CRITICAL EVALUATION OF ARCHITECTURE FROM THE ECOLOGICAL PERSPECTIVE AND ECOLOGICAL STRATEGIES FOR ARCHITECTURAL DESIGN

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Architecture.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Architecture.

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ABSTRACT

The thesis evaluates architectural design from the ecological perspective, viewing architectural practice both from the construction of nature-architecture-man trilogy as spatial units and philosophical inquires, and also from the operations of buildings and built environments functioning as shelter. Ecological and ecosystematic thinking, as studies of spatial units, conceptual frameworks and philosophical dimensions of environments, provide scientific and normative theories for architectural design. Ecological thinking understands the conception of environment in different scales as human ecosystems. Building and its environment, and its overall conception as an architectural product, which can also be conceived as a human ecosystem, need an evaluation from the ecosystematic point of view. This evaluation is done by applying scientific understanding of ecosystems to architectural processes and products, that is viewing them in systems having locational-structural-functional orders. This approach highlights both the importances of the elements of the designed systems (in this case buildings) and the relations within the systems which is a crucial point in ecological thinking.

Environmentalism and sustainability, which are politics in the background, regenerate themselves within their own dynamics. The thesis investigates how these changes are reflected in architecture. The technologically and ecologically sustained thinking and practices in the design fields generally and architecture specifically, are the main focus of the thesis. Lastly, the study searches how ecological principles can be applied on architecture with case studies.

Keywords: ecology, ecosystem, sustainability, ecological design, human ecosystems, ecological architecture.

EKOLOJİK BAKIŞ AÇISINDAN MİMARİNİN ELEŞTİREL DEĞERLENDİRMESİ VE MİMARI TASARIM İÇİN EKOLOJİK STRATEJİLER

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ÖZ

Tez mimari tasarımı ekolojik bakış açısından değerlendirmektedir. Ekolojik bakış açısı, mimari düşünce ve pratiğe hem doğa-mimarlık-insan üçlüsü kurgusunun mekansal birim tasarımları ve felsefi sorguları hem de binaların ve yapı çevrelerinin barınma fonksiyonu açısından bakar. Mekansal birimlerin tasarımları, çevrenin kavramsal çerçevesi ve felsefi boyutları açısından ekolojik ve ekosistematik düşünce, mimari tasarım için bilimsel ve nortatif kuramlar sağlar. Ekolojik düşünce çevrenin değişik ölçeklerdeki kurgulanmasını insan ekosistemleri olarak kavrar. Bina ve çevresinin de bir insan ekosistemi olarak kavramsallaştırılması, ekosistemik bakış açısından değerlendirilmesini gerektirir. Bu değerlendirme, bilimsel ekosistem anlayışının mimari süreç ve ürünlere uygulanmasını yani yöresel, yapısal ve işlevsel düzenler içindeki sistemler olarak algılanmasını içerir. Bu yaklaşım hem tasarlanmış sistemlerin elemanlarını (burada binalar) ve daha da önemlisi ekolojik düşüncenin canalıcı noktası olan sistemler içi ve arası ilşkilerin öne çıkmasını sağlar. Ekolojik düşüncenin politikasını oluşturan çevrecilik ve sürdürülebilirlik düşünceleri kendi dinamikleri içinde sürekli yenilenirler. Bu yenilemenin mimariye nasıl yansıdığı tez kapsamında yer almaktadır. Tasarım alanında ekoloji ve teknik sürdürebilirlik olarak ayrılan düşünce ve pratikler tasarım alanları için genel olarak, mimari için detaylı olarak tezin ana temasını oluşturur. Son olarak çalışma, örneklerle, ekolojik prensiplerin mimariye aktarılamasını ve uygulanabilirliğini araştırır.

Anahtar kelimeler: Ekoloji, ekosistem, sürdürebilirlik, ekolojik tasarım, insan ekosistemleri,ekolojik mimarlık.

Dedicated to:

My Father; Orhan Özkeresteci

Wish you can see more of
What I do about ecology.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

CHAPTER 1

INTRODUCTION

1.1. The Scope, Aims and Method

The general aim of this thesis is to investigate the relationship of ecology and architectural design. It is based on the survey of *ecology of architectural design* and of *the architecture of ecology*. Since ecology is a science of *relationships*, the ecological viewpoint for architectural design studies the content of architectural relationships of the physical and the cultural world with nature. It tries to place architectural design - theoretically and as a practice - in the context of ecology. The thesis tries to look from the ecological perspective to the architectural design phenomena within its broader context of design and of the whole life phenomena and tries to emphasize the importance of ecological knowledge and the ecosystemic understanding and ecological ethics together as its prime objective.

The context of ecology includes the relationship of natural environments and of human communities in history (past, present and future) in various ways and forms where the basic aim has been the sustainability and the survival of the planet as a totality. The framework of the context in the thesis is determined more or less with the notion of 'design activity' which is the primary motive of human activities that have an effect on nature. Thus the thesis is formulated on the following basic fact as a foundation: **All human activities carry an ecological dimension and have an impact on nature.**

Thus the *built environment* which is the prime object and subject of architectural design has certainly an ecological dimension both as material and as socio-cultural entity. The thesis holds an environmental deterministic view, and especially supports that the ecological dimension of design and architectural activities are one of the primary causes that disturb the ecological environment in their contact. But design activities and architecture as both material constructions and spatial arrangements can have ecological values that may help the perception of the distribution of material exchanges and cycles coherent with those of the earth.

The aim of this thesis, is then, to show, through the integration of the ecology and ecosystem concepts to design, the possibility of ecological architecture and ecologically designed environments that minimize the impacts of human activities on ecological dimensions.

The Oxford English Dictionary (2nd ed., 1989) has two definitions for ecology. First is the scientific explanation of the term, "the science of the economy of animals and plants; that branch of biology which deals with the relations of living organisms to their surroundings, their habitats and modes of life, etc." The second definition places ecology rather in a social, political and cultural dilemma in which the word refers to ecological issues dealing with both quantitative aspects of the phenomena like pollution, population, energy, transportation, housing, biodiversity loss and qualitative aspects of the phenomena like the quality of air, life, cities, environments (natural and artificial).

Ecosystem defines the study context of the discipline of ecology that forms the foundation of ecological studies. An ecosystem as a basic scientific definition, refers to 'an integrated ecological unit consisting of the living organisms and the physical environment (biotic and abiotic) in a particular area (Morgan, 1995:26).' In the science of ecology the term ***ecosystem*** is used both to define *a unit of study (spatial, with location, structure and function)* and to describe *a concept or an approach* (Yeang, 1995). This corresponds to two related aspects within the architectural discipline; one being concerned with the material processes of building and construction and how these relate to ecology and to sustainability, and the other being concerned with design and its relations with the environment as an ecological system. The focus of ecological studies on ecosystems is *relationships*.

Another point that this thesis stresses is that spatial units and productions which are the primary concern of architectural design are termed as *human ecosystems*. Human communities and their activities are not usually considered within the scientific study of ecology or they are taken as merely physical variables. Both the complex cultural and social activities of human beings and their dependence on natural surroundings necessitate a new kind of ecosystem definition termed as *human ecosystems*. Human ecosystems imply sustaining the integrity of natural surroundings and well being of human communities culturally, socially and economically. Human ecosystems thus focus on the idea of *being ecological* which corresponds to the ethics of ecosystems (biotic and abiotic), that is human beings' attitude to natural environments and nature, where the primary goal is conservation and preservation of ecological integrity. The second theme refers to the functioning of human ecosystems, which is closely linked with the first theme, where it is a matter of mutual relationship in physical, socio-cultural and philosophical dimensions. The aims in detail can be categorized as the following:

1. The study includes the critique of architectural and building design from the ecological perspective. It aims to show the context of architecture in ***broader*** (global, continental, national, regional, urban, rural) and ***finer*** (industrial production, material and energy cycles and flows in soil and water and air, natural environments (flora and fauna) and even at molecular and atomic) levels. The study observes architecture as a subsystem in relation with other subsystems and the total system. The ecological critique constructs the relationship of human activities and natural world with the understanding of the notion of **impact** and **interdependency** as a basis. So the idea of impact and interdependency of the physical, biological and the cultural world of nature and humanity relationship mutually will be the one of primary focuses in the thesis. These investigations are presented in the second chapter, under the heading 'Theoretical Background'.

2. The above mentioned critique is derived out of a reaction in the postmodern era that is based on the environmental critique. The formulation of this reaction at the present age is termed as sustainable architecture. The different periods of architectural design are usually referred to as styles. There is a tendency to mention sustainable architecture and ecological architecture as styles[1]. The thesis aims to point out that sustainable architecture is not merely a style, but factual phenomena that will place architecture in the ethical concerns for architecture. This is explained in the third chapter under the heading 'Ecology, Sustainability and Architecture'.

The thesis emphasizes that sustainable architecture is of no new phenomena but has precedents in the history of architectural design from long-evolved knowledge of traditional cultures to the intentional shaping of the designers and architects.

The general scope of concerns, over the relations of ecology and architecture which are distinguished as 'the ecology of architecture' and 'the architecture of ecology', is related with ecological issues of architecture both from the functional point of view, that is the process of building as a system, and from its relationships with nature.[2] The notion of ecology existed before the term appeared as a scientific or a political concept. Cultures in history always had, in various ways, a kind of ecological awareness of their environment; thus primitive and vernacular architecture have truly ecological implications.

3. The study tries to show variations of sustainable architectural design in relation to the variations of the perception and cognition of sustainable critique of the whole life phenomena. It brings out the determinants and variables of these different tendencies. This is another subject of Chapter 3.

4. It challenges to describe the definitions of ecological architecture on as more profound basis as possible. This necessitates that ecological architecture is not a technical subject but has a cultural and social endeavor. Chapter 3 tries to investigate also this phenomenon.

5. By the ecological and the ecosystem approach, the thesis derives basic strategies for ecological architectural design and ecological building, which will guide the designer's thinking by focusing on relationships of the elements of the design activity. This is done in the fourth chapter, 'The Ecological Design Strategies for Architecture'. The strategies are prepared by the author of the thesis, as a matrix that incorporates the sustainable measure of architectural design by relating the elements of building design with in the locational-structural and functional values.

Intentional design activity in the environment has certain formal, aesthetic and spatial attributes, which construct the relationship between human communities and nature. The design of technology as a cultural and scientific fact and the technological design of the environment is also the focus of the thesis which determines the varied spectrums of the concept of sustainability which have at their essence the notions of survival of human communities and of the planet.

Therefore the thesis will try to understand how the knowledge of ecology affects environmental perceptions of society in general and of architectural design in detail. This kind of question requires a historical perspective as well as an analysis of the present age situation and of futuristic approaches. This perception deals with 'how human beings perceive and conceive nature and their own constructed environment and react towards it, in other words *design in nature* and *design a nature of their own with their own structures and with nature's own.* The ecological design or design which concerns ecology as a prime subject turns this phenomenon to *design with nature*[3].

1.2. Method of the Thesis (An Inquiry into the Ecology of Architecture and the Architecture of Ecology)

The primary object of the study is architecture and building and the subject is its relation with ecology. Then, the study includes a methodology of:

1. UNDERSTANDING THE NOTION OF ECOLOGY and ECOSYSTEM FROM A GENERAL PERSPECTIVE: It tries to construct the relationship of the built environment phenomena and the ecological systems with the concept of ecosystem and the method of ecosystem approach. Ecology is about the entire web of interacting relationships that make life possible on earth; and it is affected by the whole spectrum of human activities. So ecology provides the critique of the relationships from both scientific and ethical views. General descriptions of applied human ecology or human ecology as core disciplines, which provide the background for the critique of human activities, are offered. The ecological approach refers to both seeing the quantitative aspects of ecology, that is within an environmental science perspective and the qualitative sense of the notion that is ethical, cultural and aesthetic. This refers to the study of the term ecology in environmentalism and from a sustainability perspective. The thesis accepts that there is a close relationship between ecology and environmental critical discourses, which is presently termed as *sustainability*[4].

The reasons of the ecological problems and the crisis in design cannot be adequately understood without having a close look at environmentalism, which is deeply rooted in the environmentalist critique of society. The environmentalist critique, beginning in the 1980s, has produced a new terminology called *sustainability*. This term has been the motto for the economical, technological, social critique and new paths of development. Sustainability has been in the front of many human activities like sustainable agriculture, planning, architecture, design, living, etc. Its conceptual dynamics both generally and specifically on architecture may provide a perspective of the relevancy of ecology and ecosystem concepts in design.

There exist problems, which are directly related with human activities and actions. The present position of humanity with both quantitative and qualitative terms present problematic positions and conditions for the survival of its own species and the whole planetary biotic community. The science of ecology and ecosystem analysis and thinking has shown that every element on earth exists within multiple relationships within a balance and has a *relationship* and environmental crisis begin when the balance is disturbed.

2. UNDERSTANDING THE IMPORTANCE OF DESIGN PHENOMENA WITHIN THE CONTEXT OF ECOLOGY and ECOSYSTEM APPROACH: Misconceived design thinking also causes the problems of global ecological crisis. This misconception is due to not understanding the natural phenomena and infusing with design. It might be said that architecture is one part of the overall design phenomena, which is in crisis. This is discussed in the 'Theoretical Background' chapter, with the responsive ideas of ecological design.

3. PLACE ARCHITECTURAL THEORY AND PRACTICE IN THE CONTEXT OF THE RELATIONSHIPS OF ECOLOGY AND DESIGN PHENOMENA: This necessitates an assessment of the built environment in both its systematic terms (building activity as physical, chemical and biological processes and products which create systems and subsystems) and cultural values concerning the aesthetic, phenomenological, philosophical dimensions. It should be noted here briefly and will be explained in detail in later chapters that the two concepts, the

material and cultural production is of interwoven complex phenomena which this thesis will analyze within a perspective of system thinking methodology.

Therefore the built environment and its ***relation*** to Nature is the main concern of this research. What this thesis focuses on is this ***relationship***. It surveys the literature of design and architecture, to find out the ***explicit*** and ***implicit*** usage of the term ecology and ecosystems as a language of design, and its ***connotations*** and ***denotations*** within architectural design. Whether used implicitly or explicitly, the main idea of ecological architecture is the ecological awareness of the world. With the increasing load of environmental issues, and the acceptance of sustainability concept despite its criticism[5], the word ecology, explicitly used as a language of design also metaphorically, has a place in all design fields and in architectural design. The implicit notions of ecology can be traced within history in the notion of ecological awareness or environmental awareness and the protective measures or the mutual relationship that human beings construct with nature and its livelihood. The survival of human communities lies in the consciousness of the dependence of survival on the environment. Whether this is presented by architectural products explicitly under the concept of sustainable architecture, or not, the ecological implication can be found in many works of architecture.

4. THE PRODUCTION OF ECOLOGICAL BUILDING STRATEGIES FOR ARCHITECTURAL DESIGN: This section asks a basic question. Is there an ultimate ecological architecture? Is some mode of architecture more ecological then the other? These questions posit one crucial point that this thesis may contribute. The thesis is after a definition, which tries to show that ecological architecture is not another style or mode of architectural production, but a critical viewpoint to architecture and architectural design. The thesis will conclude on this, and try to find the meaning of ecological architecture in the study of architectural design.

Notes to Chapter 1

[1] Currivan, Tony, Green Style, Building for a Future, Vol.6, No.1, p.17.
[2] This discussion is made by Zeiher (1996) in her book 'The Ecology of Architecture', and the Journal of Architectural Design –Profile No. 125: 'The Architecture of Ecology'. Thus, the ecology of architecture may denote the whole systemic view of building design, Zeiher connotes in her title again, the architecture of ecology.
[3] The notion of design with nature is the primary premise of ecological design and the most famous book is Ian L: Mc.Harg's (1969) 'Design with Nature'.
[4] Tekeli, 1997
[5] For the general criticism of sustainability and its various discussions, look at Orr (1992) and for architectural correspondences look at Steele (1997).

CHAPTER 2

THEORETICAL BACKGROUND

To define the relationship between nature and human beings and for human beings to find a method to act upon nature, the concept of ecology and ecosystem are the new keywords. Originating from a scientific study in biology, besides its scientific definitions, it has been the most used terms of the 20^{th} century which denoted the study of 'the totality of human beings and environment' (Odum, 1971).

The theoretical background of the thesis involves two major concepts. They can be defined basically as (i) *being ecological,* and (ii) *ecosystematic approach to design* (conceiving and shaping human activities together with natural surroundings - ecosystems). The ecological design of an artifact or any environment involves the integration of the two concepts. Thus each category has its own dynamic and changing patterns which this thesis will incorporate. Therefore the goal of such an approach is *sustaining the ecological integrity of the natural surrounding and meeting human needs.* The overall designed phenomena thus can be described as *human ecosystems.* The two concepts are briefly defined as the following assumptions.

1. *Being ecological*: The values of nature, the awareness of nature, the idea of respect, the idea of necessity of natural surroundings, in physical, biological, cultural terms. This refers much more to the normative aspect of the term and is related with the qualitative aspects of the design and the ecology connection.

