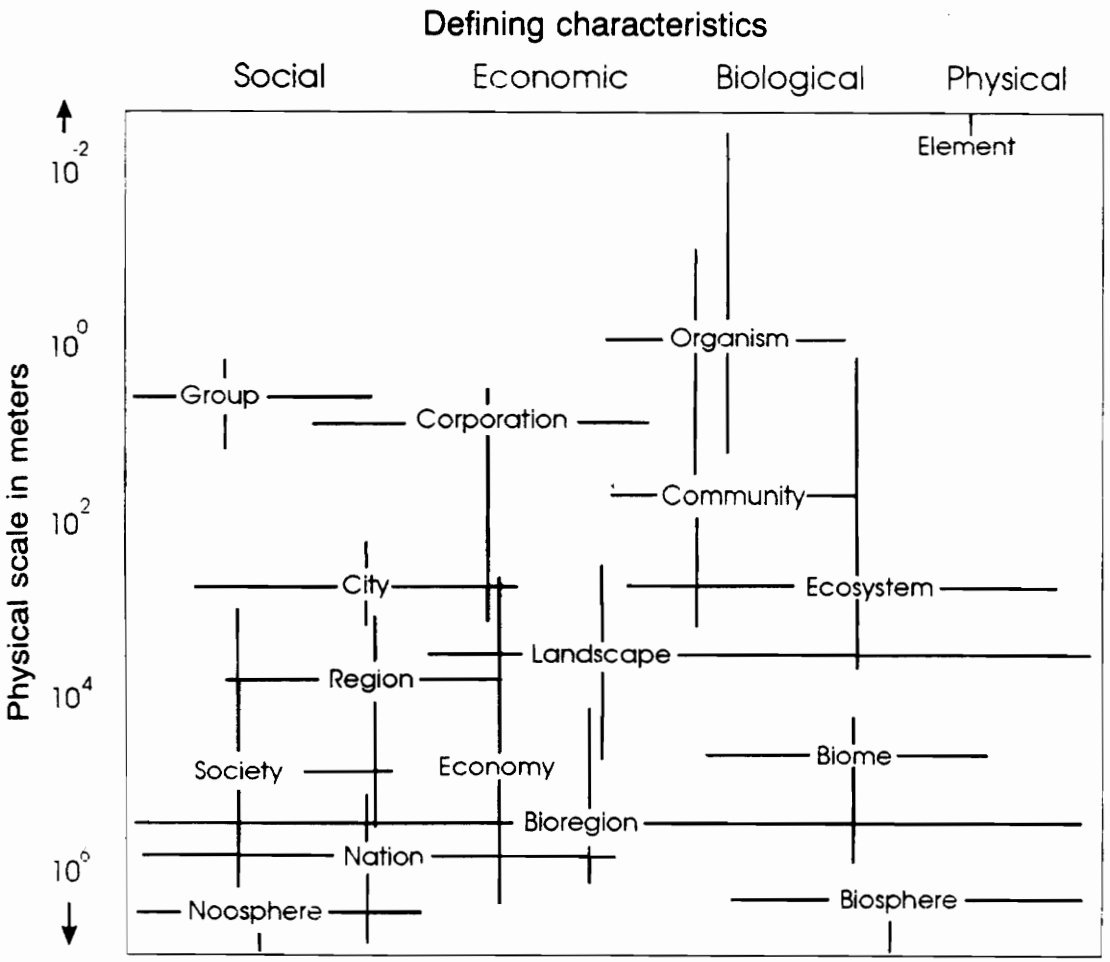


Figure 1. A classification and comparison of the terms used for entities according to their spatial scale and defining characteristics. The horizontal axis represents a continuum from physical to social structure and processes, and the vertical axis represents a continuum of scale from large to small.

Fig. 18. A Classification on Comparison of the Terms Used for Entities According to Their Spatial Scale and Defining Characteristics. From BioScience, October, 1993

This thesis will accept the Vice President's model for it's foundational classifications of sustainability, but in the next section I will investigate each of the divisions for their objectives, and then combine the divisional interests for subsequent evaluative purposes.

Part 6: Sustainability as Economics, Ecology, and Sociology

In order to develop a method for sustainability evaluation, it is necessary to appraise the interests of each of the accepted divisions of sustainability, as derived by the World Bank's Vice President. The combination of divisional concerns and questions offer a broader scope for sustainability evaluation.

Economics

Introduction

The traditional goal of economics, the postwar model, has been to maximize the economic output through project growth. The model evolved to incorporate social issues in the 1960's, and in the 1980's the model started to address environmental issues.(F&D,2) There is currently a movement, called environmental economics, which is attempting to incorporate environmental and social issues into economic decision making. The main objective of the movement is to optimize economic development while encouraging efficient resource allocation for projects.

Environmental economics attempts to follow the impacts of decision making through a series of levels in order to figure where the issues must be addressed. These levels range in size from the project level through the international level.(F&D,2) The project level addresses the issue of whether an individual project should be undertaken, based on the externalities and open-access resources. Externalities are the effects of the project, or originator, on other systematic players that can not be reimbursed monetarily.(I.E.- Environmental degradation). Open-access resources are those which are generally overutilized while not having a set value.(I.E.- Public transportation routes)

The sectoral level investigates the instrumental programs instigated by a series of projects for their completion. These programs have a higher degree of environmental and social impacts than an individual project would. This level utilizes an efficient pricing analysis for

the cost per output rate. The general rule is that the price should include the production of the next unit of material or service, thus sustaining the process.

The macroeconomic level investigates the economywide policies while accounting for the effects on the natural resource base. The desire is to "design complementary measures that will help mitigate the negative effects or enhance the positive impacts of the original policies on the environment."(Munasinghe)

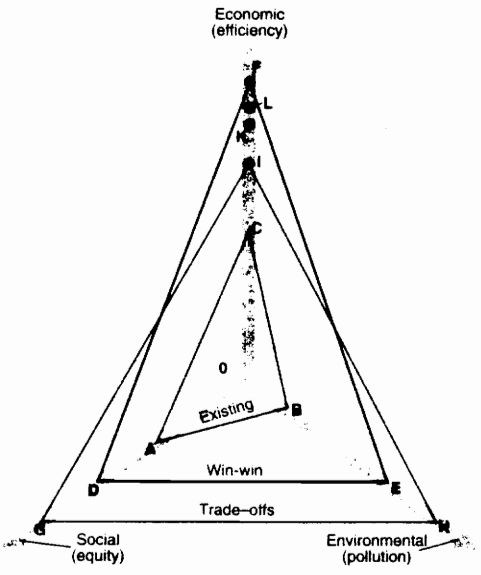
International levels locate the regional impacts and global issues of development. They are primarily interested in the permanent effects of said development on the world's systems. Munasinghe stated, "...when impacts are uncertain, sustainability suggests that limits should be imposed on resource degradation, particularly if future consequences could be irreversible and catastrophic." This relates to international unease over pollution, greenhouse gas emissions, etc. that production may introduce into the environment.

Through the investigation of these methods and models it becomes apparent that there are topics vital to understanding economics and sustainability's roles within it. These topics include: 1. A valuation methodology of systems selection and organization, 2. A system of measurement for systems: Their efficiency, cost techniques, etc., 3. An understanding of necessary modifications within existing systems for cost and environmental efficiency, and 4. The development of a series of scalar issues and questions for evaluation of programming for future reference and evaluation.

Valuation

The formation of a valuation methodology is vital to understanding the principles and objectives of a project or a system of policymaking. To understand the underlying desires of a system we must dissect it into nonmonitary value units. Munasinghe noted this as a directive for his multicriteria analysis model and his unifying matrix. He defined the economic value of a resource in terms of use and nonuse values. Use values include the following: 1. Direct Use Values- The contributions an environmental feature or factor has to production or consumption., 2. Indirect Use Values- The benefits from the environmental functions as they pertain to

production and consumption., and 3. Option Value- The willingness to pay now for future benefits expected from an existing asset. Nonuse values are those impediments/benefits which occur regardless of the user's intentions.(I.E.-Pleasure from knowing that an endangered species continues to exist.)(F&D,2) Essentially, the valuation of an environmental feature clarifies the degree to which the user will utilize and/or deplete a resource based on it's inherent properties and the costs of reducing the resource, monetarily and otherwise. Munasinghe's multicriteria analysis model clarified this valuation process by interjecting the social equity of a system, the environmental pollutive nature of the system, and the economic efficiency of said system into a visual scalar model for valuation.(See figure 19)



Multicriteria analysis: when valuation falls short

Multicriteria analysis offers policymakers an alternative when progress toward multiple objectives cannot be measured in terms of a single criterion (i.e., monetary values). Take the case of drinking water—an essential element of sustainable development—illustrated in this chart. While the economic value of water is measurable, its contribution to social and environmental goals is not easily valued monetarily. Outward movements along the axes trace improvements in three indicators: economic efficiency (net monetary benefits), social equity (service to the poor), and environmental pollution (water quality).

How are policy options assessed? First, triangle ABC describes the *existing* water supply where economic efficiency is moderate, social equity is low, and overall water quality is worst. Next, triangle DEF indicates a "win-win" future option in which all three indices improve, as could occur with a new water supply scheme that provided cleaner water, especially to the poor. The economic gains would include cheaper water and increased productivity from reductions in waterborne diseases; social gains would accrue from helping the disadvantaged; and wastewater treatment would reduce impure water discharges and overall water pollution.

After realizing such "win-win" gains, other available options would require tradeoffs. In triangle GIF, further environmental and social gains are attainable only at the expense of sharply increasing costs. In sharp contrast to the move from ABC to DEF, which is unambiguously desirable, a policymaker may not make a further shift from DEF to GIF without knowing the relative weights that society places on the three indices. Such preferences are often difficult to determine explicitly, but it is possible to narrow the options. Suppose a small economic cost, FL, yields the full social gain DG, while a large economic cost, LI, is required to realize the environmental benefit EH. Here, the social gain may better justify the economic sacrifice. Further, if budgetary constraints limit costs to less than FK, then sufficient funds exist only to pay for the social benefits, and the environmental improvements will have to be deferred.

A recent Bank study of power system planning in Sri Lanka demonstrated the versatility of this technique. For example, end-use energy efficiency measures provided "win-win" options (i.e., they were superior to all other alternatives on the basis of air quality, biodiversity loss, and economic costs). Conversely, several prominent hydropower projects could be excluded because they performed poorly in terms of both biodiversity loss and economic costs.

Fig. 19. Multicriteria Analysis Model
From Finance & Development, December 1993

Within this model one could evaluate an existing system and then produce a graphic multicriterion evaluation of alternative, or proposed, systems. The differences in graphic evaluations would allow the user to note the qualities of the alternatives in a graphic multiple objective manner. This model allows the evaluator to decide if the intended changes are "valuable" enough to proceed with under the existing circumstances.

After the multicriteria model is analyzed, the economic decisions are integrated with the social and environmental impacts of the intended project in a unifying matrix. As Munasinghe stated, "The organization of the table facilitates the tracing of impacts and coherent articulation of policies and projects, while the individual elements focus attention on valuation and other methods of assessing specific impacts to determine action priorities."(See figure 20)

Activity/policy	Main objective	Matrix of other impacts on key sustainable development issues			
		Land degradation	Air pollution	Resettlement	Others
1. Macroeconomic and sectoral policies	Macroeconomic and sectoral improvements	Positive impacts due to removal of distortions Negative impacts due to remaining constraints			
Exchange rate	Improve trade balance and economic growth	(- H)[2]			
Energy pricing	Improve economic and energy use efficiency		(+M)[4]		
Others					
2. Complementary social and environmental policies	Specific or local social and environmental improvements	Enhance positive impacts and mitigate negative impacts (above) of broader macroeconomic and sectoral policies			
Market based	Reverse negative impacts of market failures and policy distortions		(+M)[5]		
Nonmarket based		(+H)[3]	(+M)[6]		
3. Investment projects	Improve efficiency of investments	Investment decisions made more consistently with broader policy and institutional framework			
Project 1 (hydro dam)	Use of project evaluation (cost-benefit analysis, environmental assessments, multicriteria analysis, etc.)	(- H)[7]	(+M)[7]	(- M)[7]	
•					
•					
•					
Project N					

[1] A few examples of typical policies and projects as well as key environmental and social issues are shown. To illustrate, some qualitative impact assessments are also indicated—thus + and - signify beneficial and harmful impacts, while H and M indicate high and moderate.
[2] Devaluation increases profits from timber exports and leads to deforestation of open access lands.
[3] Controlling access or assigning property rights to forest lands reduces deforestation.
[4] Raising energy prices to reflect marginal costs reduces wasteful energy use and air pollution.
[5] Charging air pollution taxes reinforces effects of marginal cost pricing.
[6] Increasing financial accountability of state-owned enterprises forces them to react positively to energy price and pollution tax increases.
[7] Hydroelectric dam inundates forested land and displaces local villagers, but reduces air pollution by replacing thermal power generation.

Fig. 20. Unifying Matrix for Project Option Selection
From Finance & Development, December 1993

By utilizing these models, one can get an idea of the underlying, and possibly unrealized, issues of value within the environment and in the proposed development. The user, or evaluator, can then understand the properties of the project that are primary, and secondary, in value. Understanding the values involved in a project can start to relay the possible sustainability of said work and the desire, or lack there of, to maintain a condition or feature.

Measurement

The next step to understanding economic sustainability is to measure the systems and values that affect sustainability. Just as Munasinghe's unifying matrix measured the value of aspects within a project or environment, it is necessary to quantify the efficiency, techniques, and systems within a situation. An example of this type of evaluation is described by Lohani and Azimi in Energy Policy. Their investigation revolved around the sustainability of energy systems, their efficiencies, and the evaluation of energy alternatives on an equal scale with the established systems. They were concerned with the utilization of an end-use oriented approach to energy systems evaluation. An end-use approach, "considers the end uses of energy or the energy services performed, such as cooking, lighting, and passenger and goods transport. By considering the technical and economic details of present and alternative end-use devices, one can identify improved ways of meeting future demand for energy services."(EP, 1992) Lohani and Azimi classified end-use systems into three groups:

1. More efficient end-use devices(I.E.- better motors, stoves, etc.),
2. Synergies or technologies that permit the servicing of several end uses simultaneously, and,
3. New supply options such as renewable and decentralized resources.(p.534)

Their goal was to incorporate an optimal mix of centralized and decentralized, renewable and non-renewable supply options for the requirements of the users.

Measuring the uses and users of existing systems, modifying the systems to extend their existing functions(such as the addition of cogenerative power), and the exploration of alternative sources for needs would offer a more definitive model for sustainability evaluation.

An understanding of the quantitative uses/needs of a group or project, and the projection of future needs, would allow the designer/planner to develop highly efficient methods of supply to satisfy their needs. This evaluation model could be utilized from a national/international scale to a site specific/project scale.

Another method for measurement and evaluation was proposed by Dennis Pirages in Futures. Pirages described sustainability as an evolutionary process where mankind moves from environmentally destructive development and efficiency to one with solutions based on individual situations. He called this a transformation from existing philosophies to a post-materialist vision. A vision where society devises ways to do more with less and increase societal satisfaction without elevating levels of material consumption or environmental deterioration. He also addressed the issues of transition which political institutions would utilize in there agendas.(Futures, 2)

Pirages referenced an economist, Herman Daly, and his approach to environmental economics. Daly's model included four types of efficiency(p.202) that would substitute the traditional "throughput' and 'output per man hour' definitions of progress utilized in the economic field. Daly's position was interested in the maximization of human interests with the minimization of physical impact within the environment. His four types of efficiency were:

1. Artefact Maintenance Efficiency(AME)- AME relates to the length of time that an artefact or product is used. The maximization of the AME of an artefact in cludes the durability, reduction in repair needs, and increased longevity of products. Daly believed that the AME tended to be contrary to societal norms because consumers are motivated by pricing competitions and not qualitative reasons.
2. Artefact Service Efficiency(ASE)- ASE relates to the effectiveness of a mixture of products to satisfy society's needs. Daly stressed a need for the utilization of products so that they serve a greater portion of the potential users, allowing for less manufacturing and maintenance. An example would be mass transit use by a city allowing for less production of automobiles and less use of fossil fuels. This also holds contrary to societal norms where prosperity is based on luxury item ownership and individual product utilization.
3. Ecosystem Maintenance Efficiency(EME)- EME relates to the ability of an ecosystem to support a series of uses without long-term harm. Daly emphasized the use of efficient systems, the careful utilization of resources, using abundant resources first, and utilization of recycling when possible.

4. Ecosystem Service Efficiency(ESE)- ESE relates to the allocation of negative as pects of economic activities throughout an environment. Daly described the choosing of systems in a manner which spreads the harmful processes throughout a large regions, thus reducing the harmful effects on individual areas.

Daly noted that the sustainability of a society could be indexed by noting the level at which a society exists and progression along the dimensions of efficiency listed above.

Pirages then described the necessity of maintaining the two aspects of the "sustainability problematique." These aspects relate to the necessity of maintaining a viable natural environment and the assessment, and preservation of existing sociopolitical systems.(p.203) Pirages stated that loosing societal standards in the name of preserving of pristine environments was not a sustainable methodology. The primary problem with economics and sustainability was one of clarifying the meaning and measurement of societal progress. Historically, growth of societies has been based on the GNP, a rate of expenditure of human labor and material throughput. The rise in GNP of a country has also been related to the increased crime, etc. that a country may face, therefore it may not be an all positive index of "progress." Pirages suggested an index based on more specific and sophisticated indicators of progress and divisions dealing with human well-being within society.

Another author, Walter Corson, defined a series of indicators, statistical and otherwise, for measurement within a society. The indicators comprised a "sustainability profile."(Futures,3) A sustainability profile is a series of values between 0(not sustainable) and 100(most sustainable) relating to measurable aspects of an environment or society as sustainable. Corson defined 12 dimensions of sustainability(subdivided into 17 categories) in terms of economics, ecology, and societal sustainability to be measured. Measurement dimensions of sociological and ecological systems will be shown in their respective sections, the economic dimensions are:

Economy	Gross world product per person[a] (G). Gross domestic product (GDP) per person[a] (N) Domestic national product corrected for harm to human and natural resources (N) Unemployment rate[a] (N,L), Inflation rate[a] (N) Budget deficit or surplus and export–import ratio as % of GDP (N)

Transportation	Total production of automobiles, bicycles[e] (G,N); Passenger cars per 1000 people[d] (G,N,L) % of people using public transportation (L), % of people using car pools (L) Measures of passengers and freight carried by air, rail and road[a, e] (G,N)

Fig. 21. Indicators of Sustainability(Economic)
Scale: G-Global, R-Regional, N-National, L-Local
From Futures(3), March 1994

Corson notes, "Examination of the links between socioeconomic indicators and measures of ecological sustainability could help clarify to what extent different economic and social aspects of 'sustainable development' are ecologically sustainable."(p.213)

By utilizing measurement methodologies such as end-use analysis, environmental economics, and sustainable economics a designer can understand the underlying economic aspects and attributes of the environment that they may wish to develop in. The investigations of supply options: Centralized and decentralized, renewable and nonrenewable, synergies, cogeneration, etc. allows designers/planners the opportunity to look into alternatives and their costs as comparative models. These models offer quantitative evaluations of the environmental conditions where the valuative models investigated the qualitative aspects. It is now important to investigate modifications that would help define a clearer understanding of economic sustainability and measurement methods that would provide better evaluations of options.