2. *The ecosystematic view of the environment in relation human activities*. Thus, a holistic understanding of the environment is necessary. But the ecological understanding of the environment is more than the holistic perspective. It incorporates the ethical issues related with the well being and the survival in the natural and social environment. The difference between the terms *holistic* and *ecological* is well expressed by Fritjof Capra (1996) in the design of the artefact 'bicycle':

> "A holistic view of, say, a bicycle means to see the bicycle as a functional whole and to understand the interdependence of its parts accordingly. An ecological view of the bicycle includes that, but it adds to it the perception of how the bicycle is embedded in its natural and social environment – where the raw materials that went into it came from, how it was manufactured, how its use affects the natural environment and the community by which it is used, and so on. This distinction between holistic and ecological is even more important when we talk about living systems, for which the connections with the environment are much more vital (Capra, 1996: 6-7)."

The thesis tries to find out the shape or content of the response to the ecological phenomena of the world life and in *design fields generally*, and *in architectural design specifically*. A concentration is made on the notion of design, which is the act of human beings that accompanies both their scientific and intuitive innovative abilities.

2.1. Ecology and Ecosystem: the Meanings and the Origins

2.1.1. Ecology as a Scientific Inquiry

The term ecology is derived from the Greek word *oikos*, meaning house or home and logos (logic or knowledge). Moreover, Greeks used this word to describe a place that could be returned to and where human beings conceived and were familiar with the local environment. From this root word ecology and economy developed which tried to explain the aspects of home life. The meaning that oikos possessed within time changed from describing house to what itcontained: a living community, the household' (Nash, 1989). The term ecology was coined by Ernst Haeckl in 1869 for the first time to denote (describe) the scientific study of the relationships among organisms and their environment. Eugene P. Odum (1971) defines in his book '*Fundamentals of Ecology*' as "the study of the relations of organisms or group of organisms to their environment, or the science of interrelations between living organisms and their environment (Odum, 1971:3)." The crucial point in the science of ecology is the interrelation or the interaction concept and ecology focusing on the idea of relationship. Ecology before scientific inquiry, existed with the conception of the environmental integrity of nature and cognition of relation. "But the study of ecology is much older than the name, its roots lie in earlier investigations of the "economy of nature (Worster, 1977:18)." The major theme throughout the history of this science and ideas that underlie it has been the interdependence of living things. According to Odum (1971) ecology is a science that unites physical and biological sciences and makes a bridge between natural and social sciences. The understanding of ecology diverge into two fields. One is the conception of the ecological organizations species and population where a biological species consist of all the organisms potentially able to interbred under natural conditions and to produce fertile offspring. A population, on the other hand, consists of all the members of a single species occupying a common geographical area at the same time. Thus populations living and interacting in a specific region form ecological communities (Odum, 1971).

This population-community view of ecology is grounded in the Darwinian theory of natural selection and evolution and views ecological systems as networks of interacting organisms. In this kind of approach abiotic factors are conceived as external factors that have influences but are seen apart form the central living core of the system.

> "Darwin of course offered abundant scientific reasons for believing all life to be interrelated in its origins, but he did not push on to explore the ways in which living things were presently interrelated. The ecologists, however, went into the field, looked at nature as a whole, and used interrelationships and interdependencies to explain how it functioned as a community (Nash, 1989:56)."

The development of the science of ecology increased in the importance of ecological thinking about the planet. Another more recent view is the increasing focus on the process of energy flows and nutrients and other materials carried out in the ecosystems. Rachel Carson's (1962) 'The Silent Spring' may be an example of such an approach. This approach is characterized by its process-functional method and sees the ecosystem as a whole rather than the particular species or populations that make it up. This perspective considers the biotic living organisms and abiotic physical components of the environment as equal members of the system. Feeding relationships, that is who eats whom, where, how and when determine how energy and materials move through the system. The main unit of ecology is the ecosystem.

2.1.1.1. Ecosystem

Odum delimits modern ecology in terms of levels of organization visualized as a sort of biological spectrum. Figure 2-1 shows this spectrum (Odum, 1971:5). Within this biological spectrum a characteristic functional system occurs at each level. A system is defined as regularly interacting and interdependent components forming a unified whole. The system idea and system thinking have an important role in ecological thinking.

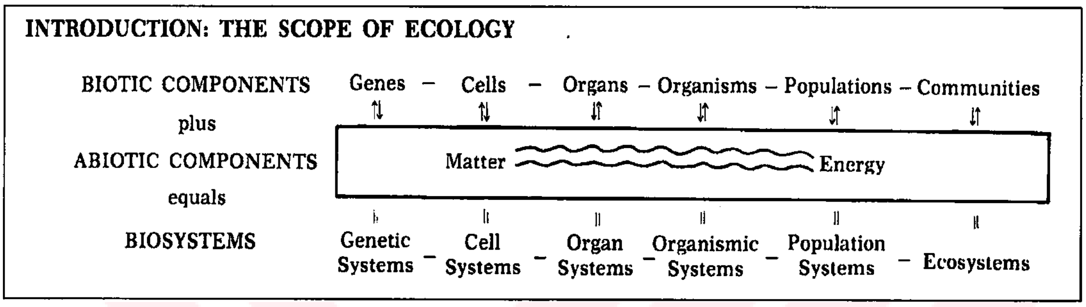

Figure 2-1. Level of organizational spectrum (Odum, 1971:5).

Odum (1971) considers system concept of ecology beyond the level of organism in the biological spectrum. The level of population, which is originally coined to denote a group of people, is considered in ecology as the group of individuals of any one kind of organism. Community in the ecological sense (biotic community) includes all the populations occupying a given area. The community and the non-living environment function together as an ecological system or ecosystem.

The term ecosystem is introduced by A.G. Tansley, in his essay “The use and abuse of vegetational concepts and terms” in 1935. “An ecosystem is constituted by both biological and physical constituents of the environment forming a spatial unit.’ This special unit can be scaled form the earth itself to a small pond. Figure 2-2 shows the physical and biological constituents of the ecosystem (Yeang, 1995:6).

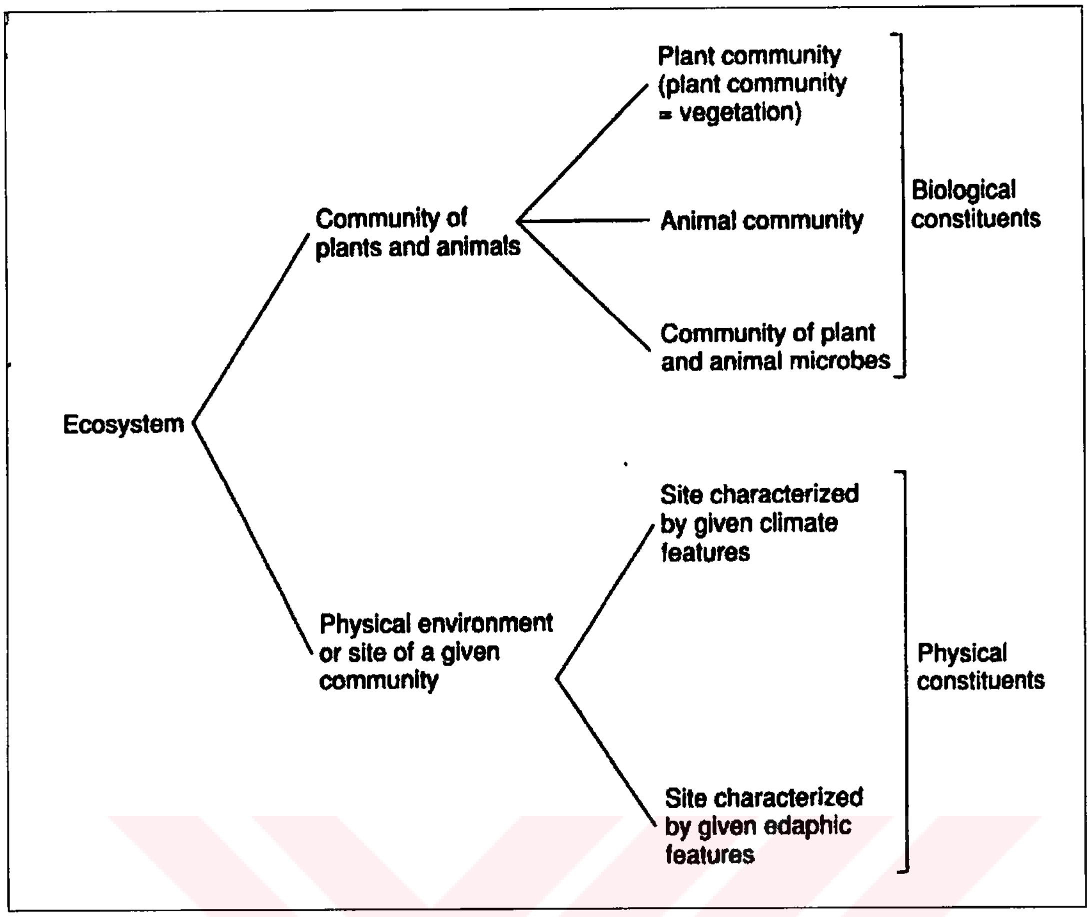

Figure 2-2. Physical and biological constituents of the ecosystem (Yeang, 1995:6.)

In Odum's definition, *ecosystem or ecological system* is 'any unit that includes all of the organisms (i.e. the community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e. exchange of materials between living and non-living parts) within the system' (Odum, 1971). Another definition also includes the temporal and spatial scales within; "An ecosystem results from the integration of all of the living and non-living factors of the environment for a delimited segment of space and time. It is a complex of organisms and environment forming a functional whole (Van Dyne, 1969:vii)."

According to Van Dyne, if the landscape is a geographical concept, the ecosystem is a functional one and thus the landscape will be understood in the functional sense. For the design purpose and the integration of ecological knowledge to the design disciplines, the new understanding of landscape must be understood according to this functional view.

The words ecology and ecosystem do not denote only the scientific approach to nature-human beings phenomena but also have a normative meaning which is expressed in the prefix and suffix of the words ecology and ecosystem. *ECO-* (from Greek oikos which means home) takes the ethical, moral side which constructs the relation with home, dwelling, living and life. In the concept and the suffix*–LOGY* and *(-)SYSTEM,* -logy denotes to producing knowledge and the word *(-)system* denotes the method of culture and technology.

2.1.2. Systems Thinking as a Basis for Understanding the Relationships

The system thinking and discipline provides the foundational basis for ecological ecosystematic thinking. The ecosystem definition denotes a conceptual approach or a unit of study for a unit of landscape or seascape for a definite segment of time (Yeang, 1995). So the conception of the ecological approach to design or the ecological design process is formulated by the understanding of the environment in *ecosystematic* *spatial units* and conceptual relations. Much of the ecological interpretation of the world depends on its being a whole, which is formulated by system thinking. "The system movement compromises any and every effort to work out the implications of using the concept of an irreducible whole, 'a system', in any area of endeavor (Checkland, 1993:99)."

In the systems thinking the observer's role is crucial. One of the characteristics of the system view is the necessity of the observer's interpretation. As sustainability is the core of the subject and as it is explained by the systems view, this can have two directions. The approach of technological sustainability is more concerned with the systems operation manipulated by the designed systems mechanism, and the filtering of natural systems are kept physically and spiritually at a level of optimization. The ecocentric view looks at the world from a maximization of the importance of the natural systems in human activity and in designed and social systems. System view is used to describe the real-word situations by using a model where the model's description and purpose is of crucial importance.

It is thus important to filter these real-world complexities and use them as knowledge for a purpose when concerned with design problems. One other important feature of system thinking is that it does not do this filtering within a reductionist attitude but focuses on the relations of each level.

> "But the ultimate objective is clear: the attainment of public knowledge of the kind which science accumulates, by means of a modified scientific method in which a form of holism replaces reductionism. Until such knowledge is accumulated our basic model has to include both an external reality and observer/describer who will, for his own purposes, use system thinking as a means of arriving at his description (Checkland, 1993:101)."

The method of the system view is usually describing the system within the framework of system and subsystems, drawing boundaries and setting out principles. Checkland as explains this process:

> "We cannot say very much about the observer and his systems description which will be true regardless of his role and purpose. All that we can say at this general level is that he will identify (or define) some entities which are coherent wholes. He will perceive (or invent) some principles of coherence which makes it meaningful to draw a boundary round an entity, distinguishing it from its environment; and he will identify (or envisage) some mechanism of control by means of which the system entity retains its identity at least in the short term. The existence of system boundary defines as 'inputs' or 'outputs' anything which crosses it, and these flows may be physical, e.g. materials, people, machines, money, or abstract, e.g., information, energy, influences. Similarly the components of the system itself may be physical entities or abstractions; in either case the components will show some degree of organization beyond that of a random aggregate of components. And finally, any whole conceived as 'a system' is, in general, at least potentially a part of a hierarchy of such things-it may contain 'sub-systems' and itself be a part of 'wider-systems' (Checkland, 1993:101)."

From a designer's point of view concerned with ecological descriptions these are explained below and a schema is provided in Figure 2.3.

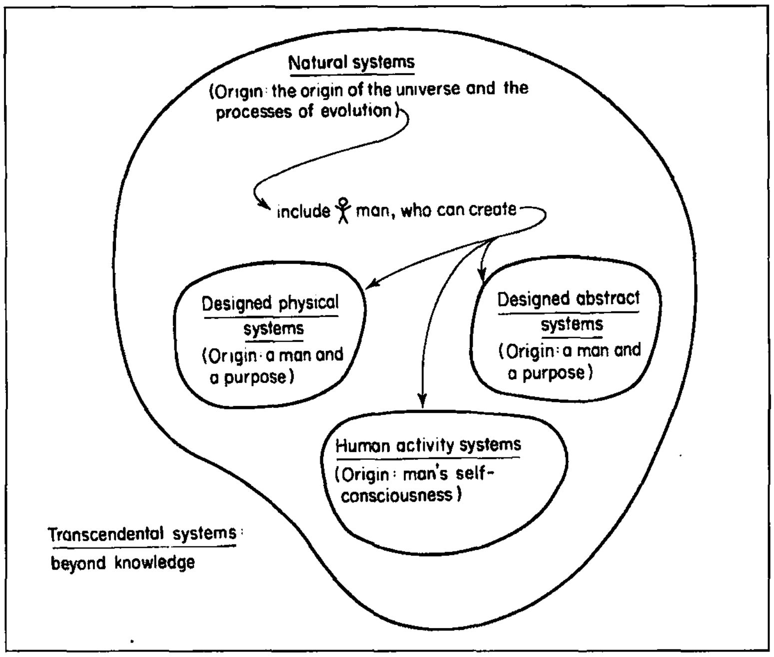

Figure 2-3. Five classes of system that make up the whole systems of the universe (Checkland, 1995:112).

Thus a description of these systems which draw the context of the ecological designer are listed below:

Natural systems: Orderliness of the solar, lunar, temporal changes and interaction of living and the non-living systems (ecosystems) and the dynamic evolution character of this.

Human Activity systems: Because of their inherent intelligence and communicative capacities, human beings are different form the other living beings and thus form complex and interactive relations with other systems. One important measure is the description of human activity system and the account of the observer and the point of view from which his/her observations are made (Checkland, 1993).

Designed systems: Checkland's argument on the designed systems is noteworthy to understand the context of design phenomena.

> 'We could if we wished use a piece of rock, a natural system, to knock nails into pieces of wood to make hen coop. But we could perform the task better if we used a hammer, a physical system designed with fitness purpose in mind... Designed physical systems exist because a need for them in some human activity system-such as the construction of hen coops- has been identified. Man as a designer is able to create physical artifacts to fulfill particular defined purposes. And similarly he may create structured sets of thoughts, the so-called 'designed abstract systems'... Man as a designer is a teleological being, able to create means of enabling end to be pursued, and to do so on the basis of conscious selection between alternatives. It is proper to restrict the word 'teleological' to use in this sense, involving human will, and not to apply it casually to natural systems. Many natural systems are of course apparently 'designed' to fulfill a purpose efficiently but 'design' is here the result of the operation of blind evolutionary forces over a long period, and ought to be distinguished from purposeful design by a human being (Checkland, 1993: 118-119)."

Social systems: social systems observed in the world will be a mixture of a rational assembly of linked activities (a human activity system) and a set of relationships which occur in a community:

> "... we think ourselves (and others) as members of a natural order of relationships-as members of a family, relatives among kinsfolk, neighbors in a particular area... (and) we think ourselves (and others) as sometimes , and for some particular purposes, having to associate formally with others-not as whole persons but partial-in order to accomplish a certain end (Checkland, 1993:121).

Transcendental Systems: systems beyond knowledge.

Observer/describer of the world outside ourselves who for some reason of his own wishes to describe it 'holistically', that is to say in terms of whole entities linked in hierarchies with other wholes (Checkland, 1993).

2.1.3. Description of Nature and Nature-Humanity Connection

To define the connection or relationship between nature and humanity the thesis has devised the three following assumptions based on the systems view discussed above.

Assumption one: The first assumption is the *description of nature*. Nature basically comprises of all plants, animals, and ecosystems, as well as the biological and non-biological materials and processes of our planet. So nature even devoid of human existence has its own rules, dynamism and regulations. It is in a continuous process and evolution.

Assumption Two: Human beings (species) concerned. By 'nature' they are separate from other creatures of the earth, and they have the capability of intellect, and use a different process and evolutionary path. Therefore by the help of intellect, achieving beyond and inherent basic instinct of survival, they have the ability to form social organizations and to progress through technology. Human beings are part of the scenario of the whole earth, but have also developed themselves and become the thinking animal, the political and social animal etc. Humanity have utilized the material in nature with the tools and built up machines, devices, buildings, erected cities etc. With all these aspects humanity manipulated nature and also created human nature. They have their own rules of dynamism and regulations that can be named *culture*.

Assumption Three: It is seen that when the two assumptions are juxtaposed, 'naturally-as an inescapable act', a dynamic relation and dialect occurs through space and time. If they do not coincide as processes, then there exist environmental or ecological problems or crisis. A similar statement about the crisis is put forth by Sybrand Tjallingii (1992) with Figure 1., based on a conception of the relation by nature and cultural processes.

> "A is the abiotic field, B is the biotic and C is the cultural. These are fields of operation not of explanation. Cultural phenomena cannot be explained by abiotic or biotic processes, but social life has to operate within the limits set by biotic and abiotic nature. Environmental problems have resulted when these limits have been ignored (Tjallingii, 1992)."

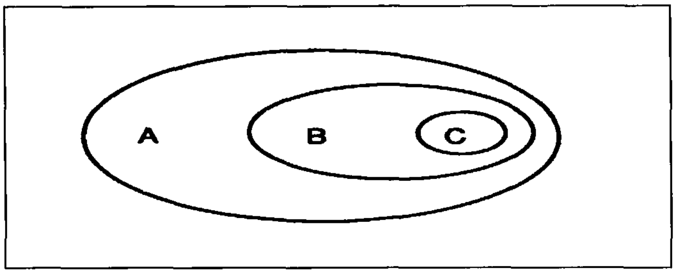

Figure 2-4. Diagram showing the Abiotic(A), Biotic(B) and Cultural(C) relationships (Tjallingii, 1992).

These assumptions have both physical and philosophical implications. The dilemma of nature and human beings is also a continuous and dynamic process and phenomenon. The meaning of being or happening ecological, that is being in accordance or harmony with the natural forces lies in the thinking and finding philosophical and realistic solutions in accordance with the 'overlapping' of two assumptions. Ecosystem understanding views the human settlements and architectural products as systems, designed by human beings, not totally controlled but accepting that human beings have partial control over their environmental applications. It will try to bring ecological design critique and will try to give basic principles and guidelines.

All human endeavors are related with nature in a general sense. Nature may be described as the entire diverse community of living things on this planet. Nature includes also the physical environment upon which the community depends, and the unseen network of subtle forces and relationships, which lie behind the surface appearances of both the organic and the inorganic world. Human beings are both within and outside the world of nature. They are merely an organism among many, and they are nonetheless in a position increasingly to modify, to replace or almost totally to exclude from their surroundings as they think fit, the natural elements which once form an unquestioned part of their existence (Manning, 1979).

Human beings have evolved from nature but they have unique capabilities of being social and technological and the scope of the impact is without precedent in other species. The idea of human-nature relation as a contrast and or as a participation is one of the basic philosophical inquiries.

> "It seems that while we are separate from the rest of nature in our social and technological characteristics, and to declare humanity natural or non-natural is unhelpful. The best alternative may be to accept humankind as relatively natural and-non-natural depending on the time, place, and activity (Environmental Encyclopedia, 1994:556). "

Therefore, a philosophical construction can be made such that human beings create their own nature. This nature (culture) is termed as *second nature* (Crowe, 1995). Norman Crowe (1995) describes this phenomenon in another way based on Cicero's description:

> "We enjoy the fruit of the plains and of the mountains, the rivers and the lake are ours, we sow corn, we plant trees, we fertilize the soil by irrigation, we confine the rivers and straighten or divert their courses. In fine, by means of our hands we essay to create as it were a second world within the world of nature"[1]

Crowe (1995) speaks of two realms: the human beings-made world and the world of nature.

> "Our understanding of each is in relation to the other, the fundamental notion that the artifacts we produce compromise our world as something distinct from nature and that our sense of what is natural is therefore exclusive to the province of nature. As concepts they interact in a dialectical fashion to condition the way we approach nature and what we build (Crowe, 1995:p5)."

The cultural and philosophical construction of the natural and the artificial are of human constructions again. Crowe (1995) argues about the dialectics of the natural and the artificial world. He states that the artificial world is created mostly by an intellectual construct of mathematics, geometry and abstract theory but the alternative or artificial nature is also created by artifice and born as a reflection of the wonder humans find in the natural world (Crowe, 1995).

One of the basic assumptions that the thesis accepts that for an ecological world of design and human life, besides the natural world there exists human nature but is always linked to the natural world and the linkage is based on each other's mutual relationship (interdependence) for survival. The idea of this connection and dependence finds its ideal situation in a balance with nature and human beings. There can be no complete balance between nature and human beings but a culturally constructed ideal place for the balancing and such constructed balance between human beings and nature is place, time and activity dependent. Balance is conditioned both by direct experience and by culturally inculcated values. The balance is searching for the notion of 'quality' called harmony (a kind of rapprochement between human beings, and what they build, and nature).

2.1.4. The Ecological Critique

The problem does not remain in just material terms of individuals and societies. It also carries a philosophical and social and an aesthetical character and is related with the human beings responsibilities within nature. The common word that is used among all disciplines is ecology.

> "We need also to extend the physical and biological concepts of ecology to include the social behaviors of man-as equally critical factors within the ecosystem. The earth has not only been changed by scientific and technological transformations for particular economic and industrial functions-but these have been spurred by specific value attitudes, by politico-ethical systems, by art, by religion, by the need for social contiguity and communication as expressed in cities, by highway systems, and so forth. Such cultural transformations play more directly causative and formative roles than we customarily accord them (McHale, 1970:3)."

Thus, it is obvious that most of humanity's endeavors after a while returned back as environmental problems. Humanity, today, with the present condition of misfit technology, short-term economic and social structures, increase of population, and lifestyles is disharmonious and dangerous for the future.

There can be little doubt that the environment and the ecological balance of the planet are no longer sustainable. Unless we learn to preserve and conserve the earth's resources, and change our most basic patterns of consumption, manufacture and recycling, we may have no future. The environmental dilemma waits from everyone an ethical and a practical action towards protecting their ultimate 'home'. Basic purpose of ecological critique and its ultimate goal is to define a coherent nature and human beings in relation with ecology.

> "Like the natural world out of which it is created, the build world operates in response to its own rules, its own means to change and permanence through the interaction of a host of contributing forces. Most important among those interacting forces is our human nature in all its dimensions, including our quest for meaning in the things we create, the fundamental nature of materials out of which the world we create for ourselves is built, and our idea of nature itself (Crowe, 1995:xiii)."

The dilemma of man nature within its overall activity of habitation is seen as a struggle of its own according to Crowe. "Having once departed by creating a "second nature" all our own, it has been our task to nurture and perfect it ever since – even, it seems, to the detriment of the natural world out of which it was formed (Crowe, 1995:5)."

Crowe (1995) differentiates architecture and creating simply functional shelter. But compared to other living creatures, we are the only ones who direct our energies toward refining shelter into abodes that might be called works of art. So the deterioration of the natural world on earth is seen as "natural", this in fact has true implications. Every action of the human world as a process and a product has environmental or ecological implications. What is needed is a co-operation with nature. History bears good examples of this phenomenon but also the activities of human beings. Each day our knowledge about the environment is increasing-so technology is improving. But most of our enterprises in relation with nature have been unsuccessful and threatening when nature is concerned. The causes of this are hard to deconstruct and manifold but it will be possible to note some of them later on in the coming chapters.

"The final river is already polluted. It is remote from the purity of its origins. Nonetheless, the creation of a large-scale ecological political movement represents a significant break from the past. The egg is hatched (Bramwell, 1989:4)." It is the science and notion of ecology and the concept of ecosystems, which show that life is threatened. Ecologists accept that there exists a subtle balance on earth that sustains life and if this balance is forced too much then the crisis may end with big catastrophes.

2.1.5. Ecology as a Political and Social Inquiry

Ecology has widened the knowledge of nature and of our biotic and non-biotic environment and their relationships, both empirically and theoretically. Ecology in the scientific sense does not usually include human and human activities within ecological studies. Odum includes humankind within the study of ecology. But this has diverse implications. Mankind may be considered as a mere organism, but it has complex historical, social, cultural and technological aspects which is termed as human ecology or applied human ecology (Odum, 1971).

> "The role of man, both as symbiotic component and disruptive agency, has been particularly focused upon in recent years. Human ecology may theoretically embrace the overall study of man's relationship to his planetary earth environment. From the roots of "house-knowledge," we can assume a definition of applied human ecology as planetary housekeeping (McHale, 1970:1)."

The planet or 'home of man' has by the second half of the twentieth century, become the *minimal* conceptual unit of occupancy for the whole human family- whose planetary interdependence is now seen to be closely interwoven with the maintenance of the fragile balance of natural forces which sustain life. Man has converged on human beings and his home planet as the prime focus of his attention.

> "Where the medical-health sciences have grown to encompass overall concern with the internal metabolics of the human organism, the approach to human affairs through an ecological perspective must now deal with all the externalized metabolic systems of humanity-both the naturally occurring cycles with which man interacts, and the psycho-physical and technological systems through which all of his environmental interactions are conducted (McHale, 1970:2)."

The importance of human activities have created new terminology and theories like applied human ecology (Odum, 1971) and human ecosystems (McHarg (1969) and John Tillman Lyle (1985).

2.1.5.1. The Human Ecology Perspective

Ecology existed intuitively in the history of the world and in human history. Its relation with the human civilization is as old as human history. The concept of ecology as interrelation between human activities and nature was evident in the history of human beings in describing the relationship of human beings and nature. This happened in terms of myths, belief or cultural values in different cultures through time and places.

> "Because ecology is concerned especially with the biology of groups of organisms and with functional processes on the lands, in the oceans and in freshwaters, it is more in keeping with the modern emphasis to define ecology as the study of the structure and function of nature, it being understood that mankind is a part of nature...Today everyone is acutely aware of the environmental sciences as indispensable tools for creating and maintaining the quality of human civilization. Consequently, ecology is rapidly becoming the branch of science that is most relevant to the everyday life of every man, woman, and child (Odum, 1971:3)."

This characteristics of ecology both as a scientific and a political inquiry have expanded, and the scientific and cultural-political and social construction of ecology in the normative has been one of the important notions of humanity.

> "The word of ecology is widely used today in the normative sense, not in the biological sense. The science of ecology is one that considers energy flows within a closed system. The normative sense of the word has come to mean the belief that severe or drastic change within that system, or indeed any change which can damage any species within it, or that disturbs the system, is seen as wrong (Bramwell, 1989:4)."

Odum (1971) proposes certain 'components' for this.

> "Sociologists, anthropologists, geographers, and animal ecologists first developed an interest in the ecological approach to the study of human society. Now as we have seen, nearly all the dsiciplines and professions in both the sciences and humanities are eager to find a common meeting ground in the area of human ecology (Odum,1971:510)."

One of such most important aspects was the relationship between characteristics of places as climate, topography, flora and fauna, geological characteristics and human beings, where humans gave meanings to those characters and these meanings varied from locale to locale, from region to region. The advancement of the science of ecology brought scientific understanding to the environment, the relationship between the living things among themselves and the non-living environment were studied and the concept of ecosystem was developed by Tansley in 1939. The ecosystem or ecological system was defined by Odum as "any unit that includes all of the organisms (i.e., the community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e., exchange of materials between living and nonliving parts) within the system (Odum, 1971:8). One important aspect of this science was that human beings were outside this phenomenon. Later, Odum proposed a branch of science as applied human ecology to integrate the ecology of the natural environment with human endeavors (Odum, 1971). Today this view is supported extensively and human beings and their environment are seen as a system working together. Robert Leo Smith (1976) in his book, 'The Ecology of Man' makes a remark on this fact:

> "Through his recorded history man has rarely considered himself part of the natural world. It was there to be subdued, to be exploited, even to be enjoyed, but man himself stood aside viewing it as a spectator from a distance. Even ecologists studied natural ecosystems as if they were apart from and wholly uninfluenced by man. Man was an intruder (Smith, 1976:2)."

The ecosystem approach was not limited with the natural environment but it also affected the human sciences and terms like cultural ecology and human ecology. **In this thesis ecology and ecosystem concepts govern, approaching the environment as a human ecosystem.** Ecosystems cannot be separated from human beings. Therefore we can name the operating environment that we are in as human ecosystems.

J. Tillman Lyle as defines the place of human beings in ecosystems:

> "We humans beings are integral, interacting components of ecosystems at every level, and in order to deal adequately with these systems, we have to recognize this simple fact. In most situations, even at the level of the biosphere, we may be an overriding, controlling component, but we are a component nonetheless (Lyle, 1985:17)."

These human ecosystems are places; the knowledge on them is produced scientifically, but also by values and by cultural and social responses to the environment; for architecture of the environment, cultural-value-based information is as important as the scientific information.

2.1.6. Environmentalism and Sustainability

Each day nature is increasingly depleted as a totality by human actions. The environmental issues are conceived in quantitative terms in different scales on the earth, like global warming, ozone depletion, loss of natural ecosystems, etc. or in qualitative terms like the loss of healthy environments, losing the spiritual and cultural relationship with nature etc. The two problems exist together and a new morality has emerged.

> "Ecology was the science, which could interpret fragments of evidence that told us something was wrong with this world – dead birds, oil in the sea, poisoned crops, and the population explosion... What it meant was everything links up... Here was a new morality, and a strategy for human survival rolled into one"[2]

At the present age humanity is conscious that there are physical limits to growth by the overuse of resources, linear processes of production and consumption force or even the limits have been exceeded and there is a depletion of natural biotic life, and the present quality of life is questioned. There exists a threat to basic life-systems of the earth. There is also a spiritual crisis. Therefore ecology is a mode of thought; both a philosophical inquiry, and a matter of morality, but it is also a mode of operative action.

The history of the modern environmental critique is new but its traces are found in the deep mythical, religious and spiritual relationship of the human beings-nature relationship. Environmental critique is then generally about society and the relationship between society and nature. Environmentalism is the reaction to the crisis of the environment. Environmentalism took over several names, like green/Green became another word for environmentalism. The movement was not a single total phenomenon but it appeared in several divergent paths, which have common. But what the movement does as a totality is a general political, economical, scientific and social critique of human beings.

David Orr mentions three main aspects of the crisis, prospecting the future. One is the food crisis, depending on issues like pollution increase and the loss of fertile areas and problems of agricultural processes. The second is the problem of energy based on the energy-intense life modes of humanity, third is the loss of biodiversity and the decrease in natural areas. The three crises occur in relation with each other, and are interrelated happenings.

> "These three crises feed upon each other. They are interactive in ways that we know it. Together they constitute the first planetary crisis, one that will either spur humans to a much higher state or cause our demise. It is not too much to say that the decisions about how or whether life will be lived in the next century are being made now. We have a decade or two in which we must make unprecedented changes in the way we relate to each other and to nature (Orr, 1992:3)."

Almost every human action today calls forth an environmental issue. Certain titles include air pollution and changes in the atmosphere, water pollution, land degradation, and loss of biodiversity, depletion of resources, thereat to life forms and ecosystems.

The three basic issues that stand out from the statistics can be stated as:

1. Population Problems: Population is one of the important factors contributing to environmental problems. The carrying capacity of the earth is very much related with the population size of the planet. Carrying capacity is defined as the maximum number of individuals of species that can be sustained by an environment without decreasing the capacity of the environment to sustain that same amount in the future (Botkin, 1995). The definition has a quantitative character but to think in quantitative terms is the ultimate point in this subject.

> "Many people, however realize that the current population explosion together with the environmental damage which goes hand in hand with population growth, virtually guarantees a pre-programmed human tragedy one scale not only immeasurable but also, and perhaps more importantly, inexcusable (Daniels, 1994:18)"

2. The increase in Human–Related Activities and their impacts, and an Accompanying Decreases in the Resources of the Planet.

3. Growing Inequity between The Rich and The Poor –Between Rich and Poor Nations and Between Rich and Poor within some countries.

The crisis is not only in terms of quantitative measures, it is a crisis of quality too. For what kind of food we eat, what kind of air we breath and what kind of spaces we live in and experience are also questioned in the sustainability debate. The answers to these lie in the human value and production systems.

The reaction to all this phenomena, to both the quantitative and qualitative signals of the environmental depletion and degradation have brought out its modern phenomena, which is environmentalism. Environmentalism or the consciousness of the environment and the respect for it is as old as human history. Based on this fact environmentalism is a historical process and also an ideological one. Pepper comments on this ideological debate.