Modifications for Future Study

Joan Martin-Brown, one of the heads of the United Nations Environmental Programme, defined a the need to progress to a system of 'enlightened economics'. Environmental economics programming evaluates the needed modifications of economics and technologies within a culture or condition and then applies the most appropriate systems for human benefits within the operational requirements of the ecosystem.(ES&T, 2) Objectives of this system are: To avoid increasing the stresses on existing financial systems, reduce new technology's threat to public health, maximize the reuse of material, reduce wastes, and

maintain the system without requiring that governmental systems expand to regulate and monitor such progress. Another goal of this program would be the assignment of value to other life forms and to maintain ecosystems for their species diversity. Martin-Brown's model requires the ideological modification of economic thinking and the increased responsibilities of producers within society.

There are many barriers to such a model of thinking. Common barriers to sustainable development, and/or enlightened economics, were described by Lohani and Azimi(EP). These are:

1. A lack of information or awareness among consumers, especially about recently available or rapidly evolving technologies,
2. General uncertainty regarding savings and cost effectiveness, as well as future energy prices,
3. Lack of capital and resistance to buying equipment with a greater purchase cost,
4. Requirements for rapid payback and high rate of return for building owners, occupants, businesses and industries, and,
5. The separation of responsibilities for making capitol investments and paying operationing costs. There tends to be no incentive for a landlord to purchase energy responsive machines, etc. due to the separation of user and owner and the process of charging for electricity.(p. 534)

It becomes quite apparent that manufacturer/user relations are currently a matter of advertisement and the polling of consumers for their stylistic interests. A greater investment in user education and manufacturer responsibility for the dispersal of product information and research results would greatly improve this process.

Another modification necessary for the progress of sustainable developmental practices is the equalization of energy costs based on the real costs of the energy source. This process involves evaluating the life-cycle costs of the source. This includes the ecological consequences of production, use, and disposal. Lohani and Azimi noted that there are massive subsidies for energy research and production of some energy sources. These benefits give false measurements as to an energy source's viability. A classic example of this is petroleum. Gasoline prices in the United States do not directly relate to the costs of finding resources and the manufacturing process. Government regulations, import tariffs, and subsidies

for U.S. production bring the product to consumers at a fraction of the nominal, or comprehensive costs. The U.S. Department of Energy substantiated this in their National Energy Strategy report of 1991/1992. They noted the nominal costs of gasoline in 1993 was to be about $1.25-1.30 per gallon, when in fact the consumer was paying only $0.95-1.00 per gallon. This pricing strategy completely misinforms the consumer of the inherent costs of the product and therefore reduces their ability to accept alternatives and the costs associated with them. If one looks at the global markets, petroleum costs range from $3-5(American) per gallon. Those costs are directly related the importation, refinery, and utilization costs in those countries. This is one driving reason for European countries to investigate alternative energy systems. The inherent costs associated with maintaining a petroleum market are far too great for the amount of time the product will continue to be needed. Another problem with resource management as it pertains to petroleum is that the costs of petroleum do not directly relate to the decreasing nature of the resource. Petroleum is not a renewable resource, at least in our lifetime, and should be weighted by it's inability to be a consistent resource. This would allow alternative energy sources to obtain a better standing within the U.S. and the world community.

The creation of a standardized measurement methodology and a comparative model to explore existing and alternative product efficiency rates would be a major improvement. Measuring the energy efficiency of a product type would inform consumers as to the abilities of a product to be efficient. When compared with older models, and quantified into dollars savings for simple consumer evaluation, market qualitative standards would rise and consumer knowledge of alternatives would rise. The same standards could be utilized for other scaled intentions. Lohani and Azimi noted, "...the cost effectiveness of energy conservation measures is ultimately determined by the energy savings that are realized in actual use. Energy saving realized from past conservation efforts should be measured in a sample of projects and compared with expected savings in order to improve future energy saving projections and modify conservation strategies, if necessary"(EP) By setting up a project scale evaluative

model designers and evaluators could begin to understand and estimate progress in sustainable development.

Walter Corson noted economic transitions and economic and technological strategies that would help the advancement of sustainability. He noted that improvement of product quality would reduce the need for increased output of energy and products. He also stated the importance of including the social harm and natural resource degradation into the cost of the product or service.(Futures, 3) Corson listed some needed measures for economic and technological change, they are:

1. Estimate and publicize the full social and ecological costs of natural resources, goods, and services.
2. Phase out government subsidies for natural resources such as timber, water, minerals, and grazing land so that their prices reflect the full costs of their use.
3. Phase in full-cost pricing so producers and consumers begin to absorb the full costs of commodities.
4. Implement 'sustainable development accounting' for nations, regions, and business firms so their accounts include the costs of harm to natural and human resources caused by their activities.
5. Implement ecological tax reform by increasing taxes on destructive activities such as pollution and deforestation, and lowering taxes on income from constructive activities such as work or savings.
6. Reduce the external debts of developing nations through debt-for-nature exchanges and other means.
7. Provide government incentives and form public-private partnerships to promote development and implementation of sustainable technologies.
8. Direct government purchases to assist commercialization of efficient and resource-conserving technologies.
9. Shift government support from military expenditures to sustainable enterprise projects and programmes to reduce poverty and protect the environment.
10. Establish environmental standards for certification of consumer products. and,
11. Promote environmentally responsible advertising.(p.210)

Modifications are called for on all levels of government and societal economics. Designers can benefit from these modifications by being offered equal information and analysis for a series of products and processes. This information allows the designer to weigh alternatives equally with established methods and correctly estimate product value, or cost, based on the related issues of production and disposal(life-cycle costs) of the product.

Questions for Designers

Finally, economic understanding of sustainability should be directed towards designers in the manner of project scaled questions. These questions form a basis of understanding economic sustainability within the project, and, depending on the scale of the project can define some of the options available to the designer. Some economic evaluative questions for designers are as follows:

1. What are the current economic aspects/conditions within the site/project?
2. Are there any resources that dominate or are dominated by the site/project? Can they be utilized for project benefit/profit?
3. Are the existing conditions of the site/project maintainable or worth sustaining?
4. Considering the objectives of the project, how do modifications to the site/project effect the perceived value of the site/project? Would it be considered a win-win or trade-off situation? Are the costs too 'expensive' to justify modifica tions to the site/project?
5. Are the costs of site/project modification irreversible? Would the benefits related to modifications be worth the inability to get the original systems back?
6. Systemswise, are there any end-use systems available that would increase site/project efficiency?
7. Can modification be optimized through utilization of a hybrid of many systems to geather? Would waste be minimized through hybrid measures?
8. Are there any synergies, or the possibility of cogeneration, that will service multiple facets of the site/project?
9. Would there be any added benefits by decentralizing energy sources, etc. within the site/project? Added efficiency?
10. Are the systems implemented able to be upgraded or modified when the technology is available to do so? Will the system become archaic?
11. Are the products/systems maintainable for extended periods of time without major repairs or replacement?(AME)
12. Are there any ways to increase user efficiency through the offering of centralized services or areas of interest?(ASE)
13. Can the environment support proposed development without showing noticeable strain or degradation?(EME)
14. Are the negative aspects of the project able to be distributed so that the negative aspects are minimal to the surrounding environment?
15. Are the actual costs of modification understood by the participants of the site/project? Do they understand the reasoning for systems selection? Are they informed of the alternatives available? Are they aware of the costs associated with the systems used and their efficiencies?

By asking these questions, and hopefully integrating their own, the designer may gain an understanding of site/project economic issues and incorporate these issues into their working methodologies.

Ecology

Introduction

Ecology has traditionally been associated with the physical and biological functions of the natural environment. Colin Rees noted that ecology has generally been separated from human affairs and only in recent years has been reintroduced as an influence to human interests and was being influenced by human interests. He noted that a sophistication has taken place in regards to ecological perception, one where current attitudes accept the limits of ecological systems and resources. This perception embraces three fundamental principles of ecology(F&D, 3), they are:

1. Human economic activity is a subsystem that operates within a larger, but finite, ecosystem. Disordering of the ecosystem(e.g., depletion and pollution) even tually interferes with the life-support systems sustaining the economy.,
2. As expanding economic activity and growing human populations use increasing amounts of natural resources and produce ever-increasing volumes of waste, the limits(or carrying capacities) of ecosystems are being exceeded., and,
3. Some development impacts will, if drastic enough, cause long-term, and even erreversible, environmental changes.(p. 14)

This maturation of society changes the role of the ecologist and the changes needed in the study of environmental sustainability.

Ecologists have traditionally investigated the systems that form the environment: The components of the environment and their interrelationships for descriptive and scientific understanding purposes. The primary challenge for today's ecologist is to estimate and predict the effects of human intervention and development upon the relevant natural systems in the surrounding environments or ecosystems. Rees suggests that ecologists may eventually be consulted in the placement of industrial projects so that projects would be developed in natural environments that could absorb the pollutants from production.

Another role developing in ecology sustainability is as the developer of strategic agendas for future civilizational development. Rees noted three approaches for these agendas:

1. Encourage the integration of ecological considerations into economic and sectoral development policies.,
2. Devise anticipatory and preventive strategis for development projects., and.,
3. Demonstrate how sould ecological policies and practices benefit development.

By playing an initial role in developmental practices, ecologists enter the process at the 'ground floor' instead of playing the role of anti-development advocate that tends to be the noticed case. An ecologists perspective could address issues of the dyanmic roles between natural systems and the indirect effects of development upon an environment.

Ecologists could play larger national/international roles in development management practices. By adding their viewpoints to governments, the ecologist can help formulate national conservation strategies, environmental sector reviews, ecological or natural resource profiles, and environmental action plans. These plans address the environmental problems of a country and identify the policies, institutional measures, and investments that would respond to these problems.(p. 15) An important aspect Reece noted is that ecological factors should be integrated into mainstream economic policy decisions and that environmetal assessments should include policy-based lending, which is second only to project lending in the banking industry.

Ecological sustainability includes the understanding, conserving, and the utilizing of environmental systems on many levels. These levels include sites, bioregions, national, and international ecological issues. There are some important understandings that must be made as to how the environment exists and sustains itself. Lester Milbrath noted a series of imperatives for the understanding of natural systems. These imperatives are:

TABLE 1. IMPERATIVES OF NATURE'S SYSTEMS

(1) Biogeochemical patterns do change. Humans can, and are, changing them.
(2) These systems constitute a web of life that is interlocked and highly complex. Human-induced perturbations can produce chaotic behaviour.
(3) Nature abhors maximizing the population of any one species; diversity is essential for ecosystem stability.
(4) Earth is a closed system in which space and resources are finite.
(5) All creatures (plant and animal) seek organic (maturational) growth and development.
(6) Growth in populations of reproducing species is exponential when unchecked. Since persistent doubling is impossible, given finite limits, growth must be limited.
(7) Most animal species survive by finding a niche utilizing support from one or more other species. Cooperation, not competition, is the key to survival.

Fig.22. Imperative of Nature's Systems
From Futures(4), 1994

These imperatives describe relationships that are not consistently understood, nor considered by most people. They are aspects of the environment that have an effect on, and are affected by, modifications within the environment. Conservation of an environment includes a basic understanding of the systems and imperatives that are associated with the environment so they will be accounted for before/during development. A major conservation movement being investigated is biodiversity conservation.

Biodiversity conservation relates issues of utilization, examination, and the preservation of lands into the conservation process. Walter Reid describes these elements visually.(See figure 23)

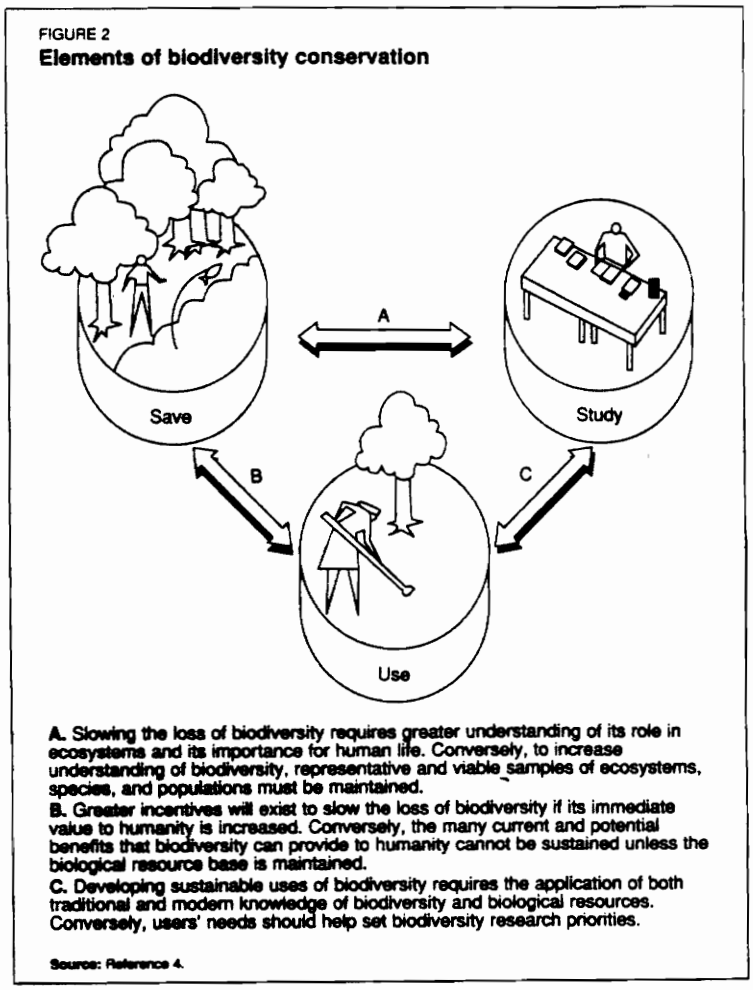


Fig. 23. Elements of Biodiversity Conservation
From Environmental Science and Technology(3), 1992

The figure gives a very basic understanding of the elements and the interrelationships between them. Reid then described the scope and levels of biodiversity conservation.(See figure 24)

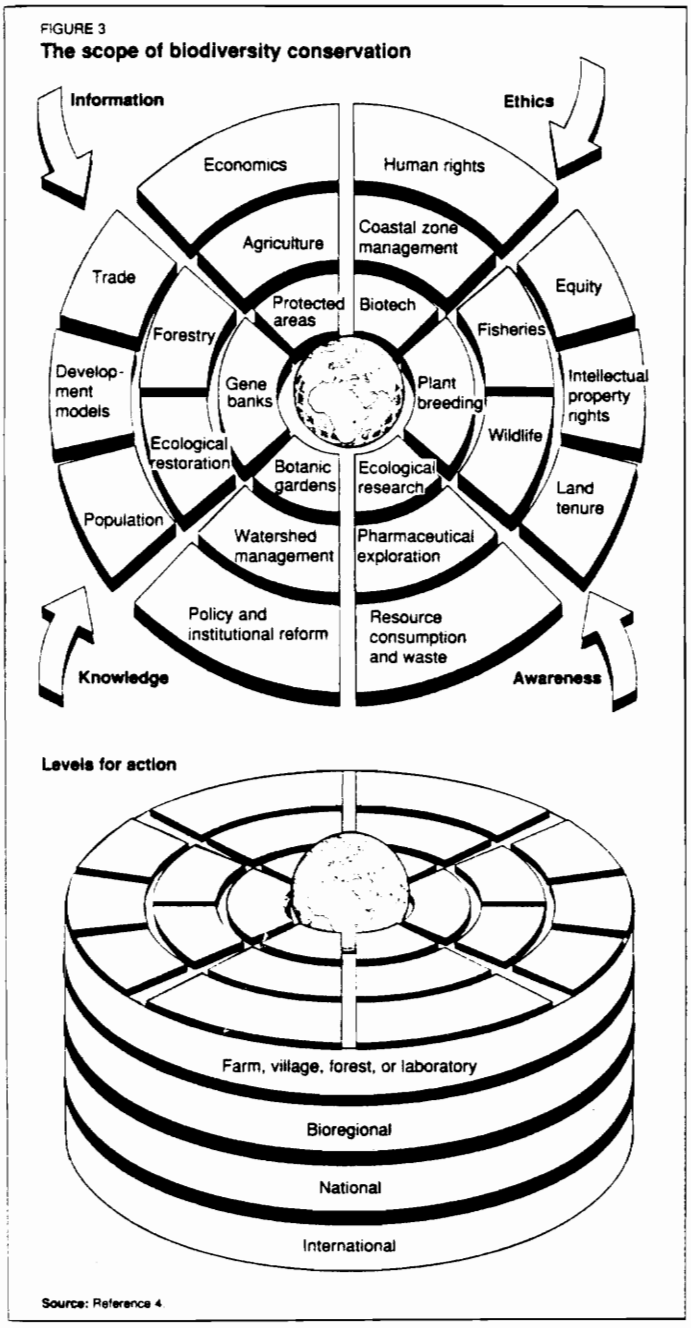


Fig. 24. The Scope and Levels of Biodiversity Conservation
From Environmental Science and Technology(3), 1992

This figure gives much more defined headings for biodiversity conservation. As D. Scott Slocombe noted, "For any ecosystem, a critical step is developing adequate understanding of the state and dynamics of the ecological and institutional aspects of the ecosystem to specifically determine the character and roots of obstacles to more sustainable management Simplifying problems or glossing over potentially difficult political and cultural issues is as much an obstacle as plain ignorance."(BioScience, 1993) Reid accumulated the defining figures through his organization, the World Resources Institute, and their research leading to the publication: Global Biodiveristy Strategy of 1992. It is their task to define systems and strategies for conservation.

Once taken above the site scale investigation, a project would fall into a category known as bioregional. K. Sale noted, "Bioregionalism focuses on regions and communities, defined ecologically, culturally, and historically." Bioregional separation helps define the ecosystems that exist in an area. Slocombe noted, "Ecosystems emphasize the biological and physical characteristics of a region, with some addition of socioeconomic characteristics. There is generally less consideration of socioeconomic characteristics for bioregional units in which the goal is definition of a coherent unit in terms of linked biological, physical, and cultural characteristics."(Bioscience, 1993)

For designers it becomes apparent that understanding ecological sustainability is quite a bit like understanding economic sustainability. We would be far better off if we could define the following: 1. A valuation methodology for systems understanding, 2. A system of measurement for ecological systems levels and progressions, 3. An understanding of modifications that may compliment existing study/management, and, 4. A series of scalar questions and issues to help designers investigate ecological conditions for their developmental studies.