> "A study of the history of green ideas about the relationship between society and nature also reveals that these ideas are, and always have been, part of deeper ideological debates. Ideologies are sets of ideas that form the basis of a personal or group worldview: a particular perspective on how the world is, and ought to be. Ideologies usually contain hidden assumptions which may go unchallenged – they seem obvious 'common sense ' and not worth debating. But really these assumptions are challengeable, other being little more than a way of rationalizing and justifying the material position in society often person or group who uses that – they are weapons in a political battle (Pepper, 1996:2)."

Environmentalism can then be traced as myth about society–nature/environment that is constructed human beings and culture. It creates different modes of thought, behavior and actions and operations against/for nature. There are a diversity of myths, which rest firmly on what a society believes and the ideologies that it upholds. According to the believes and societal actions the idea of nature can take on general characteristics like *nature benign* for the ones who believe in free market economics, *nature ephemeral* for radical environmentalist, *nature perverse/tolerant* for those who believe that development is acceptable to the laws and limits of nature (Pepper, 1996).

> "Each myth functions as a cultural filter, so that adherents are predisposed to learn different thing about the environment and to construct different knowledge about it. In this way beliefs about nature and society's relation with it are linked with particular rationality, that support the modes of action appropriate for sustaining the myths."[3]

Pepper describes the notion of modern environmentalism; modern environmentalism is a state of critical approach to the environmental issue occurring especially by the mid 20th century. David Orr (1992) also states that the crisis and the response are new and this kind of a formulation has not occurred previously in history. Of course in history there lies the incident of environmental awareness and environmental dilemmas which lie in the religious cultural and technical characteristic of societies but the cries of environmental problems and the solutions a post-modern debate are all new. Environmentalism depends on perception. So the perception of the real environmental situation by the cultural constructions of the societies is the focus of environmental dilemmas. Such an approach is described in Pepper (1996) based on a model of environment and environmental perception proposed by D. Jeans (1974)[4] which is explained in Figure 2-5.

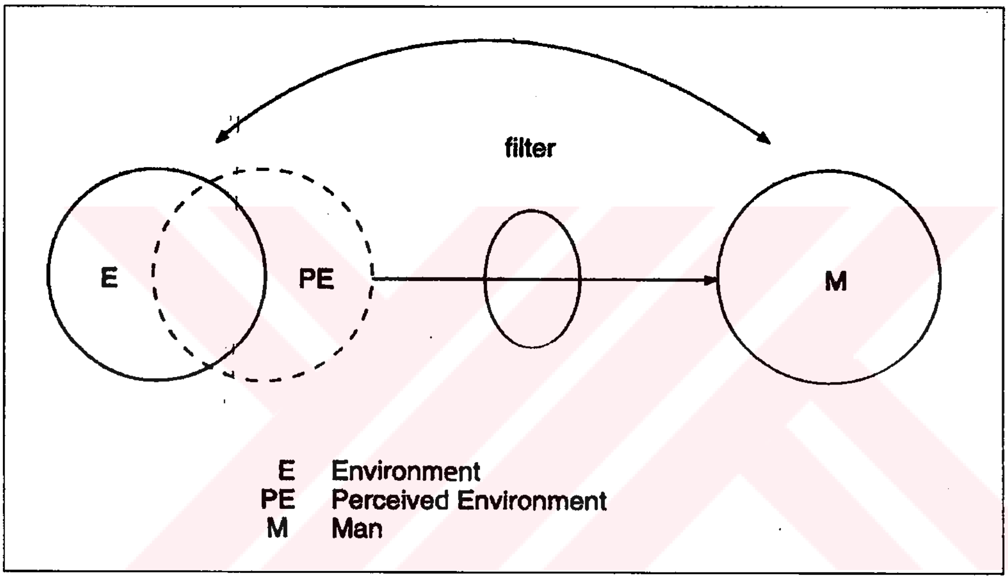

Figure 2-5. The Idea of Filter

> "The real environment.... is seen through a cultural filter, made up of attitudes, limits set by observation techniques, and past experience. By studying the filter and reconstructing the perceived environment the observer is able to explain particular options and actions on the part of the group being studied."[5]

Before the modern period the lenses in the cultural filter- in the 'glasses' with which human beings looked at nature – were composed of religious myths and teachings. In the modern period lenses consisting of the scientific worldview gradually replaced religious myths and teachings. Despite today's skepticism, science is still imagined to be the leading source of authority (Pepper, 1996).

Environmentalism in its inherent characteristics is also an ideology and also a criticism over reality.

> "It often says that we experience environmental problems because, at root, we have undesirable values about nature. These link with the undesirable way that, individually and in-groups, we value and behave toward each other. Hence there is a specifically green critique of existing society and conventional values – what greens are against- together with beliefs about what future society should be like if it is to be sustainable and environmentally benign, what greens are for (Pepper, 1996:10)."

2.1.6.1. Historical Roots of Environmental Crisis

Many authors have written on the sources of human-caused ecological crisis. Basically the views concentrated on religion, culture, science, economics, ethics and even on human beings themselves. David Orr states five reasons behind the environmental crisis: social, wrong understanding of the relationship between economy and nature, science and technology, evolution, or human beings' perverse will to *use* the earth. Thus he names the roots of environmental crisis as the crisis of sustainability which will be described under another title in the following sections.

> "Five possibilities stand out. The crisis may be interpreted as a result of one or more social traps; it may stem from flaws in our understanding of the relation between the economy and the earth; it could be a result of the relation between the drive to dominate nature evident in our science and technology; it may have deeper roots that can be traced to wrong turns in our evolution; or finally, it may be due to sheer human perversity. I am inclined to believe that any full explanation of the causes of our plight would

> implicate all five. They are like the layers of an onion, peel one off and you discover yet another below. In the intellectual peeling, asking “why?” leads to the next layer and deeper levels of causation. I will consider these from the “outside in,” from the most apparent and, I think, least problematic causes to deeper ones that become harder to define and more difficult to resolve (Orr, 1992:5).”

Religion, especially Judeo Christian beliefs are, according Lynn White, the primary source of the environmental crisis. He refers to the Bible especially to the section in Genesis, which tells people to multiply and subdue the earth (White, 1967). There exist other passages in the Bible that also orders to be friendly with nature, but the present real world condition proves dominance of the first view. He finds a solution in the religious origins again, exemplifying St. Francis who was known to be a friend of nature. St. Francis could talk to animals and he had an ethical view that all living things on earth, including humans were equal. One of the important points in White’s text is his stating that religion was also the primary source of environmental religion.

A reaction to White came from Lewis W. Moncrief (1970). He stated that religion was not the primary cause of environmental crisis but that the crisis had a much more cultural basis that was influenced by ‘the forces of democracy, technology, urbanization, increasing individual wealth, and an aggressive attitude toward nature’. Science and technology together with the emerging social and economic structure of the societies are the other reasons of the exploitation and misuse of the earth.

Rene Dubos (1969) in his essay, ‘A Theology of the Earth’ mentions another aspect of environmental crisis. He states that respect for nature and for the earth, which is formulated as a kind of nature-religion is lost. Nature-religion denotes that nature and natural processes have a relation with human existence and is brought out to existence in the forms of myths, folk and even physical surroundings as architecture. The concept of ‘genius of the place’ that each environment has special qualities of its own and is reflected on the culture of its inhabitants is directly linked with this sacramental view of nature. He states that solutions to ecological crisis can be found through the understanding of the concept of place. Like Lynn White, Dubos also gives a historical Christian name as an example of well-connected relation of humanity and the earth. St. Benedict and his monastery are Dubos' example of ecological living and of the true sense of genius of the place.

St. Benedict created the first great monastery in the western world on Monte Cassino, in Italy, in the sixth century. He must have been a wise human being, because he formulated the rules of conduct for Monte Cassino, rules which became a model for monastic life all over the world: he decided that the monks should not only pray to God but should also work. Moreover, he urged that the monastery be self-sufficient. The rule of work and the need for self-sufficiency led the Benedictine monks to master a multiplicity of practical arts, especially those relating to building and to architecture. The monks learned to manage the land in such a manner that it supplied them with food and clothing, and in such a manner that it retained its productivity despite intensive cultivation. Moreover, they developed an architecture which was lasting, well-suited to the country in which they lived as well as to their activities, and which for these reasons had great functional beauty (Dubos, 1969).

The above mentioned conditions raise a reaction to the current modes of production and consumption and living. Any theory and practice of a discipline should keep the above issues in mind. Cliff Moughtin (1996), in his book 'Urban Design: Green Dimensions' writes on this issue:

> "Any discussion of which does not address environmental issues has little meaning at a time of declining natural resources, ozone layer destruction, increasing pollution and fears of the greenhouse effect. The long-term survival of the planet as a vehicle for sustained human occupation in anything other than a degraded lifestyle is in some doubt. In these circumstances any discussion of the aesthetics of city design in a pure or abstract form unrelated to environmental concerns could be described as superficial and rather like rearranging the deckchairs on the Titanic (Moughtin, 1996:1)."

As stated in the section "The roots of environmental crisis", the cause of the environmental issues rest on religion, culture, technology and science, and the anthropocentric views of human beings. The approach to nature in terms of using and inhabiting it is an ethical concern too. "An ethic, ecologically, is a limitation on freedom of action in the struggle for existence. An ethic, philosophically, is a differentiation of social from anti-social conduct. These are two definitions of one thing. The thing has its origins in the tendency of interdependent individuals or groups to evolve modes of co-operation"(Leopold, 1949).

Aldo Leopold infuses the concept of land ethic into the literature of ecology. For him, the land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively the land (Leopold, 1949). With this concept of land, land is no more a bare place to be utilized without any limitation; besides, it is aware of the limits of the human beings in intervening the environment. The concept of land ethic proposes to look at the land as an ecosystem and provides the philosophical basis for conservation and the health of the land.

Environmental relations of human beings are as old as their origins. But it is after the Industrial Revolution and the 20th century that the environment fell into a great crisis. This caused a birth of thought and action called the green movement within environmental movement. The environmental movement started with Rachel Carson's book: Silent Spring. This book gave evidences of how chemicals and technology cause environmental deterioration, both for nature and human beings' well being. After this, people started to criticize their mode of living, production and consumption and their relations with nature.

Environmental movement has some categories. Its development was parallel to the views of sustainability put forth by Orr. It will be studied later extensively because the history and the philosophy of the green movement are the basis of the knowledge of ecological design. The history of knowledge of nature will also be studied within the limits of its relation with the built environment.

2.1.7. From Environmentalism to Sustainability

After 1980s environmentalism preached another word for environmental issues: sustainability. Emerging out of the environmental movement, sustainability is a widely accepted ethical principle, with a continuously redefined context, and the sustainability movement's real place will be within this search (Tekeli, 1997). As stated by Tekeli, the primary source of the environmental debate is the differentiation of human beings from other living beings. This differentiation is given by the emotional and intellectual capabilities. Thus through the emotional and intellectual capabilities, human beings could communicate in ways different than other creatures. And this communication and information is made possible passed on through generations. Such capability is the motive for Homo Sapiens' development and progress, which is 'natural' in character. Tekeli states three main components of human culture; these are economy, technology and ethics that determine the fields of production and consumption. The modernist period powered by industrial society and the myth of rational science and consumerism soon started to show their impact physically and socially on nature as a totality in all places and cultures of the world. Environmentalism has started with the consciousness that human beings are out of control of their own living and are threatening basic life support systems. Tekeli describes the evolution of modern environmentalism and the coming of the sustainability movement as the following:

> "The reason of Modernity which continuously thinks over itself could not remain silent against such a result. The short-term morality that it had developed had been insufficient. Instead of the morality that maximizes humanity's short-term profits, a need for a new kind of ethic which would guarantee his long term existence had occurred (Tekeli, 1997)."

The movement has its own divergent points or its two camps. Two main themes exist within the movement's own dynamism. Many authors of environmental criticism see this as a duality within the debate. This is described as the ecocentric mode and the technocentric mode described by T. O'Riordan, (1976), or environment centered or human centered (anthropocentric) as described by Tekeli (1997), shallow and deep by Arne Naess (1973), green and Green by Dobson (1991) and others.

> "The primary differences between the two have to do with assumptions about future growth, the scale of economic activity, the balance between top-down and grass roots activism, the kinds of technology, and the relationship between communities and larger political and economic structure. Without anyone saying as much, the former approach reinforces a tendency toward a global technocracy and a continuation along the present path of development, albeit more efficiency. The other view requires a rejuvenation of civic culture and the rise of an ecologically literate and ecologically competent citizenry who understand global issues, but who also know how to live well in their places (Orr, 1992:1)."

2.1.7.1. The Ecocentric Mode

The ecocentric mode is described by T O'Riordan (1976) "resting upon the supposition of a natural order in which all things moved according to natural law, in which the most delicate and perfect balanced was maintained up to the point at which man entered with all his ignorance and presumption (O'Riordan, 1976:1)."

Green with capital G is used for those who think that our current lifestyles are the aspiration of infinite growth on a planet which is finite in size and capacity and sustainability depends upon the system's being fundamentally changed; and green with small capital g is used for those who think that environmental problems can be solved within the present political and economic system (Dobson, 1991).

The ecocentric understanding of nature is motivated by the philosophies of the romantic transcendentalists of mid-nineteenth century America. Nature according to this thought enjoyed its own morality. If deeply understood, nature could open ways for sympathetic and responsive human beings to a new spiritual world of their own potential, their obligations to others, and their responsibilities to the life-supporting processes of his natural surroundings.

> "The power of transcendentalism lay not so much in its naturalism as in its intense social morality about democracy, truth, beauty, and a respect for nature. Their rudimentary understanding of the ecosystem led the transcendentalist to believe that democracy could only be attained by imitating what they understood as the lesson of nature- the pursuit of self-actualization and creative diversity with mutually sustaining communities (O'Riordan, 1976:4)."

According to O'Riordan, the philosophy of the ecocentric mode had two lines of codes, one is bioethic and the other the theme of self-reliance.

Bioethics is reasoning in favor to protect the integrity of natural ecosystems, not simply for the pleasure of human beings but as a biotic right. Nature for the bioethic supporter contains its own 'purpose', which should be respected as a matter of ethical principle. Nature itself creates an 'architecture of its own', which has a grandeur which both humbles and ennobles human beings, and stimulates them to emulate it' (O'Riordan, 1976). In the bioethic understanding nature has its intrinsic worth, in its own right, regardless of its use value to humans. Humans are therefore morally obliged to respect plants, animals and all nature, which have a right to existence and to humane treatment (Pepper, 1996). The idea of conservation and land ethic developed by Aldo Leopold is an extension of this. The conservation idea and human idea is totally a human construct. " Conservation is based on human value systems. Its validation lies in the human situation and the human heart (O'Riordan, 1976:4)." This bioethic principle is influential in the environmental policy making issues especially in places to designate national parks and wilderness areas. The most intense idea of nature and the bioethic finds its definition in the 'Deep Ecology' movement that takes this bioethic principle to biological egalitarianism and informs that all creatures belong to the same unified whole and that they deserve equal consideration.

The bioethic motif is of importance to modern environmentalism in that it stresses the essential humility of human beings in the face of natural forces. Nature produces 'resistance' which human beings ignore at their cost or peril, but which they can accept and understand to their inestimable benefit. Thus, bioethics incorporates the notion of *limits*, or nonnegotiable barriers to certain uses of natural areas. There is of course a long-standing controversy over just where and how demanding these limits are, an issue which permeates the growth–nongrowth debate. The bioethical viewpoint is that 'limits' establish their own kind of morality upon human beings, a challenge to his ingenuity and 'humanness' which constantly demands recognition and response (O'Riordan, 1976).

Pepper (1996) finds the background of this biocentricism in modes of thoughts like Taoism, Buddhism, Hinduism and in some Christian nature mystics such as St. Francis, witchcraft and paganism, American Indian spirituality, ecofeminism, bioregionalism, ecological science and populist American politics.

The ecocentric mode's other type of existence was the theme of **self-reliance** which was the method of linking self actualization to a sense of collective responsibility lying in the establishment of small, self-sustaining communities where nature was still very much in evidence (O'Riordan, 1976)

O'Riordan lists Peter Kropotkin, Ebenezer Howard, Patrick Geddes, Parrick Abecrombie, Lewis Mumford, Paul Goodman, Theodore Roszak, and Murray Bookchin within this group of thought

> "All these writers (and their intellectual colleagues) were profoundly disturbed by the dehumanizing and desocializing effects of rapid industrialization and urbanization, especially the impersonal and alienating atmosphere of the megalopolis, the intellectually deadening aspects of occupational specialization, and the increasingly wasteful diversion of scarce resources (energy, skilled manpower, time and organizational talent) into the maintenance and administration of excessively large industrial, social, and governmental organizations (O'Riordan, 1976:7)."

Kropotkin's main ideas were based on the dependence of a regional pattern of decentralized communities where agriculture flourished besides small industrial enterprises and the inhabitants enjoyed a breadth of education and a mix of occupations that combined manual labor with creative intellectual activity. He also encouraged local crafts and arts. " The Kropotkin utopia consisted of a simple life based upon limited expectations where there was little demand (and little need) for constant material progress. On the other hand he supported the science and technology within limits. Kropotkin's thoughts were reformulated in a way by Schumacher (1973) a hundred years later by his book. Schumacher advocated small scale organization, economy of energy use, intermediate technology and creative communal labor, Pirages and Erlich the convivial community, Roszak the visionary commonwealth, and Heilbroner the monastic commune (O'Riordan, 1976).

> "These notions are also environmentally important because they claim to provide a basis for social improvement with little or no increase in energy use. [Even Kropotkin regarded energy as the limiting factor, in fact he defined economics as 'a science devoted to a study of the needs of men and of the means of satisfying them with the least possible waste of energy (O'Riordan, 1976:9)."

Under the light of these descriptions the summary ofecocentrisim mode of thought includes:

Natural morality: A set of rules for human behavior based upon the limits and obligations imposed by natural ecosystems.

The ecosystemic metaphors: Of permanence and stability, diversity, creativity, homeostasis and the protection of options.

Ends and means: Nature of democracy, participation, and communication

2.1.7.2. The Technocentric Mode

The technocentric mode denotes the application of rational and 'value-free' scientific and managerial techniques by a professional elite, who regard natural environment as 'neutral stuff' from which human beings could profitably shape their destiny (O'Riordan, 1976,). Basic characteristics of the technocentric movement thus followed accepting the problem of the world as a problem that could be fixed up or fine-tuned. It used policies of thought optimism against the issues, value free approaches to nature, disapproval of widespread public participation.

2.1.8. Sustainability (The New Definition of Environmentalism and the Critique of Human Activity)

By Philip H. Lewis's definition, sustainability is, "the degree to which our methods of using the life-support system will provide our descendants with as good a life as ours, or better; preserving or restoring the environment in which they live so as to be stable in the relationships of all parts of the system (Lewis, 1996:241)."

The root of the word 'to sustain' means to support, to keep alive and to keep going continuously. Sustainable then describes an object to which is given support, relief nourishment or supplied with sustenance and thus continuously kept alive or prolonged. The origins of the word date back to late 1970's though the starters of such a phenomenon date back to the emerging consciousness of environmental problems in 1960s. Rachel Carson's 'Silent Spring' which was published in 1962 was an outstanding feature of the movement and the first 'Earth Day' in 1970 was the beginning of the environmental reaction and the growth of an environmental movement throughout the world. The 'Limits to Growth' study and its report were signaling the problems of growth and the scarcity of resources. İlhan Tekeli (1997) states that, the term emerged for the first time in 1977, in Dennis Pirages' book, The Sustainable Society[6]. A second book by Pirages again in 1978, "Repairs, Reuse, Recycling-First Steps toward a Sustainable Society"(Tekeli). In 1980 the term appeared in a publication produced by the International Union for the Conservation of Nature (UCN). In this report the term was used with the development scheme. (Steele, 1997). But the term has gained a central focal terminology and was introduced to the international arena by *Our Common Future*, the 1987 report of the World Commission on Environment and Development (Tekeli, 1997). Also the Brudtland Commission was chartered by United Nations to examine the planet's critical social and environmental problems and to formulate realistic proposals in order to solve them in ways that ensure sustained human progress without exhausting the resources of future generations. The so-called Brudtland report defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs. (Our Common Future, p.4)". In other words, sustainability meant that economic growth can and should be managed so that natural resources can be used in such a way that the "quality of life" of future generations is to be provided for. (Steele,1996). This report has been a turning point in the environmental movement (Tekeli,1997). It is characterized by its wide acceptance and was linked to development schemes and economical decisions.

The Club of Rome's publishing of the Limits to Growth in 1972 was an early work for the environmental movement about growth and scarcity of resources. But the Limits to Growth have had both supporters and anti-supporters. But the risks of our common future was accepted by the majority and influenced many professionals and activists, and the publication became a primary source.

Taking sustainability as a universal discourse and Our Common Future report as a source, the United Nations Earth Summit in Rio, in June 1992, produced another report Agenda 21, which included recommendation and guidelines for environmental issues of the planet from poverty to environmental health focusing on the local governmental applications and pubic participation to solve these problems. Agenda 21 included proposals for allocations of international aid for local governments. This has urged local governments from different countries to prepare their own Agenda 21's, which included primarily the following issues: Resource conservation, Built Environment, Environmental quality, Social Equality, Political Participation.

Currently the two approaches to environmentalism that has been discussed are reflected on the issue of sustainability. The global ecosystem is the idea of an open system that receives its energy from the outer world. Within this energy flow exits, abiotic, biotic essences, excluding human and human beings' subsystems.

> "We know that the natural world is essential to life, but we cannot determine to preserve everything that is natural because everything we do has some impact on the land. The key to sustainability is to understand the nature of the impact and its implications to the natural world and cultural system (Lewis, 1996,1)."

Tekeli (1997) states an important and basic thinking of sustainability.

> "There would never be a sustainability issue unless human being were different than the other living beings and no problem of inquiry. Such a differentiation occurred from the ability of human beings having intelligence and communication prior to other living being on earth. Besides genetically codes of information transfer, human being constantly passed multiplying information to other generations. This was the primary source of development and progress which was stated before".[7]

Sustainability in the global and in the local sense is to interpret an awareness of the planetary diseases and to strive for the solutions. It is awareness from many perspectives of the human perception of the environment. "Whether we like it or not, a considerable level of development –of change in the global landscape- will be necessary to meet the needs of the world's growing population and to redress present imbalances (Lyle, 1993:3)." Ecological perspective, is for maintenance, and regeneration of biodiversity in general. The economic point of view necessitates the idea of impact on the environment at the first instance as having a priority over other values. Sustainability has been a common denominator of environmental or green approaches of the world. But these approaches are not in unity and have diverse, sometimes quite contradictory meanings.

2.1.8.1. Environmental Crisis as the Crisis of Sustainability

David Orr (1992) states the crisis of environmental movement and its new mode sustainability in the scope of the past and present systems of actions, in various phenomena. These are summarized below with the assumption that they relate to various architectural issues:

***The crisis as a social trap*:** This depends on the way we use fossils, land, water, forests, minerals, and biological diversity and productivity. The idea of commons is a 'tragedy of commons' actually. Garrett Hardin's essay 'Tragedy of Commons"[8] described this as an example. The villager grazes an additional cow to increase his benefit but in the long term overgrazing is an environmental problem for the village which will run down the total system. Likewise, we are dependent on resources as material and energy and the running of such a linear system will at the end turn down the total system. Against such a reality the reasoning of human beings by the idea of commons is a crucial fact. The idea of commons is an idea that includes the idea of impact or at least the questioning of impact which may help rational human beings to chose more appropriate solutions to their needs and lifestyles.

***The crisis as consequence of economic growth*:** Development and progress is stated as an indispensable character of human beings. But growth may not be the growth trend of contemporary society which does not carry an ethic of limits in the total system of human beings and the earth. The idea of growth also effects the idea of wealth and dependency of material wealth is a crucial problem. Against such a problem, the economy of no-growth or steady-state economical ideas were put forth which depend on more cyclic intervention of the systems that run the system and the increase on low entropy.

The crisis as the result of the urge to dominate nature: domination in nature as myth and as ideology. Here religion and science is seen as ideological standpoints 20th century ideologies are capitalism, the cult of instrumental reason and industrial culture as stated by Orr (1996). So technology is the main motif, and belief in technology and technological progress is seen as a positive asset in society.

Against such an attitude of no limits, critics prefer the notion of appropriate technology and/or optimum technology for optimum needs. Besides, the technological myth should incorporate 'wisdom' in order to be appropriate. Against the cultural ideologies of western civilizations, the eastern modes of thought like Buddhism, Hinduism and Zen towards nature carry much more an ecological and holistic point of view. The counterpart of such philosophies is seen in a way in the deep ecological movement of environmentalism.

***The crisis as the result of an evolutionary wrong turn*:** This refers to the exclusion of indigenous culture and the loss of the notion of place and dwelling in the mentality of modern cultures. This notion is also described as alienation from the natural world. The contact that an individual loses with his/her natural surrounding and 'places' is a problem of the designing minds of actual society.The design of spaces usually disregards such a fact. This notion, has been the cause of the society's loss of its historical and natural surroundings.

> "In considering the causes of the crisis of sustainability, there is a tendency to sidestep the possibility that we are flawed, cantankerous, willful, perhaps fallen, but certainly not entirely planet-broken, race. These traits, however, may explain evolutionary wrong turns, flaws in our culture and science, and an affinity for social traps. It's us (Orr, 1992:17)."

Orr states that ethics, respect, cleverness, idea of limits, community and the commons will always have to fight, with the mind of the technological civilization and of the individualistic economy (Orr, 1992).

> "Finally, the word 'crisis', based on a medical analogy, misleads us into thinking that after the fever breaks things will revert to normal. This is not so. As long as anything like our present civilization lasts it must monitor and restring human demands against the biosphere. This will require an unprecedented vigilance and the institutionalization (or ritualization) of restraints through some combination of law, coercion, education, religion, social structure, myth, taboo, and market forces. History offers little help, since there is no example of a society that was or is both technologically dynamic and environmentally sustainable. It remains to be seen how and whether these two can be harmonized (Orr,1992:21)."

2.1.8.2. Criticism of Sustainability and the Variations of the Theme:

The reasons for the crisis of sustainability and the environmental dilemmas were stated by five possibilities by Orr(1992). As explained before, the environmental critique diverges into two paths, which have their roots in T O'Riordan's explanations of ecocentricism and technocentricism. The ecocentric discourse has taken the conservation of the environment as a priority and it is opposed to the changes in ecosystems caused by human actions. The other technocentric or anthropocentric view favors maximizing the well being and profit despite natural catastrophes. The sustainability debate and description described by the report Our Common Future, inherently possesses dilemmas of the environmentalist movement. It is criticized as being too flexible and not opposing the development's effect on nature radically. Tekeli criticizes the time dependency of the description and states that it should have the justice or equity in time as well as in space. The sustainability divergence is well described by Orr (1992) as technological sustainability and ecological sustainability.

Sustainability stood as a solution to the resource shortage and misuse of nature. The term usage meant a positive aspect on environmental critique but the term is also criticized extensively. According to David Orr (1992), the term sustainability has two meanings in general as an approach to the interaction of human beings and nature.

The first view is **technological sustainability** and the second is **ecological sustainability**. The former one refers to 'fixing the environment with better technology and solutions generated with the existing system'.

> "Advocates of technological sustainability tend to believe that every problem has either a technological answer or a market solution. There are no dilemmas to be avoided, or domains where angels fear to thread. Resource scarcity will be solved by materials substitution, or genetic engineering. Energy shortages will be solved by more efficiency improvements and for some, by nuclear fusion (Orr, 1992:24)."

David Orr states the basis of technological sustainability as the following: Humans can use nature, have total dominion and control of nature with population control. Humanity is economic and within such a belief has to maximize profits and minimize losses where economic growth is essential. Causes of unsustainability are only those of inaccurate pricing and poor technology. And they could be 'fixed-up' or 'fine-tuned' (Orr, 1992).

The second approach to sustainability is **ecological sustainability**, which has a different perspective than the first one. It believes that solutions of technological sustainability will not suffice to solve all the problems. Alternative solutions to the modes of the society like agriculture, shelter, energy use, urban design, transportation, economics, community patterns, resource use, forestry, the importance of wilderness, are offered besides our central values. Again Orr(1992) states the ideas that form the foundation of the approach.

Humans are limited, fallible creatures: The limits can be of two kinds. One is that comprehension may be limited, the other is about limited willingness and the sense of good inherent in human nature.

Active citizenship is necessary. Regional action, restoring civic virtue, a high degree of ecological literacy and ecological competence throughout the population.

Past practices, traditional knowledge, folkways should be deeply considered.

> "Ecological sustainability will require a patient and systematic effort to restore and preserve traditional knowledge of the land and its functions. This is knowledge of specific place and their peculiar traits of soils, microclimate, wildlife, and vegetation, as well as the history and the cultural practices that work in each particular setting. Sustainability will not come primarily form homogenized top-down approaches but from the careful adaptation of people to particular places. This is as much a process of rediscovery as it is of research (Orr, 1992:33)."

Nature should be regarded as a basis for design: Ecological knowledge and the protection of the ecosystems as design criteria for houses, cities, neighborhood, technologies and regional economies. "Sustainability depends upon replicating the structure and function of natural systems (Orr, 1992:33)." Such a notion of design emerges out of three beliefs according to Orr (1992). First is the working and functioning of the biosphere for millions of years and miraculous functional, aesthetic and structural capacity of the natural system and process that can be useful in artificial processes. "In other words, human activity will be disruptive unless it is designed to fit within ecological processes and the carrying capacity of nature systems (Orr, 1992:35)." Secondly, the analogy of the human systems with the ecosystem is a valid method because ecosystems show themselves capable of stability and regulation within their own system and carry on their life processes. The analogies of energy efficiency, closed loops, redundancy, and decentralization are against entropy. The present industrial systems thus follow linear paths, perpetual growth and progress that increase entropy. Thirdly the mysticism of the belief of the natural forces and powers is respected. Issues of scale and centralization are important.

The idea of scale is important in two terms. The human scale refers to the capacity of humanity or the community to perceive and control what he is in relation with. Scale refers to such a notion that when things are at their appropriate size and scale the systems are operable and manageable.

Interrelatedness, holism, system approach are the keywords for ecological sustainability:. Against the Cartesian logic of reductionism and the modern idea of fragmentation, a more deep concern on pattern, processes, contact and holism is important. The understanding of the ecological properties of systems depend on the understanding of relations with each other.

The two different paths of sustainability cannot be totally evaluated as a choice for individuals, groups and societies, but people as habitants or professionals are urged to follow one or a mixture of these alternatives. This depends on the complex systematic relationships of the aspects of society and its practices. Both meanings share almost the same view of environmental crisis as a threat but they differ in practice.

> "These two practices are partly complementary, but their practitioners tend to have very different views about the extent of our plight, technology, centralized power, economics and economic growth, social change and how it occurs, the role of public participation, the importance of value changes, and ultimately very different visions of a sustainable society (Orr, 1992:24)."

The thesis tries to prove the validity of the above approaches on design disciplines. The thesis is concerned mainly with the phenomena in architectural, urban and landscape design. There are other design disciplines like product design and also management design (where it is not a design of a product but a process). It must not be forgotten that the sustainable view of society requires a holistic approach in all the modes of the society.

> "The modern world has failed; a postmodern world is still to be born. Transitions such as this are times of both promise and peril. The promise comes from the necessity (read opportunity) to reconsider, rethink, reform, restore and rebuild our world and worldviews. This process raises old issues, and some new ones, having to do with the balance between centralization and decentralization, urban and rural, freedom and order, individual and community, scared and secular, organic and mechanical. The peril comes from both the urgency and scope of our plight and the resulting pressures that could cause us to make the transition badly. The nightmare hanging over humanity is that the same approaches to sustainability reflect the present condition of green or environmental approaches in design disciplines (Orr, 1992:24)."

A sustainable society with all its agents present for a sustainable future that will provide the ecological integrity of the planet as a whole and basic human needs as a totality can be possible through policies that can affect the way we live, think, behave. The behavioral, philosophical, social and cultural formulations summarized from Tekeli's proposal for sustainable policies are (Tekeli, 1997):

- The societal system should achieve to reproduce itself through continuous improvement of the quality of life.
- Priority must be given to the policies that will continuously decrease the impact of the societal system on the environment.
- Environmental quality must be preserved and the life-support system should continue. Water, soil and air quality, landscape values and the ecological system processes must be conserved.
- Principles for production with the limits of consumption must be carefully respected.
- Principles for the efficient use of natural sources in technical and economical fields should be provided and decision making must be rethought.
- The deeds that may prevent opportunities in the future that has no turning back must be escaped, the chance for the future should be sustained.
- International relations should be reorganized in order to help sustainability.

2.1.9. Ecology, Sustainability and Design

This section looks at the phenomena of design. It assumes that the crisis we are dealing with is also a *design crisis*. Design, we can assume, is basic to all human activity. The interpretation of the problem of sustainability mentioned in the above chapters is also a *problem of design*. The primary causes of the design crisis are closely linked with the crisis of sustainability explained in the following quotation:

> "In many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. Design manifest culture, and culture rests firmly on the foundation of what we believe to be true about the world. Our present forms of agriculture, architecture engineering, and industry are derived from design epistemologies incompatible with nature's own. It is clear that we have not given design a rich enough context. We have used design cleverly in the service of narrowly defined human interests but have neglected its relationship with our fellow creatures. Such myopic design cannot fail to degrade the living world, and by extension, our own health (Van Der Ryn & Cowan, 1996:9)."

Since it is design that is seen as the saver from the crisis, the problem of sustainability can be grasped as a *design problem*. Design can be seen as a product of societies' actions. It should be kept in mind that not every process and phenomenon of society is intentionally designed but there are at least some aspects where *design is one of the cornerstones of society*. Design in this sense implements not only the professionals but also includes the actions of humanity and thus it is futuristic.