Valuation

The valuation of an ecosystem's facets is subjective at best. The definition of ecological sustainability and the issues of which systems should be preserved are quite contradictory for different disciplines. Gale and Cordray noted, "...depending on the sustainability type,

what is sustained may be one or more VECs(Valued Ecosystem Components) within human systems, natural ecosystems, and ecosystems modified by human intrusion or control."(Rural Sociology) A valued ecosystem component(VEC) relates to something of specific value to an ecosystem. The component may be a specific species of animal or plant that has economic or aesthetic value, it may relate to systems that interact between others for the viability of the series of systems, or it can be as large as the entire ecosystem's value to the maintenance of the region.(p.312)

The sustaining of an ecosystem, or VEC, typically relates to a the values gives to the systems by the particular group with the decision making power over the ecosystem. This decision making process is comprised by the economic, biological, aesthetic, cultural, and historical values of the group.(p.313) There are many models/methodologies related to the valuation of ecosystems. These are:

1. Global Niche Preservation- The valuation of an area leads to sustaining specific local ecosystems that are judged as integral parts to a larger goal of sustaining the earth. The rationale is that humans and ecosystems are interdependent within these niches.(p.319)
2. Global Product Sustainability- This movement relies on the valuation of unique resources, or resources of increasing scarcity or value, as they may relate to an international market. The rationale for this model is that individual areas of the world could supply specific, specialized products for the world market. This would allow for a balance of supply within the markets without depletion of many sources at once.(p.320)
3. Ecosystem Identity Sustainability- The typing of a land's ecosystem characteristics could lead to simple methods of classifying ecosystems. An ecosystem could be typed in terms of it's vegetation, aquatic, fauna, human use categories, productive categories, etc.. This model offers identification of forests, deserts, estuaries, wetlands, etc. in classifications other than in terms of specific characteristics, as Gale and Cordray explained, such as old growth forest, which is common today. The rationale basis is that conservation of an ecosystem relates to the many parts of such a system and not solely on specific characteristics of value at the present time.(p.320)
4. Self Sufficient Sustainability- Natural systems exist in a sustainable manner based on the checks and balances within the environment. The maintenance of natural resource ecosystem integrity would allow for the continuance of environmental integrity without need for human intervention and maintenance. The rationale for this model is ecocentric in that it prefers the natural, nondependant environment to the human developed world.(p.322)

5. Ecosystem Insurance Sustainability- This model calls for the ecosystems, plants, and/or animal types to be divided into two categories: Those which would supply traditional products and/or uses for humans, and those which would be protected in a natural state as a 'genetic storehouse.' Gale and Cordray state that this system of dual management emphasizes the products of society and in corporates the preservationist's emphasis of other needed systems. The rationale is one concerned with ecosystem disaster. Without the ability to recover the resources(plants, animals, etc.) of an ecosystem, the ecosystem is permanently lost and the potential for products is lost.(p.324)
6. Ecosystem Benefit Sustainability- This method addresses the ecosystems exist for their own purposes, not for the desires of human beings. Those ecosystems, even if not self-sustainable, are better than the human influenced ones. The rationale is a reflection of a biocentric perspective, nature is better than man.(p.325)

The selection of an ecological valuation model or methodology allows designers to weigh out the ecological options within the proposed site/project based on their perceptions of the goals or basis of the project. Combinations of valuative models are possible, but hybrid models should be reviewed with extra discretion.

Measurement

Measurement related to ecological systems is possible through scientific investigation of systems. Walter Corson's indicators of sustainability model suggests specific measurements available that may coincide with ecological sustainability evaluations.(See figure 25)

Natural resources and environment

Energy	Energy use, total and per person[a] (G,N,L) Energy efficiency index[a] (N), % of energy from renewable sources[a] (G,N,L) Energy imports as % of consumption[a] (N), Fossil fuel reserves[a] (G,N)
Non-fuel minerals	Aluminium consumption per person, % of aluminium recycled[b] (N) Metal reserves[a] (G), Metal reserves index[a] (N)
Solid waste	Municipal solid waste, total and per person[a,d] (G,N,L) % of glass and paper recycled[b,d] (N,L)
Hazardous waste	Hazardous waste generated, total, per person, and per km^2 [b,d] (N,L) Emissions of selected gaseous, liquid and solid toxic substances (N,L)
Atmosphere and climate	Greenhouse gas emissions, total and per person[a] (G,N) Carbon emissions from energy use (G,N,L) Atmospheric concentration of carbon dioxide[a] (G), Average global air temperature[e] (G)
Acidification	Emissions of sulphur and nitrogen oxides, total and per person[a,b] (N) Acidity of rainfall, surface water, soil[b] (L)

Fresh water quality	Nitrogen and phosphorus concentration in major rivers[a,c] (R) Concentration of nitrogen, phosphorus, and organic chemicals in surface and groundwater[b] (L) Biological and chemical oxygen demand[b] (L)
Food and agriculture	Index of food production per person[a,d] (G,N). Grain production per person (G,N) Food import dependency ratio[a] (N). % of food consumption produced locally (L) Pesticide use[a,b] (N). % of food produced without chemical pesticides (L)
Land and soil	Rate of rural to urban conversion (G,N). % of area in parks, gardens, open space (L) Land degradation as % of vegetated land[a] (G,R) Rate of soil loss from water and wind erosion (G,N)
Forests	% of land area in forest and woodland[a] (G,N,L) Deforestation rate [a,d] (G,N). Reforested area as % of deforested area[a] (G,N)
Natural habitat	% of land under protected status[a] (G,N) Number and extent of protected areas[a] (G,N,L). Protected area index[a] (N)
Wildlife	% of wildlife species at risk[a] (G,N,L). Species risk index[a] (N)
Marine resources, fisheries	Marine fish catch as % of estimated sustainable yield[a,e] (G,R) Coastal ocean pollution index[a] (N). Municipal and industrial discharges to coastal waters[b] (L) Total suspended solids and biological and chemical oxygen demand in coastal waters[b] (L)

Fig. 25. Indicators of Sustainability(Ecological)
Scale: G-Global, R-Regional, N-National, L-Local
From Futures(3), March 1994

These measurable indicators can inform the designer as to some of the quantitative issues involved with the ecological sustainability of a site or project. It is now possible measure how some development may cause ecological changes within the environment. It is important now to understand possible modifications that would provide a better understanding of ecological sustainability and ways to evaluate developmental options.

Modifications for Future Study

D. Scott Slocombe stressed the need to modify into an ecosystem management strategy. Ecosystem management incorporates the views of ecologists, social sciences, human ecology, and sustainable development.(BioScience,1993) Benefits of such a program include larger public information networks and publications for educational purposes, symposiums and reports on scientific improvements, cooperative ventures between regions, etc.. This type of system would allow for standardization of methodology if accepted by a country or continent, and would lead to operational management systems.(p.615) Slocombe noted, "Involved in this process is the need to develop adequate understanding of the state and dynamics of the ecological and institutional aspects of the ecosystem to specifically determine the character and roots of obstacles to more sustainable management."(p.617) It would also be important to address the political and cultural foundations of the area effected by the ecosystem. The main aspects to the system are as follows:

1. Describe parts, systems, environments, and their interactions,
2. Recognize ecosystems as holistic, comprehensive, and transdisciplinary,
3. Include people and their activities in the ecosystem,
4. Describe system dynamics through concepts such as stability and feedback,
5. Define the ecosystem naturally, for example, bioregionally, instead of arbitrarily,
6. Look at different levels and/or scales of system structure, process, and function,
7. Recognize goals and take an active, management orientation,
8. Incorporate stakeholder and institutional factors in the analysis,
9. Use an anticipatory, flexible research and planning process,
10. Entail an ethics of quality, well-being, and integrity, and,
11. Recognize systemic limits to action-defining and seeking sustainability.(p.617)

This system utilizes substantive methods and process methods for ecosystem identification and management. Figure 26 shows the substantive and process methods related to this model.

Substantive methods	Process methods
Multidisciplinary studies with integrative modeling and GIS methods	Facilitated, representative scoping workshops and ongoing consultation
Comprehensive studies using theory and detailed knowledge	Incentives and methods for institutional cooperation
Innovative approaches to evaluation and definition of criteria	Consensus goal definition and related planning for their achievement
Ongoing, multilevel monitoring	Newsletters and consultation to disseminate information
Use of expert and public knowledge to develop hypotheses and models	Testing and revising results and process
Using scenarios and working backward from desired future scenarios (backcasting)	Developing visions of desired futures and scenario-development exercises

Fig. 26. Methods Needed to Elaborate an Ecosystems Approach
From BioScience, October, 1993

Utilization of these methods would allow the designer the ability to understand the ecology of an area within many dimensions of evaluation. The methods are directly related to development research. Research needed for developing ecosystem based management was noted as:

1. Determine the kinds of information needed to define watershed, bioregional, and ecosystem-based management units.,
2. Explore the implications for planning and management of these different methods of definition., and,
3. Explore the relationships between these definitions of management units and people's perceptions of the regional system or place they inhabit.(p.619)

Slocombe concluded his study of ecosystem management by stating, "Ultimately, one's support for ecosystem approaches, as for systems approaches, depends generally on whether one thinks their advantages and unique contributions outweigh the potential for vagueness, functionalism, and determinism."(p.618)

Colin Rees also described needed modifications for ecological sustainability. He believed that national and international changes are in order. The modifications needed must be formulated at the highest, policy forming levels. These modifications would then cut across the jurisdictional lines of many agencies and therefore the effects upon each agency's interests could be studied and compared with each others. Also, the economic aspects of material resources should be studied to help determine the desirability of projects as they relate to sustainable development.(F&D,3)

Finally, Walter H. Corson relayed the transitions necessary for ecologically sustainable development.(Futures,3) The transitions related to environmental and resources were:

> Resource Transitions to greater reliance on nature's 'income' of renewable natural resources, without excessively depleting nature's 'capitol' of non-renewable resources.
>
> Environmental Transitions from activities that degrade natural resources to practices that protect and restore the biosphere and it's life-support systems.(p.208)

Modifications are called for on all levels of ecological study and ecological management. Designers can refer to these models/issues of modification and address their projects with increased understanding of the ecological management processes. The information allows designers to weigh ecological issues with the understanding that culture and politics are relatively inseparable to ecological sustainability. It is those interrelationships that may eventually define the sustainability of an ecosystem.

Questions for Designers

Finally, ecological sustainability should be directed towards designers as a set of questions for site/project investigation. These questions offer a basis for ecological investigation and may help define the issues and options associated with the project. Some basic ecological evaluative questions for designers are as follows:

1. What are the current ecological aspects/conditions within the site/project?
2. Are there any ecosystem aspects that are susceptible to damage by the project?
3. Are there any aspects of the ecosystem that are particularly valuable to the aes thetic nature of the site/project and require maintenance?
4. Are the clients informed of the ecological influences upon the site/project?
5. Is the value of the ecological systems an interest of the group/organization?
6. Is there a defined model for valuation practices that describes the nature of the site/project? Is there a hybrid of methods/models that better explores the site/project with regards to ecological sustainability?
7. Is there the possibility of organizing a watchdog committee or organization for the preservation of ecological conditions within the project? Would this increase the viability of the project? Would this justify ecologically sound measures?
8. Would modifications to the site/project alter the measurable ecological aspects of the area?
9. Are there possibilities of mitigation to reduce the effects of modifications within the ecosystem?

10. Are there specific measurable aspects of ecological sustainability that are important to the site/project, but are not covered within the given parameters?
11. What are the cultural/political influences that affect the site/project?
12. Are there ecological systems that can be altered for better cultural/political accep tance without reducing the ecosystem's sustainability?
13. Is there a possibility of computer or equasional modeling to test the ecological sustainability of systems? Is it possible to forcast future ecosystem well-being as related to the modifications?
14. Is there the possibility of testing specific project modifications on a small scale for ecological sustainability?

The questions above offer the designer a starting point for ecological sustainability evaluation. By utilizing these questions, and integrating their own, the designer may gain a better understanding of ecological sustainability and it's pertinence to specific site/project design. These principles could be integrated into working methodologies.

Sociology

Introduction

Sociology as a profession has historically dealt with the evaluation of societies and the characteristics of human activities within communities. Studies typically include the organization of participants within civilizational constructs as well as their relationships with environmental factors. The current sociologist must accept man's role within a world social order; one which accepts mankind as a player within world systems, but not the only, or predominant, player within the system. Michael Cernea, the World Bank's Adviser for Social Policy and Sociology, noted that sustainable development includes the study of human activities as they degrade the environment.(F&D,4) Human intervention in the environment, and resource utilization by societies, has compounding effects within the environment and therefore must be associated with the sustainability of said environments. Cernea stated, "Sustainability must be 'socially constructed'- that is, arrangements of a social and economic nature must be made purposively."(p.11) There are two sets of sociological elements that help describe developmental sustainability, they are:

1. A set of concepts that help explain social action, the relationships among people, their complex forms of social organization, their institutionalized arrangements, and the culture, motives, stimuli and values that regulate their behavior vis-a-vis each other and natural resources., and,
2. A set of social techniques apt to prompt coordinated social action, inhibit detrimental behavior, foster association, craft alternative social arrangements, and help develop social capitol.(p.11)

These elements offer insight into the underlying aspects of humans, their organizational patterns, and the relationships they hold with their environment. These elements also establish an understanding of the social organization within a society and can be utilized to formulate programming to support sustainable development.

Sustainable societal development involves many players: The inhabitants of the society, the relationships between individuals and the other members of the society(dominant players vs. minute players), and the infrastructure of the society including laws, ownership, authority organization, management, etc.(p.12) The formulation of sustainable relationships and management tactics must include all levels of players in the society, as well as, a social ethic concerning sustainable relationships within the community. The relationships, and organizations, involve two social concepts. These concepts are:

1. Organizational Intensity- The level of emphasis, high or low, with which a program invests in social 'software,' building organizational structures and institutional capacity., and,
2. Organizational Density- The frequency and strength of various forms of social organizations that make up a given cultural fabric and the frequency with which individuals participate in multiple networks of socially organized activities.(p.13)

The concepts describe how user participation and organizational constructs are the foundations for societal formulation. These constructs relate to a series of societal imperatives as derived by Lester Milbrath(Futures,4).(See Figure 27)

TABLE 2. ADDITIONAL SOCIETAL IMPERATIVES FOR SURVIVAL AND FLOURISHING OF HUMAN LIFE

(1) Safety/security
(2) Order
(3) Continuity
(4) Equity/justice
(5) Compassion
(6) Societal cohesion
(7) Substantial agreement on fundamental values
(8) Provision of necessary goods and services—basic human needs
(9) Opportunity for self-fulfilment and expression

Fig. 27. Societal Imperatives for Human Survival and Flourishing
From, Futures(4), March 1994

Societies are sustainable only if they meet the noted imperatives while supporting the organizational density and organizational intensity required for survival in the environments which they choose to exist.

Existing societies face serious questions relating to sustainability and continued growth. Not only must they meet the imperatives and organizational issues for societal existence, they must also apply the sustainable alternatives within existing social constructs. This is a much harder aspect of sustainable development. Societies that are already existing have set understandings of sociological foundations that are to be followed for development. The application of new systems and understandings falls contrary to societal norms and could be considered a threat to the existing society.

Robert Olson noted the relationship of a society's growth and development as pertaining to the pressures placed against it by the environment and the political conditions within the society.(Futures,5) A social transformation, leading to sustainability, would relate to a change of perspective; One from stressing the quantitative growth of a society to the qualitative development within the society.(p.163) Goals pertaining to a society's development change to address the qualitative expectations of the society and eventually incentives develop to bolster the societal transformation. It is important to relate societal well-being, including economic, to the transformations that are taking place. The addressing of large societal developmental factors, such as unemployment, underemployment, poverty, debt, etc.(p.163) is vital to un-

derstanding the viability, and possibilities, of sustainable development and social transformations.

Two models dominate societal organization in the 1990's, they are materialism and transcendentalism. Duane Elgin gave descriptions of each organization, as well as a third organization that is emerging with sustainable thinking.(Futures,5) They are:

1. Materialism- Material is considered the primary basis of reality. Consciousness is considered secondary in nature and only emerges with high degrees of complexity within organizational constructs. This is the prominent model utilized in Westernized, or modern, industrial societies.,
2. Transcendentalism- Consciousness is believed to be the primary form of reality with material playing a secondary role. This coincides with many Eastern or ancient philosophies and religions., and,
3. Co-evolutionism- The integration of Eastern and Western thought into a combined model, one which relates material and consciousness as equal players. The model assumes that there is a continual reorganization, or regeneration, of fundamental reality. The progression includes the development and refinement of both the material and conscious aspects of living.(p.236)

Each model includes the emphasis of material goods and consciousness, but the co-evolutionary model comprises an integration of thought and resource into mutually supportive developmental model. This model supports a sustainable world civilization and the formulation of a globally supportive culture.

It is also possible to break sociological sustainability into the four sections that were investigated for economic and ecological sustainability. Again, those sections are: 1. The valuation of society and it's attributes, 2. The measurement of factors within a society, 3. The modifications proposed, or considered as possible, to create a better paradigm for development, and, 4. Questions that a designer could apply to a site/project for a better understanding of sociology within sustainable development.

Valuation

Sociology is predominantly based how humans react to their surroundings. The way humans accept, or deny, a condition relays the value of the system to the participants and possibly the cultural value of the environmental factor. Richard Gale and Sheila Cordray of-

fered two systems to evaluate sociological sustainability. Both systems are concerned with the environmental preservation, but both deal with the major issues as sociologically based and valued. These systems are:

1. Dependent Social Systems Sustainability- This system is primarily concerned with the specific community and cultural social systems that utilize and/or depend on an ecosystem and it's resources. A predominantly homocentric model, this system asserts that there is a series of valued judgments that offers priority to social systems and their applications. The most valued social systems would utilize more resources than other lesser valued ones. The perceived value of a system directly relates to it's rate of resource utilization.
2. Human Benefit Sustainability- This system is concerned with maintaining a diverse series of policies, relating to human benefits, while managing resources effectively. It focuses on maintaining a centralized society instead of the supporting of smaller, resource dependent social systems that may be of little real value to the overall societal program. The system describes the utilization options of available resources, then applies resources to the most applicable models for the society's well-being.

While both systems encourage sustainable development, each supports the sociological issues of sustainability in different terms; One emphasizing the development of dominant programs within a society, while the other focuses on the supporting of a larger society.

The value of a system can be related to the interaction of the participants and their feelings of intimacy with the aspects of a society. Many programs encourage the interaction of participants with an activity and therefore with each other. This increases the bond of the participant with the project and their neighbors, creating community relationships and forming foundations of community pride. Typical programs introduced to increase user participation and alter their perception of the environment they live in are: Community gardening, neighborhood watch programming, communal housing, small town developmental practices, and community participatory design/building programs. By increasing the relationships of the inhabitants and their environments, the designer/planner increases the inherent value of the community and one's participation as a valued player.

Andrew Steer and Ernst Lutz stress the need to create relationships between environmental alterations and social practices.(F&D,5) By relating social programming to environ-

mental degradation, the designer/planner can infer the viability of alternative, sustainable practices. If a society accepts that current practices encourage environmental degradation, health problems, reduced future productivity prospects, etc. they may also accept the notion that reduced utilization of resources and better forms of resource utilization are preferable to those existing.

The modification of societal accounting techniques allows for a better perspective of environment and social coexistence. Steel and Lutz implied that environmental attributes may be overlooked for social objective reasons and then destroyed without realizing the inherent value to the society. Economic measurement of resources, including the value of said resources, utilized and unutilized, is essential to understanding the nature of resource management as it pertains to the society. When combined with a measurable aspects of society, we gain a valuable investigation tool for sociological sustainability.

Measurement

Measurement of sociological systems involves understanding the systems within society that are, or are not, sustainable and their effects on the society at large. One advantage of sociological sustainability over environmental sustainability is that the systems involved within a society are easier to define and measure because we create and interact with those systems constantly. The environment already exists and contains many facets that we have no comprehension of, nor the ability to measure the aspects.

Walter Corson noted that environmental impact, related to sociological sustainability, is a function of population, resource utilization by societal participants, and the pollution and environmental degradation caused through resource utilization.(Futures,3) His sustainability profile includes/addresses some issues associated with societal development.(See figure 28)

Social environment	
Human development	Human development index[d] (N,L), Life expectancy at birth[d] (G,N) Expenditures for education and health per person and as % of GNP[f] (G,N,L)
Housing	Average number of persons per room in housing units[a] (N,L)
Utilities	% of households without electricity[a] (N,L), Telephones per 1000 people[d] (N,L)
Security	Intentional homicides per 100 000 people[d] (N,L), War-related deaths[f] (G,N) Military expenditures as % of combined expenditures for education and health[d,f] (G,N)
Population	Annual rate of population increase, Birthrate per 1000 people, Population density[i] (G,N,L) Access to birth control index[g] (N), % of married couples using birth control[a,d] (G,N)
Health	Life expectancy at birth[a,d] (G,N,L), Infant death rate and child death rate[a,d] (G,N,L) Calorie supply and protein consumption per person, Access to safe drinking water[a] (N)
Education	Literacy index[d] (N), Schooling index[d] (N), Environmental awareness index (N) % of population over age 25 with high school education (N,L)
Culture	Daily newspaper circulation per 1000 people[d] (G,N), Radios per 1000 people[d] (G,N) Book titles published per 100 000 people[a] (N), Circulation of library materials per person (L)
Recreation	Public park area per 1000 people (N,L)
Political participation and involvement	% of population registered to vote (N,L) % of population voting in elections[k] (N,L) Political freedom index[l] (N) Civil rights index[l] (N)
Governmental stability and effectiveness	Changes of government indicator[n] (N), Communal violence indicator[n] (N) Government efficiency index[k] (N) Government employees as % of total population (N,L) Perceived responsiveness and effectiveness of government (L)

Fig. 28. Indicators of Sustainability(Sociological)
Scale: G-Global, R-Regional, N-National, L-Local
From Futures(3), March 1994

These indicators offer indexes of societal growth and maturation.(As based on cultural beliefs of progress) Issues of a society's stability are addressed from local to global scales. By addressing the scalar issues of societal developmental sustainability, the designer/planner can incorporate expectations of a society, as well as perceived enhancers for that society into their designs.

Modifications for Future Study

There are many changes implied as necessary to reaching sociological sustainability. Corson noted the needs of societal change as many transitions. These transitions are:

Lifestyle Transitions- Modify societal expectations from quantity of material items to quality of consumption patterns and behavior patterns.,

Social Transitions- Put the inhabitants of a society ahead(in priority) of bureaucracies and institutions; Reduce poverty and increase balances of responsibilities with rights within the society.,

Demographic Transitions- Stabilize populations to place humans into a better 'fit' with resources and environmental aspects.,

Gender Transitions- Reduce the issue of a gender biased society, offer equal opportunity for educational and jobs to all citizens.,

Political Transitions- Modify government from big bureaucracy to a people-oriented policy making; Encourage participation of citizens in smaller, human-scaled programs.,

Information Transitions- Improve the information collection, distribution, and management systems to offer better reference of natural and social systems; In crease education to include the larger issues of sustainability.,

Ethical and Worldview Transitions- Change ideals from growth to quality of development oriented; Reduce separation of rich from poor, relate progress to the ability of future generations to live at, or better than, current standards; Increase emphasis of the value of natural resources and systems, emphasize the relationships of systems as combining to form a larger, comprehensive system.(p.208)

Many other authors relate the same/similar topics as needed. Duane Elgin noted the need for modification of consumption patterns, housing patterns, etc. so that we reduce the impact of developing a society within the existing constraints.(Futures, 6) He also encouraged the development of a sustainable vision of the world as a guide for progress and development.(p.243) Michael Marien noted the 'social marketing' of sustainability.(Futures, 1) He encourages:

1. The increase of sustainability tactics and information to mass audiences. By publishing sustainability as a major issue, it will gain acceptance and more will be done to achieve the needed changes.,
2. Try to convince the anti-environmentalists as to the necessity of sustainability.,
3. Promote an expert in sustainable thinking, giving them a national forum for information dispersal, such as a syndicated column or national television coverage.

4. Promote books on sustainability and form a group of experts to better describe quality within sustainable literature. This would allow individuals and organizations to see selected, and accepted, examples of sustainable thinking. This would also create an accepted standard for sustainable thinking.
5. Create a 'green' Nobel Prize to encourage research and development of sustainable practices within science and industry. This would also bring sustainable thinking to the forefront of disciplines.

Finally, Lester Milbrath noted a series of norms and ethics that must be fulfilled to elevate society to sustainable levels.(Futures,4) His issues address values that a society must have to be sustainable for the masses. These norms are:(See Figure 29)

TABLE 3. SOCIAL NORMS DERIVABLE FROM PHYSICAL AND SOCIAL SYSTEM IMPERATIVES

(1) Adopt a global bioethic.
(2) Protect and nuture natural systems:
  (a) forbid behaviour that may irreversibly injure natural systems;
  (b) avoid/minimize risky actions.
(3) Protect and enhance public health.
(4) Feel compassion/obligation to other species, future generations. and people in other lands.
(5) De-emphasize violence and domination, reject war, enhance conciliation programmes.
  (a) provide peace and order.
(6) Enrich work patterns to make work fulfilling.
(7) Emphasize cooperation.
(8) Foster democratic decision making; enhance participation.
(9) Enhance freedom so long as it does not injure life systems.
(10) Provide justice/equity.
(11) Encourage holistic thinking and broad-spectrum competence.
(12) Control science and technology.

Fig. 29. Societal Norms Derived From Physical and Social Imperatives
From Futures(4), March 1994

These authors offer a variety of modifications that may bring sustainability to the front of society's thinking and into programs that would form a foundation for a sustainable future. From educating the general public to restructuring the government, societal changes would encourage sustainability research and development.

Questions for Designers

Finally, sociological sustainability should be directed towards the designer/planner in the form of project scaled questions. The questions form a basis for understanding sociological sustainability, and, depending on the scale of the project can define some topics of interest

and infer development that may enhance sociological conditions. The questions for designers are as follows:

1. What are the current sociological conditions within the site/project?
2. Are there any dominant factors, or problems, that need to be addressed?
3. Are there any social factors that are particularly successful as they exist? Are these factors worth sustaining? Would modifications/development alter these conditions?
4. Are there any political or environmental conditions that will pressure, or be pressured by, the project development?
5. What is the existing sociological model? Is it a Materialism, Transcendentalism, or Co-evolutionary system? If a Materialism or Transcendentalism system exists, would it be possible to modify into a Co-evolutionary system?
6. What are the sociological objectives of the project?
6. Are there any tested concepts or techniques that may address the objectives of the project? Will the development of a new program be necessary to address the topics/issues at hand?
7. When developing the program and objectives, what is the Organizational Intensity and Organizational Density of the proposed and existing conditions?
8. Do the proposed sociological conditions meet the needs for survival within the environmental conditions? Will the society maintain itself or flourish under the new conditions?
9. Do the proposed changes encourage Dependent Social Systems Sustainability? Do the changes encourage Human Benefit Sustainability?
10. Are there any programs that can be introduced to encourage community participation and intimacy?
11. Do the measurable indicators of the society note any needed changes? Do the indicators encourage any particular type of development?
12. Are there any social transitions that can be implemented or enhanced by the site/project?
13. Is it possible to 'socially market' the project modifications to encourage more sustainable development practices?
14. Is it possible to encourage social norms through activities proposed within the site/project? Can the design encourage positive activities and discourage the negative aspects of the area?

These questions are intended enhance a designer's perception of sociological issues as they pertain to sustainable development. By utilizing these questions, and integrating their own, the designer may be better prepared to investigate sustainable design and options within the topic. It is now time to investigate the design professions and the role of sustainability.

Part 7: Sustainability in the Design Professions: Planning, Architecture, and Landscape Architecture

Introduction

The design professions of planning, architecture, and landscape architecture are beginning to address sustainability in their projects, but each discipline has it's own inferences of what sustainability is and how it should be addressed. This fact is a major stumbling block to a comprehensive sustainable design. In order to understand aspects of sustainability within each of the disciplines it is important to study their dominant movements and interests in regards to sustainability. It is also important to note that the design disciplines have varying movements within them concerning the valuation of designs, etc. and the concerns of one school of thought may not necessarily be those of the others. Once we establish some of the concerns and issues of each discipline, we can begin to address architectural sustainability as a comprehensive series of issues, relating to the planning, architecture, and landscape architecture of the project at hand.

Planning

History

The history of planning has been long and varied. It is important to set a foundational beginning, historically speaking, for sustainability and planning. One could relate sustainability and planning as far back as the roman empire if they choose to, but for this investigation we shall start with planning practices at the end of World War Two.

The end of the war brought great economic and technological advances to society and the city. Patsy Healey and Tim Shaw stated that, "The history of the post-war planning system is one of periodic rediscovery of the importance of plans, after periods when their strategic content was allowed to lapse, and when the role of plans in making regulatory decisions was diminished."(Regional Studies,1993) The loss of the city plan is directly related to the

decentralization of the city and the residential sprawl of the second half of the twentieth century. Changes in city developmental practices have been related to economic and environmental degradation of the urban fabric. Modifications to the city structure, not being related to a strategic plan or purpose, lead to pockets of decay within cities and the spread of crime and poverty.

Healey and Shaw noted five environmental discourses which have had influence on city planning in the post-war era. These discourses are:

1. A *welfarist utilitarian approach* to the environment. This discourse relies on the environment being utilized in a manner that exploits features for enjoyment and aesthetics. The environment was to be enhanced or preserved in order to fulfill the city's inhabitants perception of the ideal landscape. This movement is notable from the 1940's onward.
2. A *growth management approach* to the environment. This discourse relied on technology and economic growth. The environment was to be designed, or planned, to increase production efficiency and conserve resources for future ease of exploitation. This movement is notable from the 1960's onward.
3. An *environmental care and management approach.* This discourse reduced the degradation of existing environments and increased the environmental quality for enjoyment and exploitation reasons. The environmental assets were preserved for the inhabitants of the area while the economic benefits of improved environmental quality were stressed. This movement is notable from the 1970's onward.
4. A *reassertion of environment as collection a of assets approach.* This discourse emphasized the conservation of environmental aspects for human exploitation and enjoyment in addition to the re-establishment of such qualities to older communities. Industrial lands would be 'transformed' into an acceptable aesthetic form for the community. This is known as a marketized utilitarian aesthetic. The movement is notable from the 1980's onward.
5. A *sustainable development approach.* This discourse absorbs the ecological conceptions of the environment into constraints and planning criterion. Concern is given to the global impact of development, the capacities and limits of said environments, and would be eventually developed into practical strategies and practices. This movement is developing in the 1990's.(p.770-771)

These discourses describe the varying influences on planning in the post-war society. The increase in economic stature of citizens and the increase of products to cater to their wealth

changed the perception of value within the city and mobility and freedom became dominant factors within the city structure. Once preservation of environmental features was reasserted as an important feature of the urban fabric, it came primarily as a restoration project for existing cities. Sustainable planning takes the process one step further by asserting the impacts of the city on other areas and emphasizes the need for limitation of societal growth and the support of qualitative growth within the city. Also involved in the sustainable planning movement is the concept of ecological modernization. This involves the beneficial relationships of environment resource conservation and economic development. Healey and Shaw note that this concept has theoretically been accepted by governments and is in the process of being integrated into planning practices. M. Jacobs identified three elements of sustainable development and ecological modernization. These elements are:

1. The entrenchment of environmental considerations in economic policy-making.,
2. A commitment to 'equity', and the fair distribution of both wealth and the effort in conserving resources, both in terms of local and global space, and intergenerational equity., and,
3. A commitment to economic development as opposed to economic growth, the former term implying a 'notion of economic welfare that acknowledges non-financial components.(Jacobs, 1991)

These elements relate the necessity of qualitative economic growth with regards given to ecological functions within the environment. This concept challenges current economic thinking and practices within many existing city and regional constructs. Emphasis would have to be redirected towards the economic relationships of ecological utilization and preservation. Jacobs continues by expressing that, "Sustainbility means that the environment should be protected in such a condition and to such a degree that environmental capacities(the ability of the environment to perform its various functions) are maintained over time: at least at levels sufficient to avoid future catastrophe, and at most at levels which give future generations the opportunity to enjoy an equal measure of environmental consumption."(p.79-80) Thus, sustainable planning would incorporate the biophysical aspects of the environment into a qualita-

tive understanding of said environments and forecast future conditions and needs of the society. Development would address both the needs of the society and the natural environment.

Finally, Healey and Shaw described ways that a regulatory planning system, with regards to sustainable development, could play a substantial role with the development of an area. The roles of regulatory planning could include:

1. Dealing with a whole range of local site-related matters, notably conservation of resources and environments, and in fostering locational patterns which minimize energy use and pollution generation,
2. Ensuring that development does not exceed ecological capacity thresholds,
3. 'Balancing' the details of environmental, social, and economic considerations in relation to specific developmental projects,
4. Promoting and managing the maintenance and enhancement of the qualities of local environments, and,
5. Dealing specifically with the locally adverse impacts of development.

Regulatory planning emphasizes the application of lands for the best possible combinations of energy and resource utilization, population management, transportation, etc. patterns.

Precedent Thoery

The 'new' sustainable model's utilization of lands with specific strategic and developmental intentions is not original, nor radical. The term sustainability is the current buzz word, but topics of urban organization and self reliancy have been investigated many times. Prior to, and following, the world wars, many famous architects and planners proposed revisions to city structure to support a new modern/technological society. Proposed designs included various topics such as communistic living, a highly technological system of buildings, high population control, modular societies, etc. Several well known alternative city plans included: The futurist Sant'Elia's Citta Nuova(1914), Garnier's Cite Industrielle(1904-1917), Le Corbusier's Ville Contemporaine(1922) and his 'radiant' plans of the 1930's, and the American classic Broadacre City(1934-1958) by Frank Lloyd Wright.

The American planner/architect, Victor Gruen, introduced a city plan in the 1950's that incorporated multiple levels of activities in segregated areas. Gruen's planning theories,

commonly known as the cellular metropolis, related diversity of purpose within a city as the key to a city's viability. David Hill noted Gruen's theories as, "The good society is organized to make the most diverse groups and experiences accessible to as many individuals as possible, and this means building good metropolises. Governments are just when they are pluralistic, democratic, and liberal."(The APA Journal, 1992) Gruen believed that the key to the development of a city is to build a series of emotionally and intellectually charged spaces, in a dense manner, so that a metropolis would induce internal movement and pleasure instead of requiring citizens to go to outlying areas for fulfillment. The density of the cellular metropolis would reduce the sprawl of the city, as well as, protect the ecosystems surrounding the city. A city would maintain it's viability through the preservation of diverse interactions and activities and by maintaining the density within the city. The city could be considered 'sustainable' due to it's ability to maintain the urban fabric without spread and further degradation of surrounding areas.

Gruen's philosophy addressed the world as made up of a unified living web of relationships, that coexists over time and space.(p.316) The levels of organization relay to the ability of an aspect, or element, to adjust to stresses within the environment. Higher states of matter, such as large animals, etc. could have many relationships within an environment and be able to adapt to environmental stresses better than the lower states existing within the environment. The formulation of a metropolis in not unlike the world model in that it is a conglomeration of small and large elements that interrelate and form the struggles that cause the "injection of diversity and variety into a meaningful organic pattern."(Gruen, 1964) Hill noted that the, "Healthy personality struggles to gain the most diverse material, intellectual, and spiritual dimensions of consciousness."(APA Journal, 1992) A diverse society would inherently offer the alternatives necessary for adequate, possibly optimal, opportunity for personal engagement and growth.

Gruen noted the death of the conventional city as being related to the rise in popularity of the automobile, the structuring of a city as based on the value of the land involved, and the rise of suburbanistic thought.(p.317) This reasoning lead the foundations for the cellular me-

tropolis. Hill noted six concepts as Gruen's spatial framework of a cellular metropolis(p.318-321), these are:

1. The separation of humane and utilitarian functions. The activities of humans would be the drivers for the city formation. Human functions would include churches, museums, libraries, universities, cultural centers, industrial centers, residencies, etc. that induce societal integration and psychological development. Utilitarian functions would include freeways and other services that are required within the city. Gruen also emphasized the separation of the public spaces regarding the humane functions. This way each function would have it's own identity and not be confused as part of something else.,
2. The cellular separation of spaces and functions. Gruen arranged the "mind" and "matter" activities into a series of organizations. A horizontal cellular system of aspects would contain the functions of animal or plant that are "basic units of life." The cell would have a center, or nucleus of purpose, cytoplasm of space, and a cell wall of a boundary or division.,
3. A vertical organization would be constructed by using "multipurpose planning." Multipurpose planning stresses that when it is possible, the functional organizations of a city(I.E.- transportation, utilities, mechanical systems, etc.) should be subterranean, while the productive activities of the city(I.E.- Offices, residences, etc.) would be above ground and obtain the light and air necessary for productive activities.,
4. A compact urban structural system. Compact urbanity is achieved through the utilization of cellularity and multipurpose planning. As Hill stated, "At the ground level, especially in the nuclei, their intersection generates a vital harmony between humanity's need of choice and development, and the humane spatial universals of vertical and horizontal ecological patterns."(p.318) Diversity and interpersonal contact would flourish under these conditions and society would benefit from the interactions.,
5. A system of cellular hierarchy within the metropolis. Gruen noted that cells would be applied at many scales and densities. The different cells would maintain individuality under the environmental conditions of the city by their sizes and by their activity levels. The order and organization of the cells would be complex and hierarchical. Hierarchy would include town centers that monitor three district centers, the districts would maintain three community centers, and community centers would be applied for three residential neighborhoods It should be noted that Gruen planned for cities to be maintained at approximately a two million population. This includes town populations of approximately 65,000 and city core populations of 50,000.,
6. A system of global metropolitanism. The world would consist of many moderately sized, manageable, city systems. Each city would contain natural areas and living patterns that would encourage modest forms of consumerism. Cities would provide many amenities for their citizens, reducing the need for individ-

ual materialistic ownership. The controlled size of the city would provide ample natural areas for citizens to enjoy between city conditions. The suburb would be nonexistent.

Hill provided a schematic representation of Gruen's city model. Figure 30 shows the structural organization of cellular metropolis, as well as, the transportation hierarchy of the city.