> "Design in relation to the earth's ecological problems refers to the future and is therefore both prognostic and hypothetical. This is exemplified in the concept of *sustainability*, which is described as "meeting the needs of the present without compromising the ability of the future generations to meet their own needs (Yeang, 1995:1)."

Design is seen as one of the catalysts of social and cultural action and the dilemma of man-nature relations. The ecological critique of design is threefold. That it pollutes, wastes and degrades. Secondly, usually it does not make useful of nature and natural processes, physically, biologically and metaphorically. Thirdly there is usually not a holistic but a more fragmentary approach to design. And it does not the see the connection between man-nature dependency and mutualism. It treats design as an abstract issue instead of addressing *real issues*.

> "As Homo Sapiens's entry in any intergalactic design competition, industrial civilization would be tossed out at the qualifying round. It doesn't fit. It won't last. The scale is wrong. And even its apologists admit that it is not pretty. The design failures of industrially/technologically driven societies are manifest in the loss of diversity of soil erosion, ugliness, poverty, injustice, social decay, and economic instability (Orr, 1994:104)."

David Orr (1994) states three main reasons of the crisis in the design–ecology/environment relationship;

- the thinking of the resources and natural as infinite, and the characterization of economies and lifestyle according to such a belief,
- failing of design intelligence against green, narrow and self-interests and the absence of community values,
- poorly equipped minds creating poor designs that reveal inadequate understanding and knowledge of relationships of the ecology-environment and the cultures (Orr, 1994).

These problems of design are also defined by David Wann as biological blindness, economic ideology and social inertia (Wann, 1996). Both Orr and Wann see the problem in poor, non-comprehensive design thinking.

> "When poorly designed, they undermine those larger pattern, creating pollution, higher costs, and social stress in the name of a spurious and short-run economizing. Bad design is not simply an engineering problem, although better engineering would often help. Its roots go deeper (Orr, 1994:105)."

These problems related to the problem of sustainability is well expressed by David Wann (1990):

> "When you think about it, poor design is responsible for many, if not most, of our environmental problems. Poor design ranges from lawn mowers through nuclear plants, from local building codes through politically engineered federal legislation. Cars pollute because they're not designed well and use an appropriate fuel. People find it difficult to ride bicycles to work because bikepaths are not designed into community plans. Toxic chemicals are discharged into rivers and into the air because manufacturing processes are poorly designed; wastes move right along with the product and then become toxic orphans in our environment (Wann, 1990:2)."

Sim Van Der Ryn calls bad design as dumb design (Van Der Ryn & Cowan, 1996). It is design that fails to consider the health of human communities or of ecosystems, let alone the prerequisites of creating an actual place.

> "Dumb design is wasteful of energy and resources. It is polluting, extravagant and profoundly dangerous. Unfortunately we are surrounded by it. We have let dumb design come to dominate the scene because we lacked the words and awareness to fight it (Van Der Ryn & Cowan, 1996:10)."

The design phenomena can be taken as a social trap that the designers, producers, and consumers have fallen into. The conception, perception, and operations of design are criticized as non-ecological and unsustainable.

> "The input/demand/design side of our economy is cluttered with toxic-laced paint ingredients, building materials, and cosmetics; products like throwaway razors that maintain their structure for hundreds of years even though the intended use is only a day or two, and energy sources that "cut butter with chainsaws" by supplying sixty-eight degrees of heat with thousand-degree nuclear reactions. We wear gas masks and gloves dealing with many of our products, transporting them in isolating containers. We haven't surrounded ourselves with a garden of good designs and ideas far from it (Wann, 1990:3)."

Design activity as the agency of society and culture is highly criticized to be against nature. As one of the causes of environmental crisis, designers and design thinking is criticized both for methodological, technical and ethical aspects and for attitudes to the earth. Design has several meanings, rather than one. Papanek describes it as "the conscious and intuitive effort to impose meaningful order (Papanek, 1992:4)." Sim Van Der Ryn defines design as 'the intentional shaping of matter energy and process to meet a perceived need and desire' (Van Der Ryn & Cowan, 1996). Design applies to making nearly everything that directly or indirectly requires energy and materials or governs their use, including housing, communities, neighborhoods, cities, transportation systems, technologies, economics, and energy policies. The concept of nature and its processes in physical and spiritual terms is a prerequisite for design disciplines of all kinds. For this humanity and the designers have to infuse the word 'ecology' into their dictionary of design. Ecology, *scientifically* and *ethically* will be the underlying principle of design thinking on earth.

There is a great body of knowledge on ecology and system design to be applied on the ecological understanding of the environment. Some authors have tried to apply the theories of ecological design and ecosystematic understanding to the ecology of the built environment. "Architects, designers, engineers, and all those who affect the environment must make everyday design decisions and take action on the basis of the information that is presently available (Yeang, 1995:2)." When information for systematic analysis and synthesis for the design is not possible, inadequate knowledge is not to blame, then preventive and conservative methods must be applied.

> "The significance of taking design action based on a proper understanding of ecological criteria is obvious. Design and planning decisions are made at the present time not only have an immediate effect on human society, but also could influence the environmental quality for subsequent generations. However, assessment and guidelines for design should be provided on the basis of what is already known and rather that the ignorance and exclusion of environmental considerations (Yeang, 1995:3)."

The differences of the contemporary design thinking and the ecological design thinking related with environmental issues is given in the following table (Table2-1) (Van Der Ryn & Cowan, 1996:26-28).

Table 2-1. Characteristics of Conventional and Ecological Design (Van Der Ryn & Cowan, 1996: 26-28)

Issue	Conventional Design	Ecological Design
Energy Source	Usually nonrenewable and destructive, relying on fossil fuels or nuclear power; the design consumes natural capital	Whenever feasible, renewable: solar, wind, small-scale hydro, or biomass; the design lives off solar income
Materials use	High-quality materials are used clumsily, and resulting toxic and low-quality materials are discarded in soil, air, and water	Restorative materials cycles in which waste for one process becomes food for the next; designed-in reuse, recycling, flexibility, case of repair, and durability
Pollution	Copious and endemic.	Minimized; scale and composition of wastes conform to the ability of ecosystems to absorb them
Toxic substances	Common and destructive, ranging from pesticides to the paints	Used extremely sparingly in very special circumstances

Table 2-1 (Continued).

Ecological accounting	Limited to compliance with mandatory requirements like environmental impact reports	Sophisticated and built in, covers a wide range of ecological impacts over entire life-cycle of the project, from extraction of materials to final recycling of components
Ecology and economics	Perceived as in opposition; short-run view	Perceived as compatible; long-run view
Design Criteria	Economics, custom, and convenience	Human and ecosystem health, ecological economics
Sensitivity to ecological context	Standard templates are replicated all over the planet with little regard to culture or place; skyscrapers look the same from New York to Cairo	Responds to bioregion: the design is integrated with local soils, vegetation, materials, culture, climate, topography; the solutions grow from place
Sensitivity to cultural context	Tends to build a homogeneous global culture; destroys local commons	Respects and nurtures traditional knowledge of place and local materials and technologies; fosters commons.
Biological, cultural and economic diversity	Employs standardized designs with high energy and materials throughput, thereby eroding biological, cultural, and economic diversity	Maintains biodiversity and the locally adapted cultures and economies that support it
Knowledge base	Narrow disciplinary focus	Integrates multiple design disciplines and wide range of sciences, comprehensive
Spatial scales	Tends to work at one scale at a time	Integrates design across multiple scales, reflecting the influence of larger scales on smaller scales and smaller on larger
Whole systems	Divides systems along boundaries that d not reflect the underlying natural processes	Works with whole systems; produces designs that provide the greatest degree of integral integrity and coherence
Role of nature	Design must be imposed on nature to provide control and predictability and meet narrowly defined human needs	Includes nature as a partner: whenever possible, substitutes nature's own design intelligence for a heavy reliance on materials and energy

Table 2-1 (Continued)

Underlying metaphors	Machine, product, part	Cell, organism, ecosystem
Level of participation	Reliance on jargon and exerts who are unwilling to communicate with public limits community involvement in critical design decisions	A commitment to clear discussion and debate; everyone is empowered to join the design process
Type of learning	Nature and technology are hidden; the design does not teach us over time	Nature and technology are made visible, the design draws us closer to the systems that ultimately sustains us
Response to sustainability crisis	Views culture and nature as inimical, tries to slow the rate at which things are getting worse by implementing mild conservation efforts without questioning underlying assumptions	Views culture and nature as potentially symbiotic; moves beyond triage to search for practices that actively regenerate human and ecosystem health

2.1.9.1. The Ethics of the Designer and Ecology

There is surely an ethical concern for the designer to think holistically and act ecologically which will be the subject of this section. But before that, it is important to question the mentality of the designer, in which contemporary attitudes of theory and practice are effective and condition positions that designers take with their clients and with society. Lyle interprets West Churchman's statement about the position of the designer of any sort in terms of moral concerns in regard to the design problems.[9] The moral difficulty of design making, planning and decision making poses three possible kinds of action from the designer. One is the goal planner who simply does the bidding of whoever is paying him and the designer is usually named as a hired gun. The second is close to the first, the difference being that the designer can draw lines of action, this may not go beyond a point of limit determined by the consciousness of a problem and issue or an impact. The third is the one who asks questions like 'Who should be served and how?' or 'Who should plan and how?'

> "These questions put the design effort in the very broadest ethical perspective in that any possible means and all possible effects are open for consideration. The project at hand is cast in the larger context where concerns for goals are passed down from higher levels of integration. Churchman calls the planner who work in this way the "ideal planner" He does not, of course, always achieve his ideals, but he strives to maintain his moral position (Lyle, 1985:139)."

Lyle adds another type of designer, advocate designer, 'the designer who is committed to a particular moral purpose and whose efforts are directed to a achieving goals justified by that purpose'. The advocate designer then can be committed to wilderness preservation, reducing resource consumption or equal distribution, or land ownership, or to some combination of these goals, and then blend all his planning efforts to achieve them (Lyle, 1985).

A fifth category of designer can be included within this discussion. This is the outlaw designer, as proposed by the book, Design Outlaws by Chris Zelov (1997). The outlaw designer is seen as the outlaw to current practices and lifestyles and uses his innovation to create a radical change in the system (Zelov, 1997).

It must not be forgotten that the ethicalviews of an individual is also affected by the social, educational and cultural situation of the society. The 'outlaw character' is also an individual's anarchist reaction to society. The anarchist view of ecological thinking was well expressed by Murray Bookchin(1989).

Human intervention with nature or the culture-nature dilemma is itself a cause or result of design. It was through design with some method or approach that humans have reached environmental crisis on earth. And it is through design that humanity can save the earth and himself. Neutra's remark on design is noteworthy.

> "Design, the act of putting constructs in an order, or disorder, seems to be human destiny. It seems to be the way into trouble and it may be the way out. It is the specific responsibility to which our species has matured, and constitutes the only chance of the thinking, foreseeing, and constructing animal, that we are, to preserve life on this shrunken planet and to survive with grace (Neutra, 1962:6)."

There is now a growing awareness of the designer's role in the environmental design perspective. The role of design in environmental problems is a reality. There is a close link between environmental and sustainability ideas and design. It can be concluded that the eco-sensitive also followed the path of development of the term.

> "We live in two interpreting worlds. The first is the living world, which has been forged in an evolutionary crucible over a period of four billion years. The second is the world of roads and cities, farms and artifacts, that people have been designing for themselves over the last few millennia. The condition that threatens both worlds –unsustainability- results from a lack of integration between them (Van Der Ryn & Cowan, 1996:17)."

1980s were the time of development from ideas of *green* to *eco* to *sustainable*, especially after the effect of the limits to growth, and with the understanding of the finite limitation of the resources. The preliminary stages of green designs notions are criticized as simplistic notions of design and environment; the more critical approach of ecology and sustainability have changed the color of the eco-sensitive design (Madge, 1997). The reason may be the populism of the sustainable debate and the increase of the environmental crisis. But still the ideas and products do not stand firmly on a certain foundation.

> "What will emerge is that this is not necessarily a cohesive or unified phenomenon-there are many shades of green and different ecological perspectives, reflecting political distinctions within the environmentalism and differences within ecological theory and practice. Although ecodesign in the last decade has been dominated by a concern for the mechanisms of putting policy into practice, a fundamental recognition has emerged that what is at stake is a new view of the world and a choice of possible futures, and it is this which has the most interesting implications for design criticism (Madge, 1997:44)."

The holistic understanding from the individual to the world in the design interface is thus explained by Wann.

> "The overall goal is total value – a design that serves the individual as well as the system. We've come to an overlook point in our evolution – at last, we perceive that we are part of a larger organism, or culture, and that our culture is in turn part of a larger organism, the biosphere. What we de for the earth, we do for ourselves. This is the holistic pragmatism of deep design, the convergence of economics, physics, biology and ethics (Wann, 1996:22)."

2.2. Ecosystem Approach, Design and Sustainability

For an ecological point of view of the landscape, we are going to look at natural system and the designed system together; such that the ecological orders of both systems and the newly created system by their integration must be studied altogether. The ecosystematic order at all stages has relevancy and importance for the designer to understand the ecosystem and to produce ecological environments. Basically the ecosystematic orders include the structure, function and the locational patterns of the ecosystem. These three orders will be the core of the discussion.

> "Ecosystematic order, while enormously complex in its infinite detail, is relatively simple in concept. In essence, ecosystems are defined by three modes of order, each of which has basic implication for regenerative design. We can think of the ecosystem as being like a house, as reflected in the word "ecology" itself: ecos means "house" in Greek, and logy refers to "study." Ecosystematic order then is analogous to the order found in buildings. First, there is the structural order of posts, beams, walls, and roof. Second, there is the functional order of material and energy flows represented by the pipes, valves, wires, switches, circuit breakers, ducts, dampers, and other apparatus. Third, there is the locational order of the floor plan. The ecosystem and its modes of order provide a conceptual model of the world that serves well as a basis for regenerative design. Any landscape, even the whole earth, is a larger house (Lyle, 1994:22-23)."

Ecosystems three main modes are function, structure and location. The description of each mode is dependent on the scales of the ecosystem. The scale is a very important issue in the formulation of an ecosystem.

The ecosystematic thinking then occurs in two concepts. It depends on our values (bioethic) and which mechanisms (self-reliance) human beings use in order to manipulate natural systems, regulate human activity systems and to construct design systems in order to have an ecological aspect for sustainability. Thus a sustainable set of subsystems and relation depends on an understanding of sustainability in two primary aspects as defined by Forman (1995): "A sustainable environment is an area in which ecological integrity and basic human needs are concurrently maintained over generations (Forman, 1995:484)." So the idea of ecologically sustainable design refers to the sustained ecological integrity of the ecosystems in different scales and the operation and relationship of the energy and material flows to meet basic human needs. The sustainable theory of design of the built environment according to the definition above is dependent on the prerequisite of the dependency on ecosystems and the mode of living ecologically. This definition, in other words, has its roots in the modes of ecocentric thinking.

The definition of ecological approach to the design of the built environment and any kind of sustainable production incorporates the idea of ecological understanding of the environment. Thus systems will be termed as ecosystems both with the understanding of this bioethic theme, keeping the ecological integrity, and the functioning of the systems to meet the basic needs.

Two issues are expressed with such an approach to design intervention. Especially for the disciplines that require spatial arrangements on nature: the built environment and the ecosystem as not separate systems but two sub-systems, which form one main ecosystem. The built environment and the ecology-ecosystem analogy can be constructed according to the following factors, which are formulated by Yeang (1995):

- The built system and the physical elements contain abiotic components, with its content of energy, matter and information.
- Flora, Fauna and people (human, animal and plant communities) contain the biotic elements
- The systems exchange energy and matter.
- Inputs from the sources as the source of energy/matter flow from the boundaries into the system.
- Cybernetic (the control system, monitoring system).
- The system metabolism.
- Output processes.

Such a viewpoint is derived from the relationship of the built environment and the natural ecosystems, which are to be termed *human ecosystems*. So, our focus will be to define and study human environments under the name human ecosystems. This is an assumption that is taken by the thesis, and the term is used (accordingly) by several writers; McHarg (1969), Lyle (1985). So the human ecosystems understanding brings us the understanding of the environments in question with the ecosystem concept and that ecological integrity is the basis. This actually refers to the bioethic theme of the ecocentric views in study and practice. So the study of a 'location or' 'place' in its ecological terms and in its system understanding is the focus of this chapter together with the subject of the self-reliant mechanism.

The second idea is on environments being 'ecological', that is, making fewer disturbances on the environment. This is again expressed in the self-reliance theme of ecocentricism. This theme in planning and urban or rural design refers basically to the self-sufficiency of the settlements and human activities. The ecosystem approach is necessary to denote because the term spatial unit is also a primary deed of design in architecture and planning. Actually the spatial unit exists in the world in scales, denoted by man again, which is defined later in the chapter on human ecosystem.