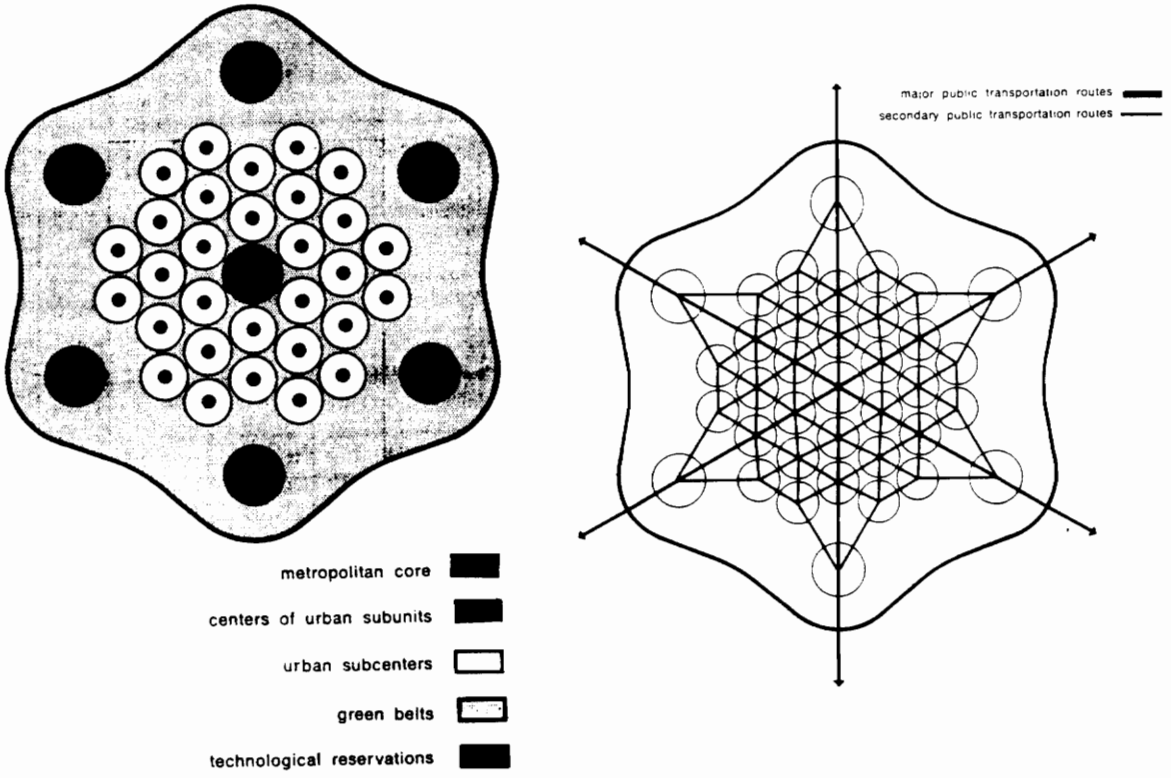


Fig. 30. Gruen's Prototype Cellular Metropolis and Transportation System Schematic
From APA Journal, Summer 1992

The city model shows clear definition of spatial hierarchy and service support leading to and from the cells. Gruen did note that this model is ideal for new city construction, but under existing conditions, this model would have to be modified to be acceptable to the established systems of organization. Gruen's model has served as inspiration for current planners/designers that are interested in sustainable or neotraditionalist planning practices. His framework has served as a resource for such contemporary designers as Sym Van der Ryn and Peter Calthorpe. The designer can learn many things from models like Gruen's. The

strengths and weaknesses of a precedent model can serve as foundations for further study and show alternative reasoning for development.

Current Issues

Once the sustainability premise is relayed as an issue in planning, and an example of precedent theory is investigated and understood, it is important to modify the premise to meet the current, possibly predominant, societal concerns regarding sustainability. Earnest Yaranella and Richard Levine describe the process of sustainable cities as virtuous, yet flawed.(Futures, 7) They noted the virtues of the sustainable city process as:

1. The shifting of the sustainability quotient of sustainable development to the positive side by locating ecological and social sustainability within a place.,
2. The overcoming of historical divisions and philosophical dualisms installed in the modern epoch by alienating and fragmenting processes of Western capitalism and industrialism., and,
3. The revisioning of global sustainability within humanly scaled terms.(p.769-770)

Yaranella and Levine describe a sustainable city as a process that changes many aspects of societal thinking and procedure. The operational changes within society may, or may not have the ability to change a societal aspect to a sustainable state. The process would have to include five regulatory or operating principles to understand successes of such a city. These principles are:

1. Individual and discrete programs of sustainable development do not necessarily lead to ecological or social sustainability. It is important to utilize programs as recycling, but it important to inform the public that these programs reduce the quantity of refuse and needed resources, but the program may not inherently change the quality of the ecosystem or it's level of sustainability. The public would believe that recycling is the key to sustainability and that they are doing enough to perpetuate sustainability within their society. Citizens may have no comprehension of what is happening to their ecosystem through their actions and programming may only postpone the need to deal with the relevant issues until the options are few and less than ideal. The principle includes promotion of 'nonreformist reforms' that increase knowledge of relevant issues and programming that encompasses a larger vision of ecological sustainability.,

2. A principle of homeostatic balance of processes and programming. An activity, or process, may neither be positive or negative by itself, but it's effects may determine the outcomes of other processes. The activity, or process, exists naturally in a larger system and finds balances within larger systems of environmental organization. In order to reach a balance, with intended results or understanding, the proposed activities and/or processes must have defined contexts for existence.
3. A principle of chaotic excess or extravagance. No process or social system can avert the action or intervention of those forces of chaos and disorder that exist within the world or universe. Chaos and disorder always exist regardless of interventions. The principle suggests that the only "solution" to such a dilemma is a series of careful and constant modifications that address the dynamic balances within a chaotic system.
4. A principle of factors and ecological scale. All systems should be designed to per form adequately, or most efficiently, on the smallest ecological scale. This way it will produce the smallest effects possible. The system efficiency would then be expanded upto a city scale, but not larger. A city would be the largest interval which could effectively address issues of sustainability and produce programmatic solutions to issues. Due to the inconsistencies of policy making and monitoring on regional, national, and international scales, they are not addressed as scales of sustainability.
5. A principle of negotiations between low level imbalances and higher levels of organization. The sustainable city has to operate within a series of larger, unsustainable systems. Issues of a city's culture, politics, economics, etc. are always influenced by out of boundary or higher scale issues. The principle addresses city issues at the smallest scale available, hoping to address issues at higher scales. The postmodern sustainable city could then be influential to larger systems by it's rates of success. This process could eventually lead to international application of city principles and actions.(p.770-771)

The principles are intended to stress that within the scalar studies and interventions of a city lie the keys to success in sustainable development. International designs for sustainability fail because they glaze over minute details that have major effects on sustainability. They are incapable of assuring positive impacts and dynamic results within a complex and changing world. Cities would evolve and modify to include systems of social and ecological sustainability. Sustainability, in theory, would flourish when it is scaled to the individual user of a city. The users then define the sustainability of spaces/places within the city. They form the commitments that propagate a sustainable world.(p.772)

In the planning practice, societal concerns over community development, health, and sustainability are growing rapidly. Fahriye Sancar, a professor at the University of Wisconsin-Madison, notes that societal contexts are facing the need for reforms and modification to maintain their viability within the changing world.(Environment and Behavior, 1994) Three frequent problems within existing societies are:

1. A loss of character or identity through the development of urban and rural environments.,
2. Growing environmental problems of waste management, habitat losses, pollution, environmental degradation, etc. that are economic and social consequences of a developing society., and,
3. Governmental programmatic over simplification and overlapping concerning envi ronmental issues and land use. These programs are rarely coordinated, nor have experts to competently address the complex issues of ecosystems.(p.315-316)

Societies are modifying themselves to fit into an international and multicultural conglomerative construct. The integration of many ideas and styles, when not addressed within a dominant contextual framework, dilute the city and regional identity into a series of emulations on a theme. The lack of a specific framework induces waste by not strategically planning or organizing spaces and purposes. Many places are modified continuously due to poor foresight and management tactics. Governmental regulation also becomes difficult when ideas and systems are misunderstood and/or misrepresented.

Sancar describes a sustainable paradigm for development as, "...the culmination of the environmental debate of the past three decades, which admits the necessity of a genuine synthesis between the global and local, natural and cultural, and psychological and institutional aspects of environmental issues." She states that the paradigm is growing in acceptance and maturity, going through three notable stages of development. Those stages, in chronological order, are:

1. The evolution of an environmental debate characterized by single resource emphasis(I.E.- Land, water, biomass, etc.) in research, education, and advocacy as well as public policy.,

2. A change in perspective to an ecological foundation instead of an environmental foundation. The emphasis shifts to the identification, conservation, and/or restoration of systemic interactions among the elements and processes of biotic systems. This is the dominant system in use today., and,
3. The creation of a full-fledged paradigm of physical conditions that meet current and future needs of the society. Implications include the acceptance of a connection between cultural, biotic and abiotic aspects of human conditions; issues related to human values and aspirations; action orientation; and land management which grows from a knowledge of systemwide effects, ecosystems, adaptability, and change.(p.322-323)

Understanding our position as being in the second stage, Sancar notes the need for the "articulation of linkages between sustainability, sense of place, planning, and design." The additions of sustainability and sense of place to planning and design allow for specificity and identity of spaces. This identity, as Gruen stressed previously, allows for diversity within society, encourages individual interpretation of space, and reduces the need for out of city experiences for individual fulfillment. Finally, E. S. Dunn notes that, "Planning for sustainability implies the design of adaptive systems that are capable of regenerating their own life support via conscious, autonomic decisions. In such an adaptive system, both knowledge and action are internally generated."(Dunn, 1971) Once the designer accepts a societal position of existence, the process of modifying a society for further sustainable development becomes more evident and tangible.

Investigation Methods

The integration of investigation methods, and the modification of existing investigation practices, may provide the designer with a reliable starting point for information gathering and increases the understanding of sustainable development. There are two informative tools that may be applied to planning investigations. The evaluative tools are the Environmental Impact Assessment(EIA) and the Ultimate Environmental Threshold(UET).

J. M. Kozlowski describes an Environmental Impact Assessment(EIA) as conceptually rooted in the common sense wisdom that it is better to prevent a problem than to cure it.(Landscape and Urban Planning,1990) It is a plan that assesses the environmental impacts

of proposed development. The EIA is a modified version of an Environmental Impact Statement(EIS) and is intended to compare the adverse aspects of multiple proposals for the elimination of the lesser environmentally suitable plans. Kozlowski notes that the model is, "not in itself a method of generating such proposals. Rather, it is a systematic process for analyzing and evaluating a plan or project presented to it."(p.308) It is intended to be applied on a planning level, not a policy making level and is to identify the potential of environmental impacts that a proposal may cause.

Planners may use the EIA process to evaluate their own principles and projects, but historically the ecological liability of the planner has been relatively undefined. According to Kozlowski, the planner may use the EIA model to inform politicians and developers as to the consequences of developmental practices and policies. The model could even be used for political leverage in the selection of projects and is considerably more supportive of sustainable design than common planning practices. A visual representation of the EIA process is seen in Figure 31:

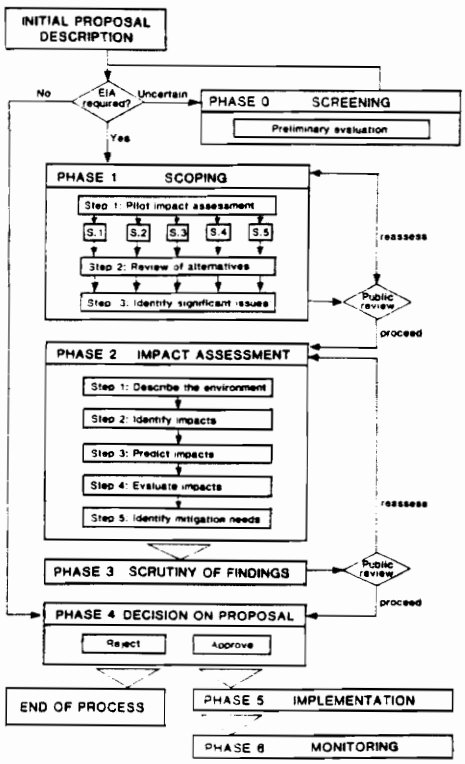


Fig. 31. EIA: General Process
From Landscape and Urban Planning, no. 19, 1990

The EIA process can take from 6 to 17 months to complete.

An Ultimate Environmental Threshold(UET) analysis model is intended to understand the limits of natural systems and assess the modifications to such systems that render irreversible damage/effects. Kozlowski addressed ecosystems and their potential for modification as, "the stress limits beyond which a given ecosystem becomes incapable of returning to its original condition and balance. Where these limits are exceeded, as a result of the functioning or developing of particular activities, a chain reaction is generated leading towards irreversible environmental damage of the whole ecosystem or of its essential parts."(p.313) The UET model is intended to provide a sound ecological developmental base for project objectives and proposals. The process must include the input of experts, such as environmental scientist, who agree with the planning proposals and concepts. They must understand, and accept, the aims of the planning profession. Kozlowski notes that it is also understood that planners would rather have, "an informed guess from an expert than an uninformed decision made by a politician or developer."(p.315) A visual example of the UET process is seen in Figure 32:

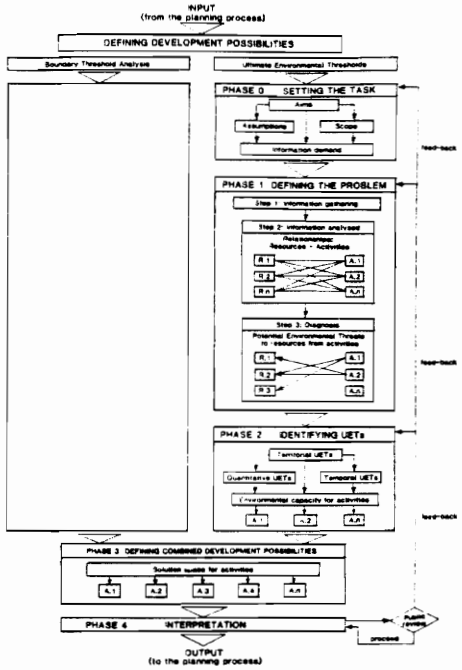


Fig. 32. UET: General Process
From Landscape and Urban Planning, no. 19, 1990

The UET process can take from a few weeks upto a year. This depends on the budget for the investigation and the number of ecological experts that are consulted for the investigation. Kozlowski stated that results are directly affected by budget and time of investigation(p.315) and budgets for UET investigations should be approximately 25% of the overall project planning budget.

One noted problem with the UET process is that there is very little empirical data and prediction techniques to predict environmental impact of developmental aspects.(p.317) Kozlowski believes that computer software, further investigation from scientific organizations, increasing the theoretical basis UET investigation, and the creation of a working manual for investigation will increase the viability of this system. Planners utilizing a revised UET process may be able to address ecological systems and the developmental limits of such systems. By analyzing the systems involved within a region or ecosystem the planner can start addressing sustainability from the ground up.

Policy Modifications/Innovations

Modifications to planning policies are also necessary for the further refinement and expansion of sustainable development. Jonathan Barnett suggests policy innovations, growth boundaries, concurrency, environmental zoning, and better developmental regulations for increased sustainability within planning.(Architectural Record,1993) His rationale is that the further development and maturation of existing cities is far more sustainable than the new development of sustainable suburban and rural communities. The city already contains many of the amenities that are required for a large scale existence, while new development requires the extension and modification of existing services and resources to accommodate the new stresses on the system. It is important to note that new community development can have minimal systematic stresses if designed for sustainability from the start. Issues of road connections, etc. are relatively moot if the community does not require sewer, power, and water links to the urban grids.

Barnett suggests a series of policy innovations to encourage the modification of existing systems for better sustainable urban, regional, and local development. The four innovations are:

1. Laws establishing growth limits around existing cities and relating new development to the availability of infrastructure and public facilities.,
2. Local zoning that ties development directly to the carrying capacity of the natural landscape and environment.,
3. Public policies that make the creation of communities the primary objective of development regulation., and,
4. Restoration of natural landscapes in by-passed and derelict urban areas, and other policies to restore vitality to older cities.(p.32)

Innovations to developmental policy practices allow for better community development under regional environmental conditions, as well as the setting of boundaries for further development.

Growth boundaries are described as, "...separating land that may one day be urbanized from land that is expected to remain rural, the essential first step in achieving sustainable development. Without the boundary there is a continual tendency for urbanization to leapfrog outwards, seeking cheaper land prices, fewer rigorous regulations, and less community opposition."(p.32) Concurrency is helpful in this process by supporting development by way of a set schedule of road and utilities appropriations. Development in suburban conditions is reduced when planners and policymakers refuse to expand faster than the set plan for city development. This also optimizes the viability of the city's utility constructs by reducing sporadic additions to power grids, etc..

Barnett encourages environmental zoning due to current planning's ideal of a "pool table" landscape.(p.33) Environmental zoning is based on Ian McHarg's theory of land classification through environmental constraints. This system gives a rating, or discounted percentage, for parcels of land based on the land's sensitivity to disturbances. Land with a high percentage would have greater inherent sensitivity and value if left undisturbed. The city, community, or region would produce a survey of lands and then rezone the area to fit the environmental constraints. Development would be encouraged in low sensitivity areas and

community density would be focused there. Environmental zoning would lead to the modification of city/regional ordinances so they become more responsive to the environmental concerns of the areas involved.

Obtaining an understanding of the history of planning, precedent theories, evaluation and planning models, developmental issues, and policy concerns offers the designer insight into many relevant topics of sustainable design and development. Planners face many societal, economic, ecological, and political issues within the delineation of space and the strategic planning of areas. The planning issues of sustainable development infer as to the architecture and landscape architecture that are most appropriate for project objectives and strategies. It is now important to investigate the architectural aspects of sustainability.

Architecture

History

The field of architecture has historically dealt with issues of the site and the environmental influences upon a site or region. Although this is the case, there have been many movements and schools of thought that have thrown out the commonalties of a period's, or region's, architecture for radical theoretical change sake in architecture. Diversity in architectural thought and design has lead to many great individual expressions of the natural, cultural, technological, and political environments of an area or region. These expressions, when over-explored and/or too numerous and varied, have also lead to losses of architectural context and the decrease of architectural integrity with regards to environmental relations. Juhani Pallasmaa expresses this as an architectural focal change; moving from the critique of societal conditions and philosophies to a self-referential, designed for building sake and not for the user/occupant construct.(The Architectural Review, June1993) The theory of an art-science pendulum relates strongly here. Architecture for art(expression) sake dominates for a period of time, then the trends change to address the scientific(functional) aspects of architecture, eventually swinging back to the artistic expression side with an increase in technological or scientific support for the architecture. The motions continue perpetually.

Within the last twenty years the architectural model in the United States has moved from the utopian/prosperous expressionism of the late 1960's-early 1970's, through the energy crisis in the mid 1970's, through the big corporate image and 'me' era of the 1980's, and into the recession and re-establishment of the economy in the 1990's.

As described above, the emphasis within architecture moved from the artistic/visual to the functional and back many times. The trendy nature of architecture in the United States tends to cloud contemporary issues and reduce them to a series of catch phrases and overstated experiments. Pallasmaa noted that the 1970's energy crisis shook architectural design into a series of "experimental ecologically motivated models." The architecture became noticed as 'hippie', 'apocalyptic', and/or 'techno-romantic' in nature.(p.79) The issue of ecological fundamentalism was never related to mainstream society, nor did architecture address it as an aspect of elegance within design. Susannah Hagan states, "Things green have no glamour, no buzz. They're worthy but dull, redolent of organic rice and the wearing of socks with sandals...As a result, conservation is all too often equated with conservatism, and it does undeniably embrace conservative elements, a nationalist, traditionalist, Ludditeism that is often hideously sentimental, hopelessly unrealistic and entirely understandable."(The Architectural Review, July 1993) The comprehensibility of technology-based design reduced it into the realm of the hardware store shelf environmental control systems improvements that insure increased efficiency for the homeowner.

Issues of engineering were addressed without incorporating architectural style and form. Hagan believes that the reintroduction of ecological concerns into architecture in the 1990's can be attained only if the relationships of technologies and systems is subtle and expressed as "a revolutionary conservation, and not a conservative revolution."(p.73) Architectural style and elegance could bring ecology back into architecture with the spiritual properties that architecture is known for.

Precedent Theory

Architecture also has many historic examples of movements and individuals that have striven to make changes in practice to encourage environmentally sound development. The 'Heimatschutz' movement in Germany, from the late 1880's through the 1930's, is a prime example of environmental concerns and regional integrity as design directives. The Heimatschutz theory began as an offshoot of the Wilhelmine movement. The Wilhelmine movement, stressing the 'reform of life', was founded on the theories of professor Earnst Rudorff, provided in the essay The Relationship of Modern Life and Nature.(History,1992) A relatively small movement with foundations primarily in art and literature, the Heimatschutz evolved by 1890 into a culture and tradition preservation organization with it's own journal, Heimat.