In Odum's definition, ecosystem or ecological system is any unit that includes all of the organisms (i.e. the community) in a given area interacting with the physical environment so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles (i.e. exchange of materials between living and non-living parts) within the system. The same definition holds true for human ecosystems if the human factor is added. Then the social, economical, technological, political and cultural, aesthetical and philosophical intervention comes into the picture. The ecologist usually views the human communities as a part but, the thesis' assumption based on McHarg (1964) and Lyle(1993) etc..., is the necessity to redescribe the ecosystem concept as a human ecosystem. Actually the intervention of man brings spatially and ecosystematically a disturbance and change to the ecosystems. The newly introduced physical structures and the new modes of flow are also new 'ecosystems', so for the observer it can be conceived as ecosystems carrying the characters of being ecosystematic spatial units and also being studied conceptually as a system with ecosystematic orders. This is the foundation of the ecological design process.

The ecosystem idea of stability or homeostasis is kept as long as its orders are kept. The idea of stability and homeostasis is no static act but a dynamic and changing flow with integrity, so that the structure and flow of the system remain in operation. So the ecosystems will continue to remain healthy and productive if the ecosystemic orders are kept within the limited amounts of the carrying capacity of the ecosystems.

The Ecosystematic order is defined by the structure, function and the locational patterns of the ecosystem which will hold the core of the ecological design process attributed in this thesis. Lyle makes an analogy of the understanding of the ecosystematic orders of natural and artificial areas and processes very interestingly with the idea of home and building. Here we can make the same analogy on the opposite direction and use this analogy to describe human ecosystems including buildings, landscapes, cities and settlements.

2.2.1. The Properties of Ecosystems for Ecological Design Thinking

Ecological thinking depends on the following assumptions according to Yeang (1995):

- It is advantageous for people to keep their environment biologically viable.
- The present state of progressive degradation of the environment by human actions and activities is unacceptable.
- It is necessary to minimize people's destructive impacts on the ecosystems as far as possible.

The idea of dependency of the built environment on nature via design is discussed by Yeang (1995) and it is proposed that the designed system is dependent on the ecosystem directly or indirectly and the ecosystematic orders, for:

- A supplier of energy and material (minerals, fuels, air, water, food).
- From a supplier point of view the resources are classified into three: Inexhaustible rescues or water solar energy)
- A supplier of certain processes (biological, physical and chemical)
- A receiver of the residues and discharges resulting from the metabolism, activities and processes of humans and their man-made systems, e.g., land disposal of wastes.

- A spatial environment in which human actions and activities are talking place.

The notion of impact is another ecological concern for the development of the built environment. The impacts of the built environment include;

- It spatially displaces a portion of the ecosystem by its physical presence. It changes the structure and functioning of the ecosystems by their own functions and structures. Simultaneously, functional composition of the built system changes the ecosystem functioning (also structure and locational patterns).
- After construction, habitation of the built environment and related human activities after both the designed systems and the environment during its life time.
- The built environment is dependent on energy and material for realization, operation and disposal. Extraction of the resources and their process and transportation of energy and matter have also impact on the environment.
- The built environment emits output of water energy and materials as heat and pollution occurring in the overall processes. The structure, function and locational patterns are affected (Yeang, 1995).

> "It is essential that we identify the environmental impacts of the designed system, including not only those inherent in the making and building of the element, but also those that the use of these elements, their disposal, and their recovery will generate. By looking at any designed system from the point of view of these interaction we are in a position to anticipate holistically those aspects of the designed system that have ecological impacts as part of our design process (Yeang, 1995:71)."

A total impact matrix of development is adapted from US National Park Service Document which is provided in Appendix A. This may be useful for the designer and developers to see the impacts of any deigned development.

2.2.2. Locational Patterns and Processes

One definition of ecology has been "the study of the structure and function of nature". Nature is a description of life on earth, including all living and non-living materials together with their physical, chemical, biological processes. Humankind is within this nature, and also outside of it. Nature as a totality can be described in ecological word as a global ecosystem. Thus the ecosystem depends on the patroller patterns of locations. So the notion of location is an indispensable aspect in the idea of ecological design because it informs the spatial patterns and configurations needed for the designer.

The particular places, physical qualities, and characters are the third important mode of the ecosystem. The climatic pattern, physical geography are the stages of understanding ecosystems and the mode of operating them basically depends on the study of the existing order, and processes on reshaping it. Lyle interprets this process to designing as building.

> "Once we understand the existing order, the process of reshaping it is something like designing a building. Structural, functional and locational patterns knit each level into a unit and also serve to join the levels together. The locational pattern –strongly influenced by the lay of the land but at the same time responsive to human needs, activities and paths of movement- corresponds to the floor plan. The landscape structure corresponds to the skeletal framework holding all the building materials in place- a network of elements that may be inert and more malleable and predictable than the living, fluctuating structure of the ecosystem, but are nevertheless inescapably interrelated. As for function, though this is not the way the term is conventionally used in architecture, a building, like and ecosystems, has a system of flows –water, sewage, electricity (energy, warm, and cool air, - that provide for life support needs...If a building seems too much a human artifact to serve as analogy for an ecosystem, consider the roots of the word ecology: oikos for "house, logos for the study of. In a sense, in designing a human ecosystem, we are shaping a macro-house, and when we design a house, we are shaping a rather small ecosystem (Lyle, 1985:197)."

The idea of impact is one of the important factors of ecological design.

> "The extent of impact and the risk of permanent degradation to the ecology of any locality posed by human action or activity varies depending on the geographical locality and on the type of human action and activity imposed on it. (Yeang, 1995:18)."

Considering the locational patterns of the ecosystems, the primary elements are geology and climate. Other factors are:

- Pattern and distribution of soils
- Topography.
- Water regimen.
- Yearly temperature profile and rainfall.
- The distribution of other species.
- Human actions
- Activity already inflicted on the locality.
- Legal or lot boundaries (The dilemma of ecological and property boundaries)

McHarg states that:

> "Previously, designers have approached ecosystems as merely physical sites on which their acts of transformation take place: ecosystems have been viewed as elements to be modified and shaped to suit the design. In the ecological approach, locations or project site needs to be individually evaluated, with consideration given to the ecosystem's own natural values, its processes, its constraints, and its inherent array of natural opportunities, all of which differ with different locations (McHarg, 1968:19)."

The impact notion depends on the disturbance and assimilative capacity of ecosystems. Any building or settlement pattern creates conflicts with the ecosystem. Most man-made structures will introduce energy and materials to the ecosystem. There will surely be an alteration. On the contrary the goal of ecological design is to find minimum conflicting ways of doing this.

> "This is because all building activity involves a redistribution and a concentration of some portions of the earth's energy and material resources from usually distant locations to a specific locality (the project site), with the end result of changing the composition of that part of the earth's biosphere as well as adding to the composition of that system (Yeang, 1995:20)."

2.2.2.1. Ecosystems (Nature) as Spatial Context: Ecology of Landscapes

The ecological integrity in the sustainable definition is concerned with the understanding of the spatial characteristics of ecosystems. Forman has derived characteristics of the ecosystems spatially and has stated certain key points for a designer in concern. Forman explains ecosystems as "an area (or volume) where species interact with the physical environment (Forman, 1995). The ecosystem includes a community within itself that is the assemblage of interacting species. Ecosystems have key components, which are stated below.

Basic characteristic of ecosystems is that they occupy a spatial unit. Spatial units are manifested as form. This is a relevant term for designers and it is also a tool for designers to understand ecosystem structure, function and locational patterns. Forman (1995) makes such an analysis and its processes are explained with a formal descriptive model. Any land that is conceived in any scale is termed mosaic: the individual trees, shrubs, rice plants, are aggregated to form the pattern of patches, corridors, and matrix on land (Forman, 1995). Matrixes occur in scales. He refers to mosaic as land mosaic and the important fact is that land mosaics are of human scale. This scale definition refers to both the perception and operation in design and management capabilities. Mosaics are heterogeneous spatial units; their patterns depend on heterogeneity such as hills, wet spots and different soil types causing vegetation.

The pattern heterogeneity depends on natural disturbances like fire, tornado, pest explosions, and changes and human activity such as agriculture, road building, settlement creation, and various other intrusions of physical structure into the lands. The pattern heterogeneity is also dependent on various biological processes. To note here a second time its importance, following the idea of form is quoted from Forman's study:

> "A more general way to understand form is to relate it to movements and change. One may say that 'form is the diagram of force'. Form and structure, i.e. what we see today, was produced by flows yesterday. The curving sand dune was shaped by wind, the rectangular vineyards by tractors, and the dendritic stream corridor by water erosion. In addition, a linkage or feedback between structure and function is evident. Not only do

> flows create structure, but also structure determines flows. For example, the arrangement of patches and corridors determines the movements of vertebrates, water, and humans across the land. Finally, movement and flows also change the land mosaic over time, much like turning a kaleidoscope to see different patterns. (Forman, 1995:5)."

Forman models the land mosaic in a patch-corridor–matrix model and states that a land mosaic is composed of only these three types of spatial elements, patches, corridors and a background matrix. Spatial elements are defined as each of the relatively homogenous units recognized in a mosaic at any scale. Patch refers to a relatively homogeneous non-linear form that differs from its surroundings. Corridor is a strip of a particular type that differs from the adjacent sides on both sides. Matrix refers to land-use type in a mosaic, characterized by extensive cover, high connectivity and /or major control over dynamics. Lastly he defines other elements of the model, which are formed by the interaction of the patch-corridor and matrix model. These are boundaries and edges, and transitions between these. His model is thus a very well described model of the landscape for the human ecosystems.

2.2.2.2. Locational Pattern Thinking for Ecological Design

In the ecological design process, as a locational pattern thinking, it is important to note what kind of elements exist in the life-cycle concept. The life cycle concept includes a methodology of asking questions about the interaction of the systems.

- What environments in the project area are affected by the activity, and how are the environments characterized?
- How do these environments change physically and chemically with the activity?
- What species are involved: aquatic, terrestrial, and marine?
- Considering the environments and species that can be identified, what ecological processes at work causing the changes that result from the activity?
- Knowing the ecological processes at work, what ecological changes can be anticipated?(Yeang,1995)

As a sequence of the design process, the elements of ecological design concerning the location include:

- The analysis of the location: The type of land use pattern, the exclusion of certain structures and activities from ecologically unsuitable locations (Hazardous areas, Preservation areas, Conservation areas).
- Siting and planning layout pattern
- Impacts during the life cycle of the designed system and the ecology exclusion of other structure and activities during and after the construction of designed system.

The designed system will affect the location;

- Disturb the ecosystems by temporary change
- Disfigure the ecosystem by a surface change
- Disrupt the ecosystem by a permanent change.

The change may be characterized as a positive effect:

- Preserve
- Enhance the ecosystem by adding the value as a resource
- Retard environmental deterioration by reducing the impacts of change
- Restore the ecosystem by replacing the designed conditions.

2.2.3. The Structural Order

The structure Ecosystem structure is defined as the structure of ecosystem element and their interactions. The structure of the ecosystem elements is formed of:

- Inorganic substances (C, N, CO_2, H_2O, etc) involved in material cycles.
- Organic compounds (proteins, carbohydrates, lipids, humic substances, etc.) that link biotic and abiotic.
- Climate regime temperature and other physical factors
- Producers, autotrophic organisms, largely green plants, which are able to manufacture food from simple inorganic substances.
- Macroconsumers or phagotrophs, heteretrophic organisms, chiefly animals which ingest other organisms or particulate organic matter
- Microconsumers, saprotrophs (decomposers) or osmotrophs, heterotrophic organisms, chiefly bacteria and fungi (Odum, 1971).

It is the structure of the community in the ecosystem, the living elements and their relation and interaction with each other that is the basic concern. Most important characteristic of the community include diversity (number of species present), growth form (trees, shrubs, herbs, mosses), dominance (controlling species by virtue of size, numbers, or activities) and trophic structure/who eats what).

> "The concept of structure and the related concepts of community and association have practical importance because of their influence on stability and on what we have called the 'sustainability" of human ecosystems. They also give us a conceptual basis for designing into humans systems the conditions required by plant and animals species as well as by people (Lyle, 1985:196)."

The structural order of the human ecosystem includes the plants, animals and people, the interaction of plants, people and the abiotic environment. Including all the things may make the study very complex but several methods have been produced like the one in Figure 2.6. It is Ian McHarg's layer cake method to analyze structure and interrelation of the structural elements of the ecosystems by 'an overlapping' process.

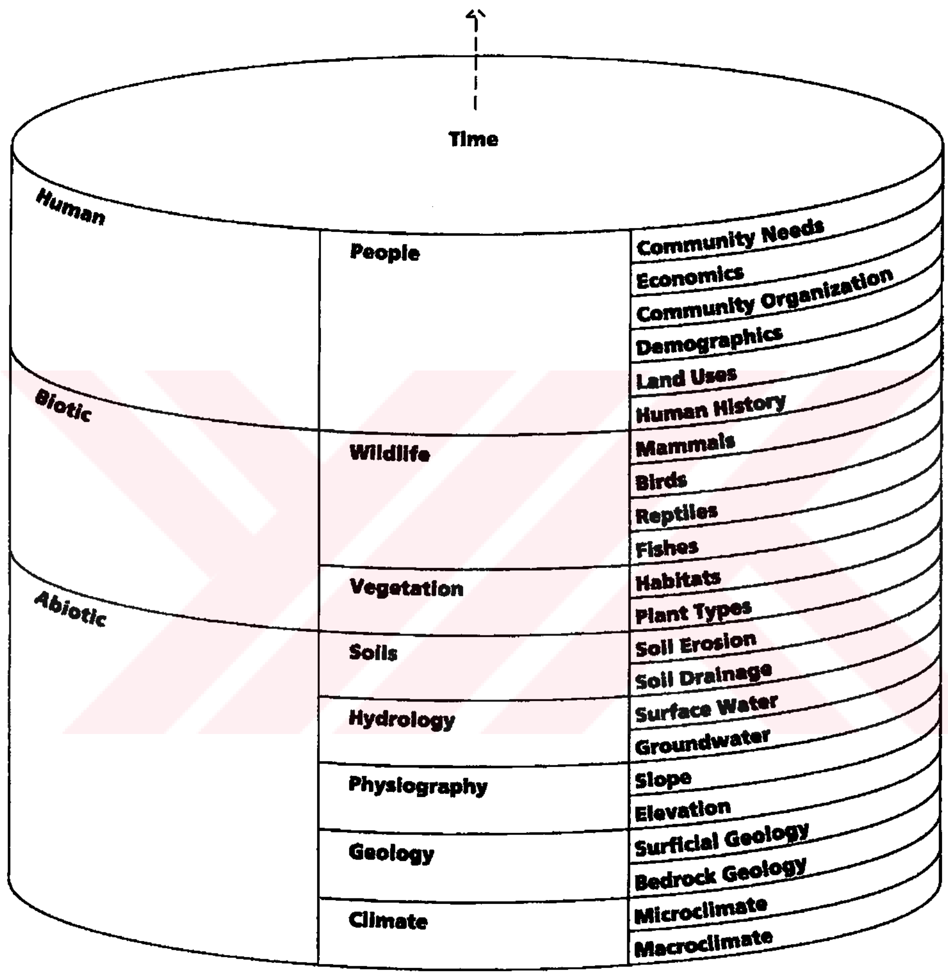

Figure 2.6. Showing a possible configuration of the human ecosystem structure modeled by Ian McHarg(1964) (Thompson and Steiner, 1997)

2.2.4. Functional Order

From the functional standpoint an ecosystem may be conveniently analyzed in terms of the following; energy circuits, food chains, diversity patterns in space and time, nutrient cycles, development and evolution, control (cybernetics) (Yeang 1995). The functions of the ecosystems mean the flow of energy and materials that distribute the necessities of life to all the species within the ecosystematic structure (Lyle, 1985). The functional point is clarified with the example "design of a spaceship".

The necessity of understanding the function of the ecosystems is expressed by Lyle in the following quotations:

> "In the light of the overwhelming dysfunction that have been brought about by misdirected flows of materials and energy-problems threaten to become even worse-learning to control such flows is one of our most urgent tasks (Lyle, 1985:197)."

In the second quotation the relationship of nature, development and the idea of regeneration is discussed:

> "In nature, development means increasing complexity. During the Paleotechnic period, development of the landscape by humans has generally meant simplification –loss of complexity, diminishing of process. It could be otherwise. Although development is inevitably alters the operation of natural processes, it is possible to integrate human development into their working order and thus retain their essential operational integrity and their capacity for regeneration (Lyle, 1994:26)."

Lyle uses the idea of regeneration in a way similar to the idea of Odum's bioregeneration. Regeneration, according to Lyle, is a method of the ecological design processes and he applies this concept in the 'Center for 'Regenerative Studies Complex in Cal Poly, Pomona, US which will be discussed thoroughly. The impact of the development can only be overcome by regeneration methods of development. Lyle uses the ecosystematic functioning: conversion, distribution, filtration, assimilation, and storage. For human ecosystems Lyle adds the human thought as the last principle for design of regenerative systems, such that human systems are seen as inseparable from the natural systems: conversion, distribution, filtration, assimilation, storage. He integrates these ideas in the overall concept of the design and he states the human intervention as 'Thought' (Figure 2-7).