In 1896, Adolf Bartels published an essay relating the Heimatschutz as being "in service of a national movement."(p.412) One point of stress was the loss of urbanism in Germany at the close of the nineteenth century. The spread of suburban development and land development was perceived as detrimental to Germany's cultural foundations and environmental integrity. The publication of a series of comparative essays, by Schultze-Naumburg in 1900, pictorially compared development models to show need for conservation of national architectural styles and land patterns. In 1904, the movement expanded and formed the Bund Heimatschutz, a statewide organization. As Jefferies notes, the Bund Heimatschutz was "aimed to attract a mass membership of active citizens, fighting to preserve not only traditional values in architecture, but also to protect wildlife, flora and fauna, country customs and traditional crafts."(p.413)

The national Heimatschutz movement participated heavily in both architecture and planning. Programs included the modification of teaching practices to stress national themes, production of example plans and models for architectural reference, and the lobbying for national and local legislation modifications to support the nationalist movement. Jefferies noted that particularly harsh attacks were made on utilitarian architecture and commercial development, those which used "cheap new materials and had no feeling for 'art' or 'culture'." (p.415) It was felt that buildings should be designed to utilize traditional materials in the in-

digenous styles of the region. Particular care was to be taken to avoid environmentally sensitive sites during development. Eventually, new materials were accepted into the movement if they helped illustrate the theories of the movement and did not reduce the architecture to anything less than the accepted constraints of the movement.

The Heimatschutz movement's leverage on the German government lead to the passing of legislation with regards to acceptable style and construction. The 'Law against the Disfigurement of Town and Country' of 1909 was directed to remove design and development that did not fall into the Heimat beliefs. Other legislation included the 'Law against the Disfigurement of Areas of Outstanding Natural Beauty' of 1902 and the Disfigurement law of 1907. These laws were enforced by a body known as the Baupolizei, or district police. A 'Building Advisory Committee' was created to approve designs and were known to "make alterations to plans submitted to them, provided that these did not cause the client unreasonable extra costs."(p.418) The movement eventually over referenced itself; theoretical and architectural bastardization of Heimat architecture and planning reduced the movement to a crony, propaganda style that would support Hitler's tastes.

A major lesson to be taken from this movement is that preservationist and conservationist efforts can be successful, but only as long as their goals remain clear and consistent. Governmental intervention on behalf of conservation movements such as the Hiematschutz initially provided sound foundation for development, yet bureaucracy took over and reduced the movement's goals to conform to the political perceptions of value for the time. Thus a theoretically sound movement was reduced to oblivion by internal mismanagement and an overly dispersed external system of programmatic responsibility.

An internally organized movement would be a key to information distribution and research for sustainability. It is imperative that the architectural and planning communities, within the United States and elsewhere, accept responsibility for watchdoging the movement and the encouraging theoretical consistency within field practices. The architectural community would also provide pressure to manufacturers for the modification to, and production of, sustainable materials and architectural systems. Refusing to utilize systems and materials

that are not considered sustainable would force manufacturers to make materials modifications without governmental interjections and standards. The field could dictate the needs and requirements of pertinent systems/materials by way of expert analysis of said systems, where as governmental intervention would be more bureaucratic in nature and may not address issues of importance within the field.. Governmental intervention and support should be maintained at a minimal level in order to retain clarity of ideas within the movement.

The AIA

The American Institute of Architects(AIA), the national organization for professional architects, is starting to play a role with regards to sustainability in architecture. In 1990, the AIA started the Committee on the Environment, an organization to investigate and report innovations to architects on a variety of topics including materials, construction techniques, etc. that preserve, conserve, or have minimal impacts on the environment. The 1993 AIA National Convention focused on the environmental issues that architects have the ability, and possibly responsibility, to address within their work. The 1993 AIA Conference addressed energy efficiency, healthy buildings, and sustainable communities. Also, the 1993 International Union of Architects(UIA) Conference addressed environmental architectural issues on the international scale. Although many countries find environmental issues important, there are many differences between which issues are important and how they can be dealt with within different cultures.

There are many skeptics of ecological or 'green' architecture. They fear, as do many of the published critics, that sustainable architecture will be pigeon holed as technological advances and not accepted as architecture in itself, but as engineering. Practicing ecological architects, such as William McDonough, state that the only way environmental issues will be addressed at the magnitude necessary for real changes within society is if architects accept a "fundamental revelation that you're going to have to do it yourself."(PA, August 1993) National and international initiatives appear to be a ways off, but the AIA's acceptance of topics and issues is considered a starting point for pressuring manufacturers.

The AIA is devising it's own framework for material classification and understanding. The Environmental Resource Guide(ERG) was devised in 1991 by the AIA's Committee on the Environment. It attempts to assess the properties of materials, their manufacturing, their lifecycle costs, and the byproducts of their production. With an understanding of the nature of materials, the architect can utilize materials with lesser environmental impacts in their projects. The sustainability of architecture is directly related to the materials being utilized and the ability to reutilize or replenish the resources needed for manufacturing.

The model is intended to supply an architect with a series of concerns/issues related to materials. The architect's priorities and project goals are then related to the materials lists to find the 'best' matches for the project. James Russell notes that the ERG is most useful when an architect's goals are energy conservation and environmental conscious design.(Architectural Record, 1991) The model is distributed as a series of materials reports, each containing an examination of a particular material, an upto date evaluation of materials efficiencies, alternative products that meet industry standards, and resource conservative products.(p.37) A visual representation of the ERG model and it's purpose is below.(See Figure 33)

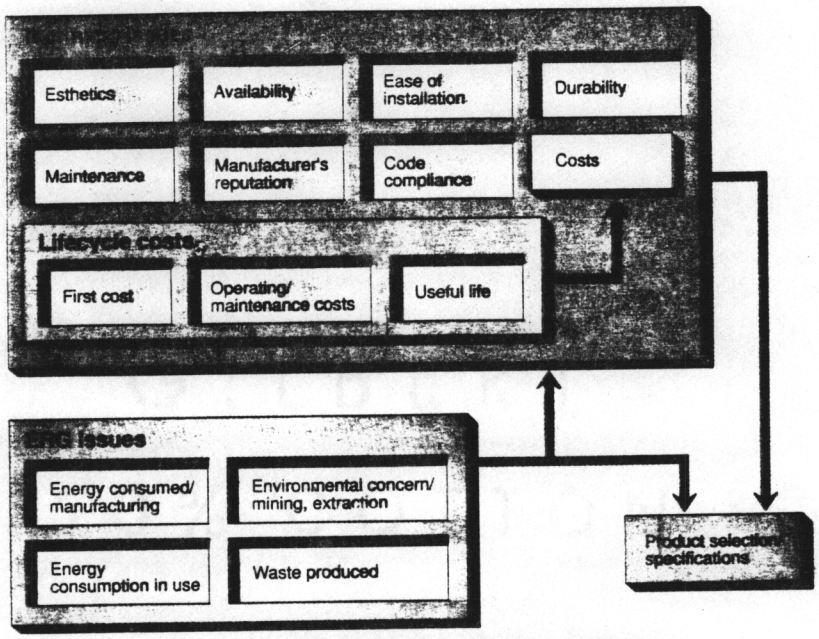


Fig. 33. The Environmental Resource Guide
From Architectural Record, October 1991

The figure shows how the ERG model can be introduced into the materials and systems selections process. The ERG issues relate to the useful life and the lifecycle of the materials. Those materials are related to technical issues of cost, reliability, code compliance, etc. and ultimately relate to a product's ability to satisfy design needs with attention being paid to environmental issues.

Another relationship Russell addressed was the design decisions and the development's environmental burden. Some project issues were addressed visually with regards to site programming.(See Figure 34)

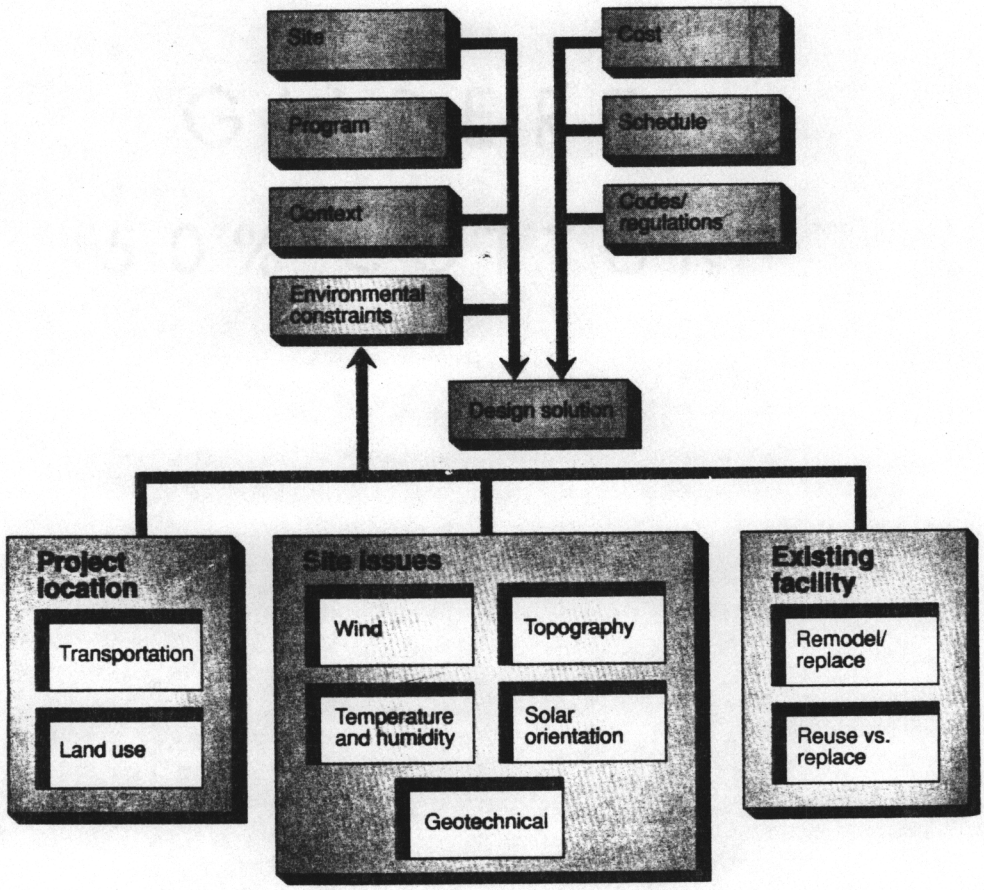


Fig. 34. Architectural Decisions vs. Environmental Burdens
From Architectural Record, October 1991

This figure starts to address some of the general issues of architectural influence upon the natural environment. Russell promotes the architect's ability to influence the environment as matters of questioning land use, site use, and the investigation of existing structures on the site.(p.39) His interest is relatively mechanical and criticized by such prominent figures as William McDonough, whose philosophy is that ecological or sustainable design can not be related solely to mechanical issues. The issues of investigation may be relatively mechanical, but ultimately it is the architect who's design influence raises the work to a piece of architecture.

A list of issues relating to the determining of nontoxic and resource-efficient materials was derived from the AIA's publication, Making a Difference: An Introduction to the Environmental Resource Guide and was published in Architecture magazine in May 1991. The adapted list of questions starts to offer questions that an architect may ask of a manufacturer in order to understand a particular material's aspects(production and otherwise). The list of questions follows:

1. How much "embodied" energy does the building material create over it's entire lifetime?
2. How much energy is required to manufacture the material and related products?
3. How much energy is used in transporting from source to project site?
4. Are renewable or sustainable energy sources used in the manufacture of the material?
5. Are there less energy-consuming, longer-lived alternatives for the same applications?
6. Are local sources for the material available?
7. Can the material be recycled or reused at the end of it's useful life in a structure?
8. How easy or difficult is the material to recycle?
9. Do different construction systems offer better opportunities?
10. How much maintenance does the material require over it's life in a structure?
11. How energy-intensive is the maintenance regimen?
12. Are waste byproducts produced during maintenance?
13. Does the material require special coatings or treatments that could present health or safety hazards?
14. If the material produces off-gasses during and after installation, how is indoor air quality affected?
15. Are hazardous solid, aqueous, or gaseous wastes produced during manufacturing process environmentally significant?

16. How do the amounts of waste resulting from manufacture, fabrication, and installation compare with alternative materials?

The questions begin to address the materials as a conglomeration of resources and processes that ultimately return to, or remain in, the environment. It is questionable if a manufacturer would divulge technical product information to individuals, but as a national organization the AIA could, with member support, sponsor independent investigation of materials and processes used in architectural practices. Manufacturers may use the publicity of their material's sustainability as a selling feature of their products.

Finally, the AIA is sponsoring workshops, seminars, and consortiums to investigate sustainable issues and disperse information to interested architects. An example of such a workshop was held in Washington D.C. in October 1993.(EPA Future Studies Unit(Internet)) Issues addressed at this workshop were:

1. Definitions of architectural sustainability,
2. What sustainable issues need to be investigated?,
3. What issues/trends do we need to anticipate as affectors to sustainability?,
4. What are any non-building solutions to sustainable issues?,
5. How do we network for information gathering?,
6. How does architecture market sustainable innovations?, and,
7. What are the current needs of architects so that sustainability within the architectural field will proceed?

Workshops and other forms of in-field investigation allow the AIA understand dominant issues concerning practitioners. Direct representation by individuals and firms give examples and questions that may otherwise not be addressed or understood by the organization.

Obtaining an understanding of the AIA's roles: It's responsibilities to architects, it's representation of architects, it's influences on the researching and addressing of issues pertaining to architectural practice, etc. allows the architect a better understanding of some programmatic issues of sustainability, as well as, seek help from the organization that is the official voice of architecture within this country. We can now investigate current and independently addressed sustainable issues, theories, and movements within American architecture.

Current Issues/Theories

There are many issues and theories concerning sustainability in architecture that are currently being investigated and addressed. These issues include matters of efficiency, materials, sources of inspiration, and methods of investigation. The architect can formulate their own practicing paradigm by learning about the issues that effect sustainability and the environments within which they choose to build in.

One issue that has dominated architectural sustainability study is how to build ecologically responsible architecture without appearing to be conservative or technical by the nature of the designs. The strategies involved in sustainable architecture planning tend to define the acceptable nature of the designs. Edward Gunts describes a spectrum of strategies from the aggressive or "active" approaches, to the neutral designing of environments.(Architecture, June 1993) The difference lies in the ways the approaches address ecological and sustainable issues on site. "Active" approaches address site issues with technological advances and "materials that minimize energy consumption and save natural resources".(p.49) The neutral designing of environments approach includes the simple, low technologies, management of the site and the architecture. Addressing site issues by the location and orientation of buildings and the utilization of passive energy strategies reduce the stresses of the architecture on the site without incurring costs past the initial construction. Both strategies offer increased ecological functionalism of the architecture, but the means of conservation differ between the strategies. Figures 35 and 36 offer examples of both the "active" or technology driven strategies and the nature driven technological strategies as defined by Croxton Collaborative.

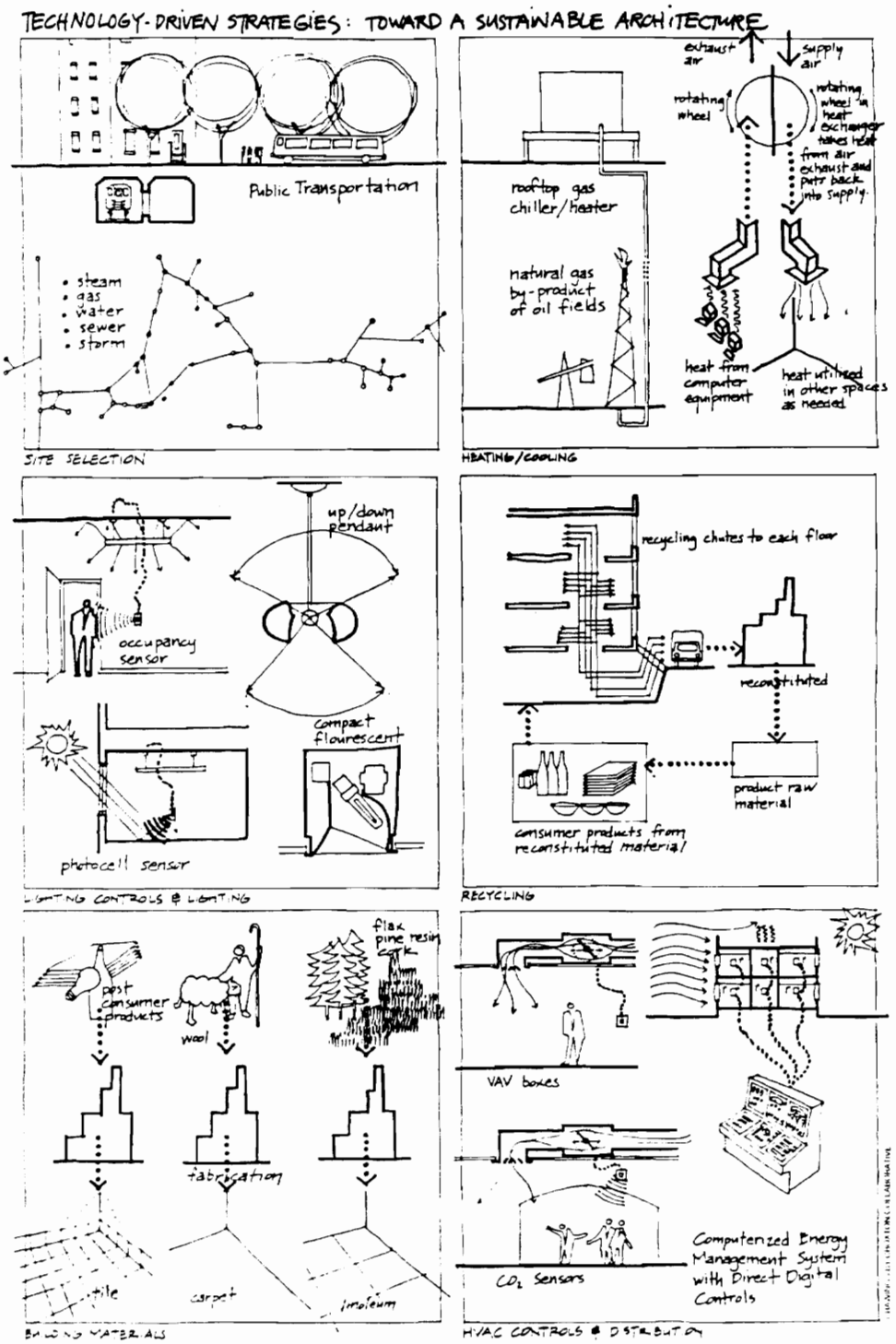


Fig. 35. Technology-Driven Strategies: Toward A Sustainable Architecture
From Architecture, June 1993

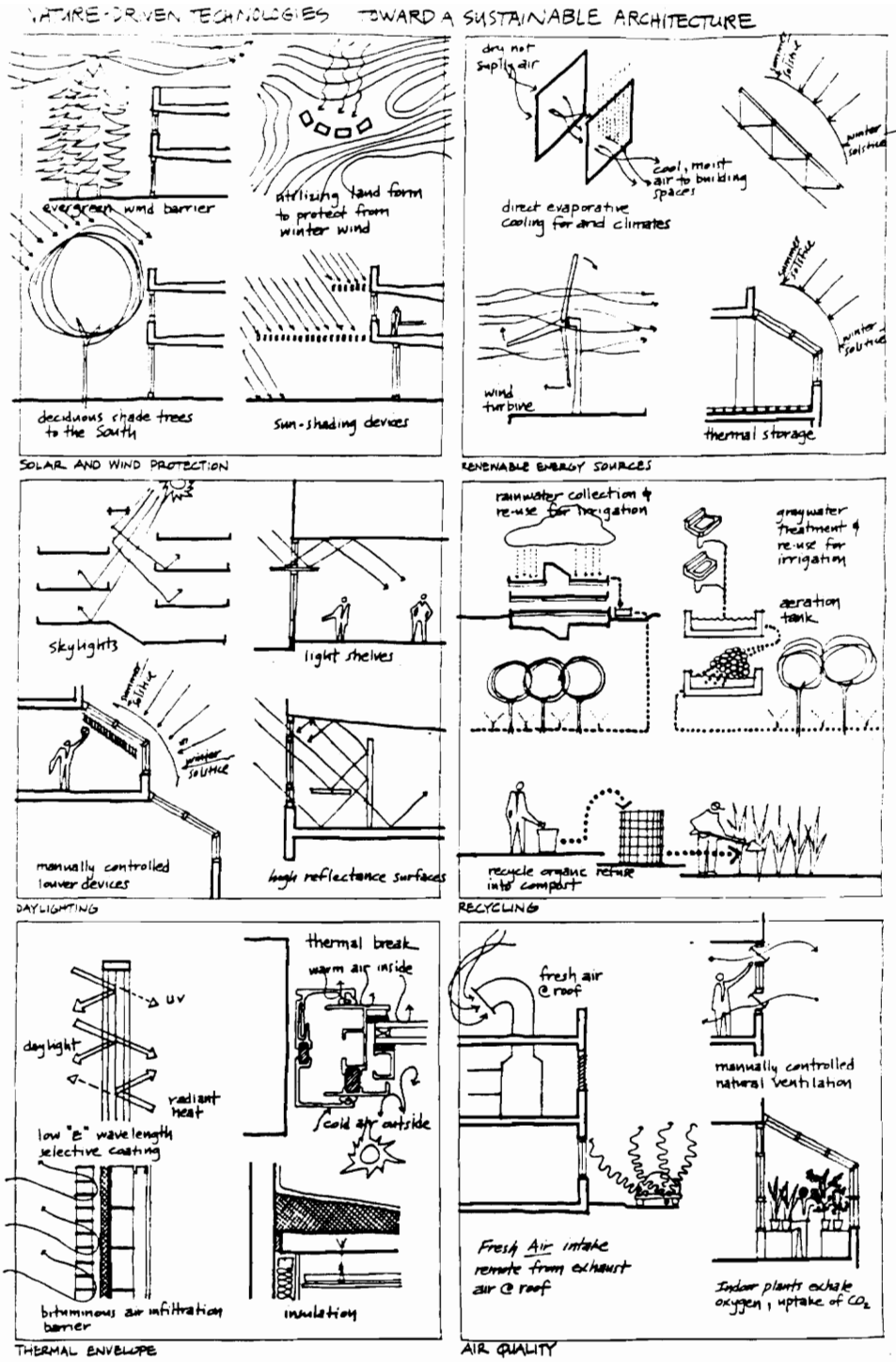


Fig. 36. Nature-Driven Technologies: Toward A Sustainable Architecture
From Architecture, June 1993

Along with sustainable strategies, a series of eco-types were differentiated as important in the advanced study and production of sustainable societies. These types offer sustainability a broader context for existence than just as an issue of technological improvements. These eco-types include:

1. Eco-Consumerism- The act of an informed public purchasing alternative products and systems of daily life because they also benefit environmental sustainability. This process also may include the purchasing of products from specific manufacturers and retailers because they support sustainability through their practices.
2. Eco-Tourism- The increased interest in regional and national parks, features, visitors centers, camping, etc. that encourage interactions with natural surroundings. Eco-tourist projects may include energy conservative or 'green' features that are not generally noticed by the public. They include reduced energy and water consuming utilities, etc. that make the feature more environmentally friendly without reducing the amenities that public expects.
3. Eco-Community- This eco-type incorporates the functioning of a community to a series of sustainable activities. Activities include pedestrian scaled environments, recycling, etc.. An eco-community would maintain itself through the services and production provided by it's own organization.(p.48-50)

The eco-type studies, when understood and practiced by the general public, introduce a need for a supportive architecture expressing the concerns and needs of the changing society.

Individual and joint venture projects with experienced firms in sustainable development and/or specialized construction, offer the architect another series of concerns and understandings as to the formulation of sustainable organizations. The firm may go so far as to hire a sustainability coordinator for their architectural endeavors. This brings the expert to the firm on a permanent basis. As was mentioned before, a firm might incorporate sustainable design into a specific design through a joint venture; after the project's completion the firm may be thought of as concerned and experienced with sustainable issues in architecture, yet lack a staffer that has experience or expertise in sustainable architecture. This misrepresents the firm and sustainable architectural practices. The transformation of sustainability to a dimensional

series of issues and scenarios help separate the practice from the purely technical, sterile, and engineered designs.

Amory Lovins and William Browning address architectural sustainability by way of another series of issues: Mainly the oversizing of building support systems.(Architectural Record, December 1992) They state that sustainability is also affected by the oversizing of HVAC systems within large building architecture. These practices increase resource utilization and encourage the inefficiency of buildings.

An example of this method is the down sizing of a building's HVAC systems through increased efficiency by utilization of natural lighting and heating/cooling systems. Natural lighting reduces the need for artificial(energy utilizing and heat producing) lighting systems. More efficient ventilation and building control systems also reduce the need to introduce environmental controls for user comfort. The reduced internal load and energy consumption of the building decrease the need for cooling systems to keep the building comfortable in warm weather. Lovins and Browning state that the architect may create a, "building that is more comfortable, yet needs about one-tenth the HVAC energy of a current large office building and(through reduced mechanicals) will cost several percent less to build."(p. 16) They reinforce this process by mentioning that manufacturers are now offering rebates, directly to designers, for increased efficiency in systems sizing practices. Thus sustainability becomes a more economically interesting venture for architectural firms, as well as doing something that is environmentally encouraging.

The integration of efficient architectural systems, for the support of sustainability, may include materials that require, or have less embodied energy. Embodied energy is the amount of energy that a specific material or system would require to be reproduced. The embodied energy includes the lifecycle of the material, not only the replacement energy value. Avi Friedman, professor at McGill University, stresses the need for efficient architectural systems and efficient material utilization within residential architecture.(PA, July 1994) His study, called the Grow Home, incorporated three parts:

1. Building utilization of alternative materials and techniques for ecological soundness. The incorporation of resource and energy efficient systems into architectural practices.
2. The investigation of site planning and sustainable community design issues., and,
3. The application of said knowledge of parts 1 and 2 to an infill site. The monitoring of the projects would supply increased understanding of systems efficiency and combinations of systems that offer 'more' sustainable solutions.

Friedman's study and cross examination of building models gave quantitative reasoning for systematic alterations within architecture. The study also offers examination of differences in material and systems embodied energy. Figure 37 shows some of the issues addressed within the study:

ENERGY AND COST SAVINGS FOR A SEMI-DETACHED GROW HOME

BUILDING	ENVIRONMENTAL BENEFITS	ENERGY SAVINGS (MJ)	ADDED CONSTR. COST
SHEATHING			
PLYWOOD TO OSB	59% LESS EMBODIED ENERGY EFFICIENT USE OF RESOURCES (BETTER USE OF WOOD FIBER)	17,493	-$368
INSULATION			
FIBER GLASS TO CELLULOSE	56% LESS EMBODIED ENERGY LESS RESOURCE DEPLETION (RECYCLED PRODUCT); BIODEGRADABLE	3,104	$441
ROOF SHINGLES			
ASPHALT TO CEDAR	43% LESS EMBODIED ENERGY LESS RESOURCE DEPLETION (RENEWABLE RESOURCE)	2,952	$1,001
SIDING			
VINYL TO CEDAR	92% LESS EMBODIED ENERGY; LESS RESOURCE DEPLETION (RENEWABLE RESOURCE)	38,124	$788
BRICK			
CLAY TO CONCRETE	55% LESS EMBODIED ENERGY	9,986	NEGL.
FLOORING			
CARPETING TO PARQUETRY	75% LESS EMBODIED ENERGY; LESS RESOURCE DEPLETION LESS TOXIC WASTE	8,347	$724
VINYL TO CERAMIC	85% LESS EMBODIED ENERGY LESS TOXIC WASTE	3,995	$908
TOTAL		**84,002**	**$3,495**

Fig. 37. Energy and Cost Savings For a Semi-Detached Grow Home
From Progressive Architecture, July 1994

An understanding of system and material embodied energy and efficiency allows the architect an informed model for building systems selections. Friedman's research offers an introduction to the types of research needed for increased understanding of systems sustainability in archi-

tecture. It is important to note that Friedman's research was produced within a collegiate environment and is therefore a first step in the attempt to produce a new type of informed architect.

One other theme being investigated within the study of sustainable architecture is the ability to reutilize existing buildings or recycle them. William McDonough stressed this point in the monumental design of the 'ecological' Wal-Mart in Lawrence, Kansas of 1993. The design included higher ceilings for multiple unit housing in the next century. McDonough encouraged design for reutilization sake, one where the commercial building would not make itself overly specific in purpose and/or style. The building, after being vacated, would offer enough incentive for minor alterations to be made and new tenants to create a new identity for the building.

The recycling of buildings can also relate to sustainability by the disassembling of older, 'unusable' structures, and selling or reutilizing the materials and systems for future construction. This theory was investigated in Portland, Oregon by Jeff Joslin.(Progressive Architecture, July 1994) Joslin studied the demolition of residential buildings: The value of materials salvageable through a careful demolition process, the ability to reuse building materials in other projects, and the economic issues of material reclamation.

Joslin studied whether the material being saved through a careful building 'defabrication' by a team of workers costs more than the fast demolition of the building by machinery and the purchasing of new materials. He found that the deconstruction process was competitive to the machine deconstruction of buildings and the materials from the defabricated buildings were generally worth $4 per square foot of building. The process starts to pay for itself and differs the costs of dumping the refuse of the demolition.(p.92) The embodied energy savings, the energy costs of replacement material through production, was about 43,513 Btus per square foot of demolished building. That is estimated to be about 9% of the total energy required for the original construction of the building.(p.92)

The study was also related to regional and national issues of construction. Joslin noted that the material savings through this process could reduce the need for new lumber by

more than 800 million board feet annually.(p.92) The economic savings of such a development would range around $1.5 billion in salvaged materials. The ecological savings of the process, though not mentioned, would be far beyond the costs of saved materials in regional ecological systems integrity and retained aesthetic value.

Joslin's investigation relates the sustainability of architecture, from the site scale to a societal scale, to the ability of developers to reutilize materials for construction multiple times. Though the reutilization rate of said material may only be around 80% efficient, the relayed ecological, societal, and economic savings of the process may reduce the environmental stresses for many more generations than the current use and demolish ethic of building utilization.

Materials efficiency and reutilization within architecture must be dealt with in a supportive and demanding manner. Debrah Dietur relayed the architectural sustainability issues of materials to the monitoring and defining of sustainable categories.(Architecture, June 1993) She applauds efforts to reach sustainability in architecture, but notes that sporadic attempts at sustainability will only confuse the topics involved. One architect's definition of sustainability in architecture may fall very short of true sustainability and/or the measure(or value) of sustainability to another architect. The lack of defined measures of sustainability within architecture, relating to materials, manufacturing, construction, recycling, etc., reduce the chances of formulating standards for sustainable materials production. A product that addresses a sustainable issue, such as not letting off vapors that cause sick building syndrome, may also be very material intensive to produce. Thus the material is not really sustainable, nor does it address many of the issues commonly associated with sustainability.

An example of unaddressed sustainability within architecture was the relationship of building innovation and the discarding of the old structures. Dietur notes, "moving into its green complex in Lawrence, Wal-Mart vacated a perfectly habitable, 86,000-squarefoot building less than a mile away, with little explanation of how the older building would be recycled. In other words, what passes for environmental habitat may turn out to be environmental hype."(p.15) The image of a company producing sustainable architecture may rise due

to public recognition and marketing of it's 'ethics', but they may only be expanding into another form of corporate architecture: 'New' company ethic within the buildings they produce, yet discard the buildings they may have built for prior company innovation.

Dietur suggests profession-wide voluntary guidelines and the stressing of industry-wide regulations for materials construction for the advance of sustainable architecture. The advance of said standards would, "require more participation from architects and a long-term investment in small-scale, project-specific solutions, rather than universal formulas based solely on technological advancements."(p.15) Architects are the ones most likely to be affected by changes in material regulations and production standards, so initial influencing of materials standards and innovations would only help stress the objectives of architectural sustainability. The time invested by architects, prior to governmental intervention for standards, would equate to expert intervention within practice regulations. The alternative is governmental regulatory decisions being made by committees of industry and advocacy influenced elected officials. It again becomes quite apparent, as William McDonough noted, that the architect needs to take on the responsibilities for the profession's development, rather than to have options dictated to practitioners by other, less informed influencing organizations.

Understanding the history of architecture, precedent theories with environmental concerns, current theories and issues of sustainability in architecture, and the organization of concepts(from the individual firm to the national level) offers the designer insight into many of the facets and relevant topics of sustainable architecture. Architects, not unlike planners, address many issues of social, economic, and ecological importance within their work. While addressing those influences within their work, the architect must maintain their design integrity and meet the needs of the client. Architectural sustainability addresses the issues of structure and program within an ever-changing environment, with the objective of creating a viable environment for activity goals for long periods of time.

It is now important to investigate the relevancy of landscape architecture to the production of a sustainable architecture.

Landscape Architecture

History

Landscape architecture, as a profession, has historically dealt with issues of the natural environment from the site to the regional level. The field has gone through many movements involving environmental and design value on the site. From the massive gardens of 16th and 17th century France to the parks of Olmsted in the early 20th century, landscape designers have dealt with the natural environment in terms of ornamentation and value of aspects within an environment. The rise of pollution and environmentalism of the 1960's brought landscape architecture into the realm of the preservationist and the ecologist. Landscape architect relations with the environment expanded to include regional planning practices, park design and preservation, to issues of nature within an urban environment.

Sustainability within landscape architecture was brought about by the increased view of the designer as an expert in ecology, hydrology, grading, plant materials, etc. that are considered aspects of environmental constructs. Landscape architects were perceived as experts and began to be seen as liable for the competent designing of natural environments. Many writers, from the 1960's to the present, have been addressing issues of the natural environment and environmental perception. Scholarly interests include the definitions of environmental space, understanding the fragility of environmental factors and features, and the creation of directives for environment development for optimal human and environmental interests.

Precedent Theory

Ian McHarg's writings of the late 1960's set a theoretical precedent for the viewing of the environment and it's development. His historic book, Design With Nature(1969), described a different ethic in the way the designer was to experience and evaluate the natural environment for competent, ecologically based development.

He perceived contemporary environmental perception as historically and religiously based, yet lacking introspection into the processes that make up the environment. McHarg

states, "Clearly the problem of man and nature is not one of providing a decorative background for the human play, or even ameliorating the grim city: It is the necessity of sustaining nature as source of life, milieu, teacher, sanctum, challenge and , most of all, of rediscovering nature's corollary of the unknown in the self, the source of meaning."(p.19) The history of developmental practices: From the subsistence community, to the exploration of the new world, to the colonization of new territories, and the incorporation of religion into development tended to support human development and growth. The environment was to be developed to support human needs. It was never considered anything more than a resource for human production. McHarg's perception of this was, "If nature receives attention, then it is only for the purpose of conquest, or even better, exploitation-for the later not only accomplishes the first objective, but provides a financial reward for the conqueror."(p.24) The economic ethic overtook other developmental issues as the primary directive and historic developmental practices reflect that ethic.

The current state of the environment, one of cities sprawling within large open areas, is seen as environmentally unsound and reflective of a lack of an ecological ethic. McHarg believes that the invention of the highway, a system laid over and through environmental aspects an, "analytical rather than the synthetic view and indifferent to natural process-indeed an anti-ecological view..."(p.31) The highway, when investigated through aerial photographs and planning maps, seems to encourage the urban sprawl of the latter 20th century. By erasing a set delineation of urban and other purpose lands, the self-contained city has proceeded to devaluate itself into a series of subcities that are dependent on transport of people, goods, and services for their viability.

McHarg tries to re-evaluate the understanding of the environment and it's features for the future study and development of land. He states, "Let us accept the proposition that nature is process, that it is interacting, that it responds to laws, representing values and opportunities for human use with certain limitations and even prohibitions to certain of these."(p.7) Land is separated into areas of interest; each containing it's own limitations, opportunities, and value towards maintaining or developing. These areas of interest are:

Surface Water	Steep Lands	Walls and Slopes at +25deg
Marshes	Prime Agricultural Lands	Promontory Sites
Floodplains	Forests and Woodlands	Open Plateaus
Aquifers	Valley Walls w/o Forest Cover	Wooded Plateaus
Aquifer Recharge Areas	Valley Walls with Forest Cover	Air Sheds

Each area of interest contains natural amenities such as: Geological patterns, ecological associations, and habitats of various animals that are specific and have their own opportunities and limitations to keep in mind.

McHarg then equates the value of the areas and their amenities to the ability, or costs, associated with the development of certain areas. A valley wall that is forested has a high value due to the vegetation, habitat, etc. that are characteristics of it. The topsoils located on the wall are threatened by the reduction of vegetation and development of these walls is not considered appropriate. It's systematic value is higher than, say, an unforested plateau where development isn't likely to interrupt many sensitive natural systems. Thus, the architect, planner, or designer would look for alternative development sites to locate their projects.

This methodology offers a rated selection process for lands by means of systematic evaluation. McHarg's method relates the functional characteristics of lands to the development and management options and values of said lands. The architect can establish the most applicable land selections for their project objectives. McHarg's model has been referenced by landscape architects, architects, and planners alike.

Current Theories

John Tillman Lyle, professor at California State Polytechnic University at Pomona and the director of Cal. Poly's Center of Regenerative Studies, proposes land management and development as based on the natural orders and organizations. The orders are considered ecosystematic, the integration of many complex environmental aspects with similar aspects and implications. These ecosystematic orders are:

1. Structural Order- "The composition of living and nonliving elements: Rocks, soil, and plant and animal species....In natural ecosystems, structure is usually consistent in that each species inhabits a particular niche and maintains ongoing interactions with other species."(p.23) The order implies an ever changing assemblage of interactions that form the support systems of an environment.
2. Functional Order- "The flow of energy and materials that distribute the necessities of life to all of the species within the ecosystematic structure These flows constitute the dynamics of the ecosystem and often explain the flux and change that it undergoes."(p.23) Natural energy(such as solar) invested in water, plants, and animal systems are reinvested, or recycled into the environment by various means. The plant dies and distributes it's organic material to the earth for reuse. The same goes for animals, water, minerals, etc. within an environment.
3. Locational Order- "The type and number of species that any ecosystem can support are determined largely by the environment in the particular place where it exists, which is in turn determined by the specific local conditions of topography, soil, and climate. An ecosystem is unique to it's location."(p.24) The qualities of certain environments dictates the species and systems available and viable.

These orders describe environmental conditions and systems in very tangible and simplistic ways. Their intent is to define inherent environmental organizations so that the designer/investigator is capable of noting more diversity within an environment and is able to evaluate an environment with an increased understanding of the environment's factors of viability.

The capability of an environment to maintain itself, or regenerate itself, is related to ecological functions of the specific environment. Environmental processes are the foundations for an environment's sustainability; each aspect of an environment defines many other participants opportunities and limitations. Lyle notes six basic phases of ecosystematic functioning, they are:

1. Conversion- The sun, being the primary source for life on earth, releases energy to the earth that is converted into many other types of energy. The absorbence of solar energy into plants allows for the growth and functioning of the plant's systems. The plant's fruit or leaf is converted to energy for animals through the digestion process. The conversion process is carried through the environ-

ment in many ways and is eventually returned to the earth by the death and decay of plant and animal material.

2. Distribution- An environment must move it's produced materials to reinforce processes and support environmental maturation. Wind and water move sediments and organics throughout an environment. The process reinforces the environment by supplying many nutrients to the system and maintaining diversity within the area.
3. Filtration- Soils and plant materials filter the nutrients being relocated through an environment by wind, erosion, and precipitation. This process maintains the quality of basic systems and resources within the environment.
4. Assimilation- The death and decomposition of plants and animals returns nutrients to the environment for further growth and development. The process provides detritus and humus to soils, enriching them, and providing new plant material with needed nutrients.
5. Storage- The ways in which the environment stores resources and energy deter mines the fragility and opportunities of that environment. Aquifers for water, mineral deposits within soils and strata, soil nutrients moving to trees and plants, etc. relate a time factor to the movement of energies within the environment.

The phases involved in the ecosystematic functioning of an area or region defines the capabilities of the environment to withstand various degrees of modification. Lyle stresses the investigation of these systematic variables in order to gain a better understanding of the processes involved within various environments.

The next step towards a sustainable design is to integrate aspects of human need and environmental function into a paradigm for development. Lyle states, "In going beyond the limitations-the narrow purpose and scope-of industrial technology and it's linear engineering, regenerative systems draw on human creativity for invention and adaptation to ever-varying circumstances. They require creative planning and design to bring together diverse factors, human and natural, and weave them into a coherent whole that is essentially a new ecosystem."(p.28) A new, human ecosystem is created utilizing the understanding of natural features and their characteristics. Development is implemented to serve human processes, but the system also serves as a viable environmental ecosystem. Cultural and biological functions are maintained and/or thrive under this system.

The utilization of ecosystematic phases, environmental evaluations, and the incorporation of human systematic relations combines to form a comprehensive system called regenerative design. In figure 38, Lyle shows how land is evaluated for community development, based on the ecosystematic functions of different topographical patterns.

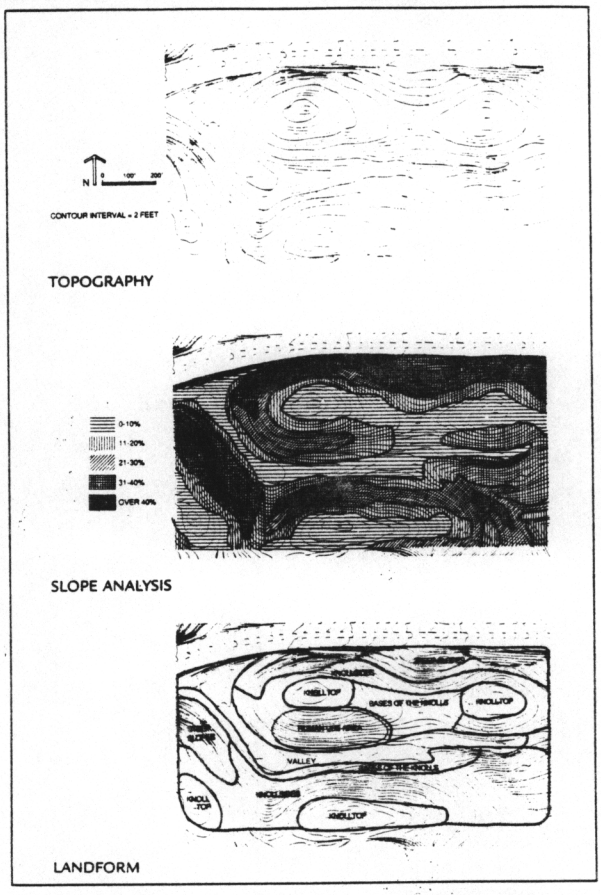


Fig. 38. Community Planning Based on Topographical Evaluation
From Regenerative Design for Sustainable Development, 1994

The figure shows how topographic features have specific utilization factors and are therefore suited to different developmental or preservational statuses. Note that this system may be derived from or integrated with some of McHarg's land analysis methodologies for the understanding of features. Topographical features containing high sensitivities would be selected for habitat or preservational functions, while areas of moderate slope and ecological function areas would be utilized for community development.

From the land selection process comes the community layout process. Land selected for human uses and benefits, such as housing, must maintain the needed systems for human survival while maintaining the safety and integrity of the community format. Figure 39 shows a schematic model of the regenerative community: The systems that are incorporated to fulfill the ecosystematic functions of the environment and the community needs for maintenance and growth.

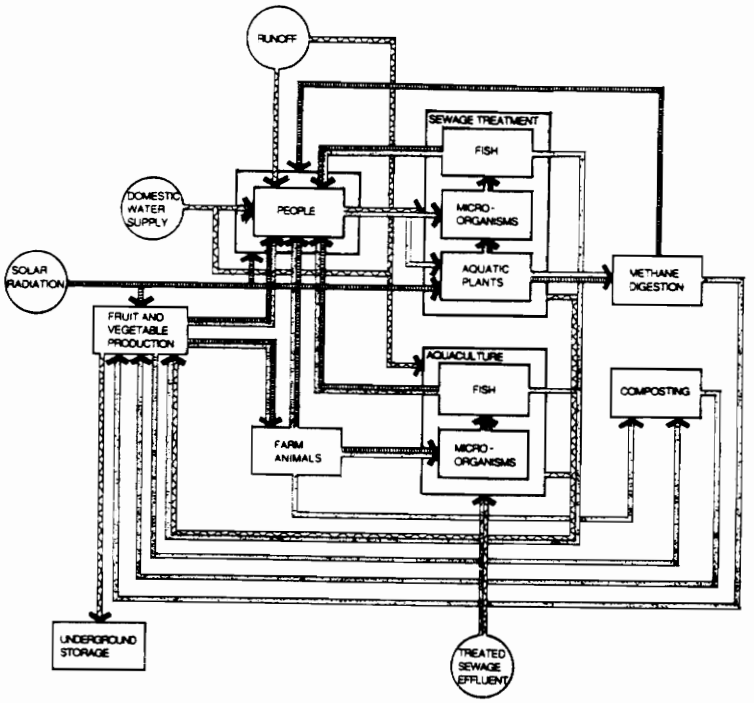


Fig. 39. Schematic Representation of the Regenerative Community
From Regenerative Design for Sustainable Development, 1994

The make-up of a community would be based on the needed systems for human activities within the existing environmental properties. The flows of energy, nutrients, and water within the community relate to the functions of the site and project objectives.

There are a series of strategies that increase the integration of optimal systems within the formulation and construction of regenerative communities. Lyle states, "With more inter-

actions involved, more options available and far more flexible technologies to deal with, regenerative design provides virtually unlimited opportunities for invention and for devising varied ways of combining elements."(p.37) The next dialogue necessary for the design process is which options are of most value to the community objectives and which combinations of systems fulfill the ecological conditions of the region and site. Regenerative community design contains twelve strategies for optimal development, they are:

1. Letting Nature Do The Work- The current philosophy of waste management, energy supply, food production, shelter, water supplies, and distribution of systems within communities has dealt with high technology, high resource utilization, and the concentrating of systems. In nature the process is carried out through ecological processes that maintain viability through evolution. Lyle suggests that the reduction of technological systems and the modifications to more natural processes. The natural processes reduce resource utilization, waste through production and maintenance, and the need for labor intensive maintenance systems. Observation and scientific evaluation of the natural systems would be the primary maintenance required within these systems.
2. Considering Nature As Both Model And Context- Lyle states that there is an importance in maintaining the ecological systems within the context of the site or region. Those systems are time tested and acceptable under the environmental conditions. Trying to maintain the project's influence on the site as equal to, or as close as possible to, the natural levels of the environment provides a viable model for development within the environmental context.
3. Aggregating, Not Isolating- The dissection of natural systems into their compo - nent tends to remove the process of interactions between components within the system. Lyle states that this has happened in the study of the environment and the study of civilizations. Cities developed from fully integrated towns and communities. The process of development removed the aspect of interactive activities and spaces, thus zoning use of lands and areas. The utilization of an area for more than one purpose, such as communal space and market space, offers a reduced footprint for development and an increased interaction base for the community. The increase of interactions within a community can be related to the pride and participation within the community.
4. Seeking Optimum Levels for Multiple Functions, Not The Maximum Or Minimum Level For Any One- Lyle states that historically development has been goal oriented, design has been utilized for the optimization of one particular objective with the exclusion of all other aspects of the process or area. That mentality has made for the precise estimation of systems and their function, but has cost the other facets of the environment into a non-sustainable level. The re

generative process would incorporate other systems into an approximation of value required within an overall system for viability. The overall system would then be planned according to the approximations for the best match of all aspects of the environment, not for the maximum production of one aspect.

5. Matching Technology To Needs- The appropriateness of systems implementation is related to the need of, and the difficulty of, obtaining an outcome. Lyle notes that the utilization of fossil fuels to function HVAC systems, instead of utilizing the natural processes of heating and ventilation, produced an overly technical solution to an easy aspect of comfort control. The utilization of highly technical systems is justified when the system reduces the resource utilization and burden of desired outcomes. The need is to define the project needs and to maintain an equilibrium of technology and requirements.
6. Using Information To Replace Power- The accurate description of systems requirements is the key to the accurate designing and sizing of systems. Oversizing of systems increases the resource utilization of the system, as well as over produces the desired outcome. This concept was raised in the HVAC sizing of buildings in the Architectural section. Lyle stresses the need to size systems to accurately represent the needs of the project.
7. Providing Multiple Pathways- The ability of a community or building to feed off of multiple systems for the optimum use of systems. This occurs primarily with energy production within regenerative buildings and communities. As Lyle suggested, the Rocky Mountain Institute utilizes photovoltaic units for power production during the day. After the optimum production of solar energy has passed, the control systems of the building change over to alternative energy systems for power. This methodology for power supply and consumption requires multiple systems for power production and the related high prices of installation, but they may be capable of supplying power to utilities when there is an overflow of energy within the system.
8. Seeking Common Solutions To Disparate Problems- Municipal systems of management, such as sanitary sewers, are devoted to single purpose management with minimal goals for solutions to other aspects of the community. A regenerative system would utilize many systems, not unlike natural ecosystems, to resolve the complex issues of on-site management. The systems therefore reemphasize the natural order of organization and support those systems by their organization.
9. Managing Storage As A Key To Sustainability- Traditional resource utilization tends to deal with reserves as unending storages for utilization. The process is unrealistic at best. Regenerative practices support the theory that these reserves vary in amount due to environmental conditions and processes. They support the utilization of resources in relation to the replenishing of the resource bases.
10. Shaping Form To Guide Flow- This strategy stresses the ability to shape the environment to obtain a series of objectives, without reducing the quality of the

environment. By utilizing non-pollutive products, the community may achieve it's objectives, but in a friendlier manner for the environment.

11. Shaping Form To Manifest Process- Technological systems and processes tend to be very intense and demand attention in their forms. The objective is as much covering up the unsightly aspects of production as the act of producing itself. Regenerative processes are intended to be seen by their nature. This system consists of combinations of natural elements in organizations that are functional and not unsightly. Lyle stresses that these systems create a reinforcing natural aesthetic within the landscape.
12. Prioritizing For Sustainability- The process of transition between using the technology based systems and the utilization of regenerative systems requires many decisions of ethics and priorities. The attempt of integrating the new ideas and methods will expand the public's perception of possibilities and lead to a change of priorities with regards to material and process selection. Lyle stresses the need for integrating concepts into decision making processes for the expansion of the regenerative theory.

The strategies are intended to increase the designer's perception of necessary concepts and issues with regards to community design. When taken in consideration, and utilized as a basis for investigation, the strategies become the foundation for systems guidelines and community planning practices.

Lyle's regenerative model is an example of the maturation of sustainable theory with regards to landscape architecture. While it's implications relate to architecture and planning, the model tries to define systems within ecosystems and emphasizes responsible planning practices for community development. When taken into investigations, the designer may be more capable to evaluate existing environmental conditions.

Policy Issues

Once a region has been evaluated, using McHarg or Lyle's methodologies, the question arises of how to uniformly evaluate and regulate developmentally sustainable patterns and policy making. Michael Ellison, the President of the Landscape Institute, feels that many 'sustainable' landscapes are aesthetically preferable to man made systems, yet may not perform as they should and are confused attempts at innovations.(Landscape Design, 1994) He notes that some communities are redefining the principles of sustainable design without look-

ing towards experts for design policy input. The regulations regarding sustainability are questionable and "should be asked for an explanation."(p.47)

Another aspect in need for understanding is the delineation of lands for development. Ellison notes that, "...we ignore the visual consequences for those wide open spaces which are unfortunate enough to be earmarked as extensive industrial sites; but in any cost-benefit analysis it is essential not to ignore either side of the account." The lack of concern for the aesthetic properties of an environment is another way of polluting the environment. The environment may be sustainably viable, yet the appearance may not be beneficial and then becomes a cost of development that must be accounted for.

Ellison concludes by expressing that policy must relate to the issues of environmental value and sponsored by the authorities that produce the policy. He states, "It might also raise the question of whether it is right for central government to proclaim a policy allegedly in the national interest while leaving it to individual entrepreneurs and local planning authorities to decide whose windswept horizons are to pay for it."(p.47) It is convenient for the government to state interest in a policy or issue, but it is another thing entirely for a governmental agency to produce a plan for management that includes measures for policy payment.

Community policy making has taken on sustainability in many ways. Communities are creating water control projects, as well as other community infrastructure projects to increase environmental quality and create viable alternatives to technologies based models for the mitigation of community wastes, etc.. Heidi Fischer notes, "Many regions of the country have already turned to these kinds of issues- called "soft infrastructure"- to help solve problems brought on by "hard"-engineered systems."(Utne Reader, 1993)

The utilization of alternative systems forms ecological foundations in community areas that are not usually addressed by such systems. An example is the use of flood tolerant trees over gravel catch basins. The implementation of this type of system allows parking areas, etc. to drain by natural means while reducing the water in the lot. The process offers adds to the visual aesthetic of the parking area and relieves the community sanitary sewer of some stress. It would also help recharge the area's aquifers.

Fischer addresses the issue of economics with these implemented alternative systems. She states, "Though new planting and landscape design often involve a greater initial investment than do traditionally engineered systems- more land taken off the tax rolls or a heftier cash outlay to support the painstaking process of establishing native vegetation- they have big long-term payoffs."(p.47) The value of lands, surrounding these alternative systems, would remain higher than if the environment were reduced or destroyed for the engineered systems. The tax structure of the community would modify to absorb the losses of the naturally kept lands by accepting the increases around the new amenities.

Experimentation with sustainable systems within an environment does attract attention and criticism from various sources. An example of good intention challenged by advocacy groups is the Ahmanson Ranch.(Landscape Architecture, 1994) Environmental advocates and other interest groups have been suing(for a total of nine lawsuits) the project due to it's implementation of housing techniques and site development. Although an experiment, such as the Ahmanson Ranch, may not be feasible after some time and observation, the data produced through such a process may offer further directives into sustainable planning and aspects of design.

The process of experimentation and development may include team efforts for the maximization of the multiple aspects of the area or region. As Lyle and McHarg implied, the varied systems require respect and understanding for viable development. Therefore, it may be in the best interest to accept or require the services of many experts to develop initial understandings of regional aspects. The information may set precedence for future development and provide information the individual project would require for sustainable, or regenerative, architecture.

The Haymount development project in eastern Virginia is such a case where multiple experts were consulted to support the development of a sustainable community. A team of architects, landscape architects, engineers, hydrologists, and planners established a series of concerns and standards for the integrated design process.(p.59) They accepted McHarg's theory of a sustainable landscape: A landscape is only sustainable if taken as a series of inter-

related systems. The exclusion of a system as valued reduces the environment to a series of processes that can not be maintained naturally. The team attempted to address the environmental systems of the region by expert analysis of the aspects. The project was then designed to support said systems and organizations within the environment.

Community and other sustainable developmental interests help increase client awareness and public perception of environmental processes and constructs. Landscape architect Carol Franklin thinks that it is the designers job to lead the public in it's developmental tastes.(p.61) To abide by public perceptions of value within community constructs, the architect, or landscape architect, provides a service like a politician. In order to be utilized for services, the architect must appeal to the desires of the public in their designs. By defining the values of development, the designer obtains the leader position. Their actions in defining regulations and developmental patterns allows the respective fields a gained position of authority and freedom.

By understanding the many theories, concerns, and positions of the landscape architect, one can begin to define their prospective roles within the sustainable developmental model. The landscape architect's concerns for natural systems within the environment, the inherent aesthetics of environmental aspects, and the design of supportive landscape systems for human and environmental gain become intricate aspects of a sustainable development. The integration of the landscape architect's expertise into the sustainable model offers additional introspection into ecological systems in a design manner.

It is now possible to integrate the design profession's interests and the ecological, economic, and sociological constructs of civilization into a structure for architectural review and an understanding of developmental issues that can be applied in various scales and constructs.

Appendix

(Publications and Periodicals appear in chronological order of their use within the thesis)

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Vita

Hans Russell Howland was born on May 14, 1971 in Rochester, New York. He was raised in a small suburb called Penfield. His childhood included many travels to Europe and the home countries of his parents and ancestors. His parents encouraged him to investigate his interests. Their understanding and patience allowed him to explore and express his curiosity freely. They supported many courses and travels that helped form the foundations of his architectural interests and studies

Throughout his childhood he participated in athletics and scouting. He participated in the Boy Scouts and received his Eagle Scout Award while in the eighth grade. Athletically, he participated in high school cross country and track. After reasonable success, he was recruited to attend the University at Buffalo and run for the track team.

At the University at Buffalo, he studied many different topics and won All-Conference honors for his running. During his sophomore year, he became interested in the architecture program. He produced a portfolio and was accepted into the program. He received his Bachelor's of Professional Studies in Architecture in May of 1993.

While at the University at Buffalo he realized that his architectural investigation would require more than the typical four years. He was concerned with the environment's role within design. He decided that he would have to study landscape architecture to help develop his architectural style. After concluding his studies in Buffalo, he departed for the Virginia Polytechnic Institute in Blacksburg, Virginia.

Virginia Tech supplied Hans with many opportunities to explore and develop his environmental interests. His studies revolved around understanding the environment dimensions and deriving a vernacular or environmentally appropriate architecture to suit specific environments. The architecture would enhance environmental conditions and systems.

Upon graduating with a Master's of Landscape Architecture, he will be attending the University of Oregon to attain his Master's of Architecture.

Hans Howland