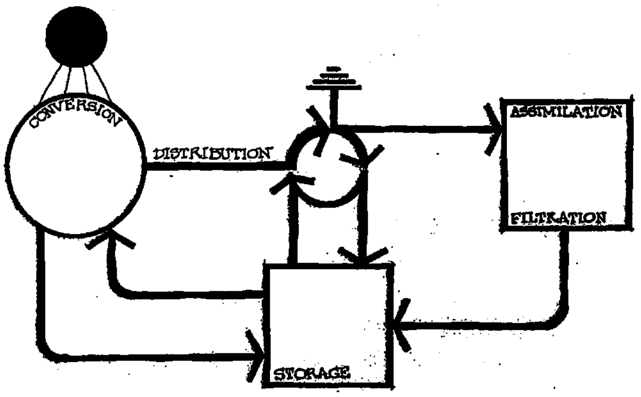

Figure 2-7. Principles of regenerative capacities of ecosystems (Lyle, 1993:26).

The functional order can be best explained by the idea of a spaceship. It is in some ways valid to describe the functional relationship of life-support systems.

2.2.4.1.The Design of a Spaceship

The description of the built environment and spacecraft is a nice method to show the importance of the flows of human life and the life-support system. The environment of the spaceship is the designed system or vice versa, and the energy and materials flow is important to pay attention in terms of making analogous or real contributions to the understanding of the built environment and the ecosystems relationship. While the locational and structural orders tie the designed system to the environment, the functioning is the internal mechanism of the ecosystems. Spaceships are buildings constructed for a temporal scale. Science fiction stories and films also demonstrated some buildings of this kind and also some space stations. The study of such a system may provide the knowledge of the structure and the function and process of living systems that provide the life support systems for the dwellers. This is a whole system design in these terms. The idea of sustainability and survival can be well supported by the understanding of this phenomenon.

> "In most broad aspects the problems of man's survival in an artificial spacecraft are the same the problems involved in his continued survival on his earth spaceship, which is rapidly reaching critical levels of crowding. For example, detection and control of air and water pollution, adequate quantity and nutritional quality of food, what to do with accumulated toxic wastes and garbage, and the social problems created by reduced living spaces are common concerns of cities and spacecraft (Odum, 1971:498)."

Until the present most realized systems were based on a limited time and were not regenerative. This is studied and criticized by Odum and also by a holistic critique about biosphere.

> "The fact that we are not able to engineer a completely closed ecosystem that would be reliable for a long existence in space (nor can anyone predict when we will be able to do so because we have not yet given it serious attention) is striking evidence of our ignorance of, contempt for, and lack of interest in the study of vital balances that keep our own biosphere operational. Therefore, future efforts to construct a life-support system by miniaturizing the biosphere and determining the minimum ecosystem for man is a goal that is as important for the quality of human life on earth as it is for the successful exploration of the planets (Odum, 1971:498)".

The type of life-support systems is categorized into three types by Odum according to their flow of energy, cycling of matter and type of regulation (Figure 2-8). Regulation is done by either external mechanical hardware or internal homeostatic interactive biological mechanism or both. Longevity depends on the reliability of the factors given in Figure 2.9.

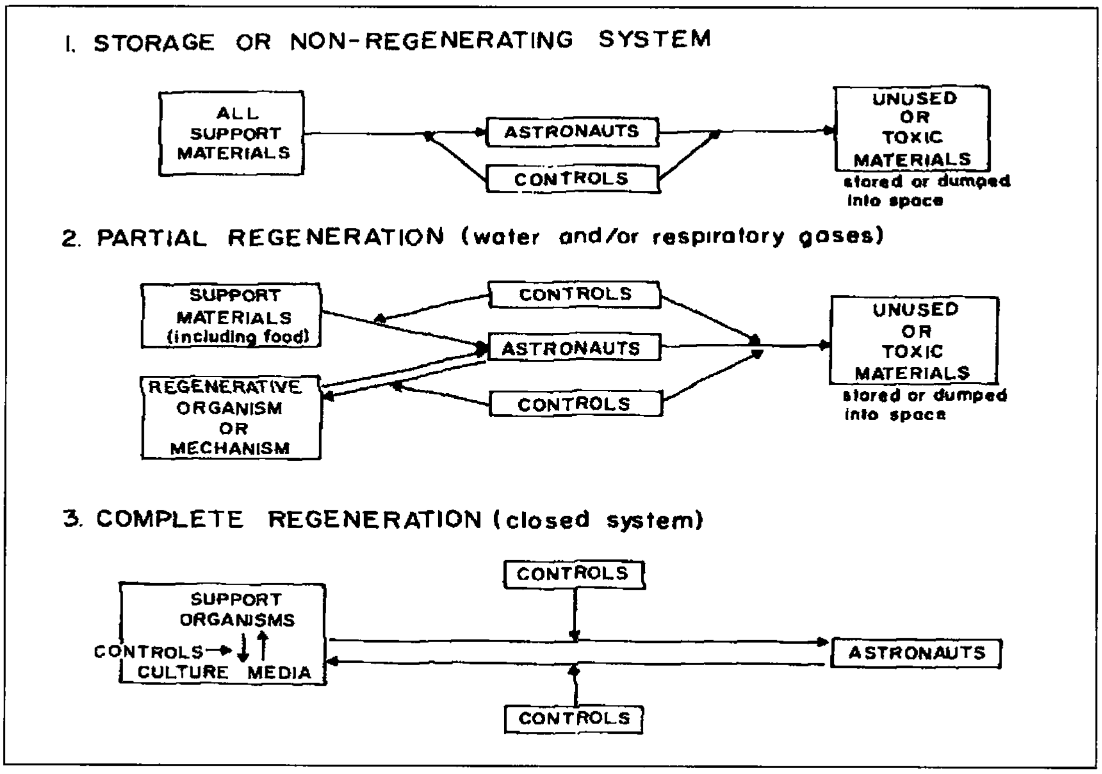

Figure 2-8. Three types of life-support system functioning (Odum, 1971).

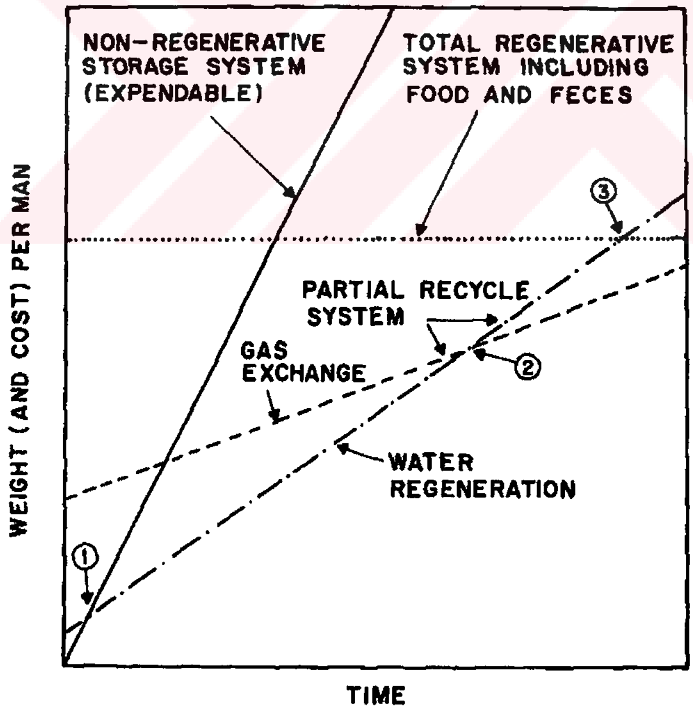

Figure 2-9. The factors of the longevity of life-support systems

Odum provides two differentiation approaches to the functioning of the system. Mechanical-chemoregeneration or mechanical-chemical and regeneration systems or bioregenerative system (Figure 2-10 and Figure 2-11).

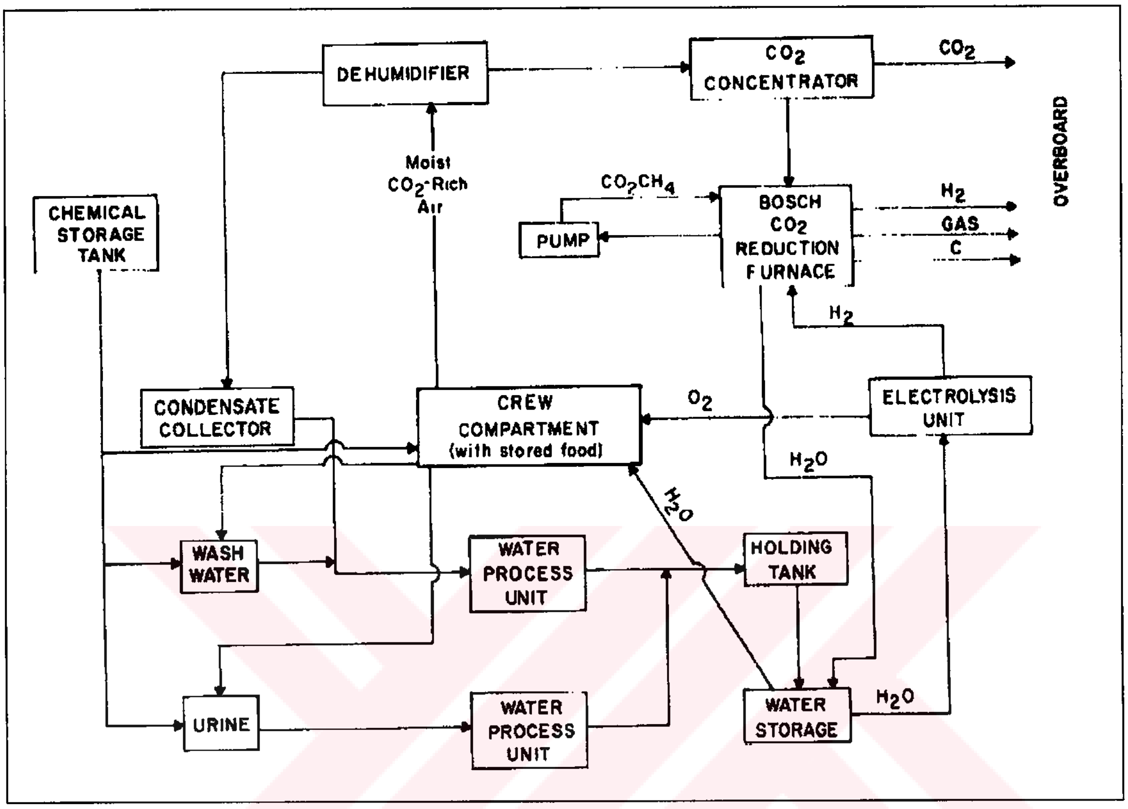

Figure 2-10. The mechanical-chemical operation of life-support systems.

> "The reliability of the mechanical system, in so far as tested on the ground, seems to be god for missions of up to 100 days. As with any mechanical device, failure or reduced performance, necessitating on-board repair or a mission abort, can be expected with increasing time of operation due to wear. Finally, it is difficult to build a system that must handle liquids and gases at very high temperatures and pressures without leaks, which could be serious sources of contamination and fires. The procedure of dumping waste materials into space pollution or superpass to the contamination of extraterrestrial life systems if these exist is not ignored. Although the regenerative system seems relatively simple in theory, one is impressed with the large and complex equipment necessary to replace the most elementary function of nature! (Odum, 1971:503)."

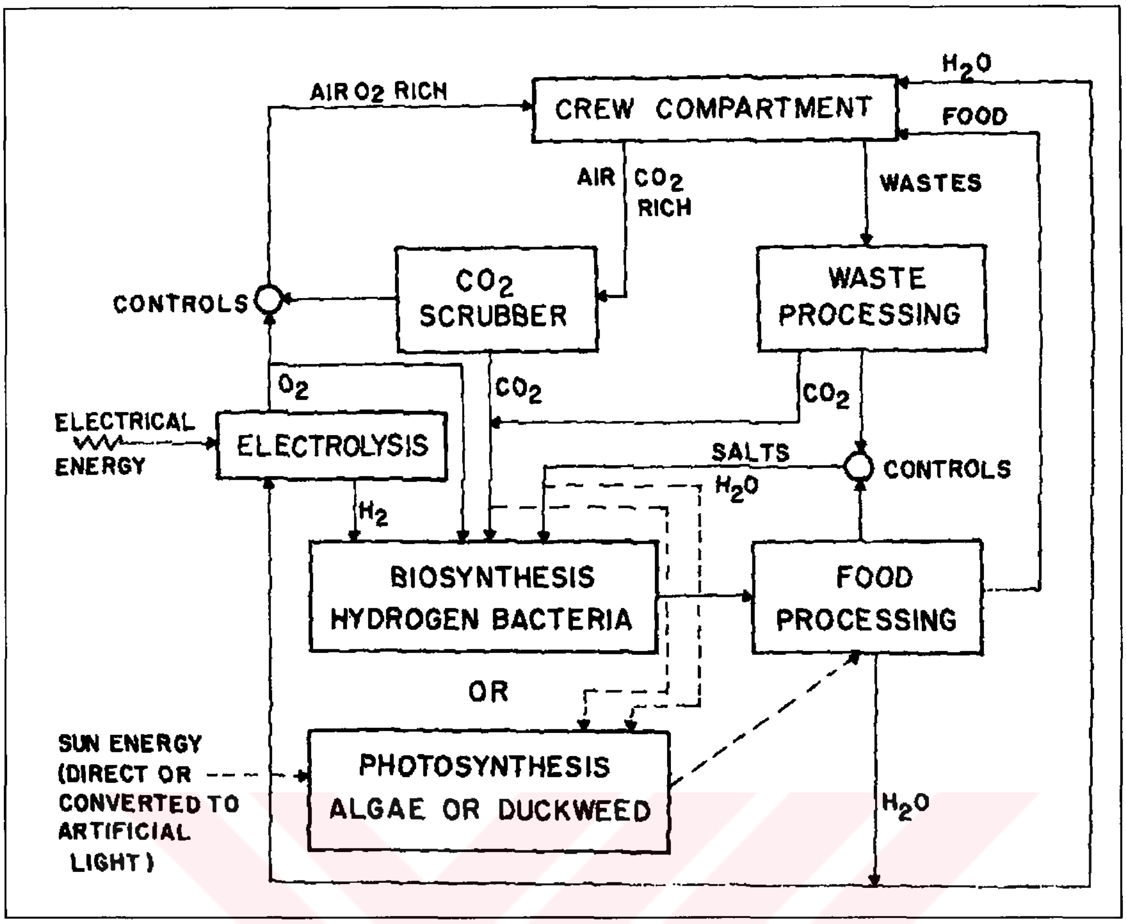

Figure 2-11. The bioregenerative life-support systems.

To understand how nature works and what the elements of the system are, McHarg uses an interesting example in the Chapter of 'The Cast and the Capsule' in *Design with Nature*:

> "In an study of experimental environment, with Louis I. Kahn, the subject was to find out how an astronaut might be sent to the moon with the least possible baggage to sustain him. The answer was a recirculating biological system with florescent tube representing the sun, a quantity of air, some water, some algae growing in water, some bacteria and a man... In the hypothetical capsule the man breathes air, consumes oxygen, and exhales carbondioxide; the algae consume carbondioxide and expel oxygen into the air, which the man breathes, and so an oxygen-carbondioxide cycle is ensured. The man thirsts, drink water, urinates, this passes into the water medium in which the algae and bacteria exist, the water is consumed by the algae, transpired, condensed, the man drinks the condensations and a closed cycle of water exists. When hungry, the man eats some algae,

> digests them, then defecates. Subsequently, the decomposers reduce the excrement into forms utilizable by the algae, which grow. The man eats more algae, and so a food chain has been created. The only import to the system is the light from the fluorescent tube-fossil sunlight; the only export from the system is heat...The system depends first upon the sun, the net production of photosynthesis after respiration, upon the water and upon the cycling and recycling of the materials in the system by the decomposers. It is quite clear that the process requires that the substance or wastes, the output of one creature, are the imports of or inputs of the other. Is this indeed the way he world works? Yes, at least in essential terms. United we are as men, plant parasites, happily consuming the oxygen wastes of plan metabolism, rescue from encompassing ordure by both the decomposer and the plant, eating, burning and thus sustaining life from the energy of the sun, transmuted by photosynthesis. Now before we indulge in fulsome self-praise for our services to both plant and bacteria, let us stop to consider that they both existed before man and need him not at all. Our wastes are useful, but not necessary man (McHarg, 1964:44)."

The spaceship example is given to demonstrate the difference between the technologically driven understanding of design and biologically (ecologically or nature-) driven technologies of design. The designed system is based on the systematic thinking of the output and input model as shown in the spaceship example. Lastly the functional attributes of designing could then include,

- Designing for cyclic use
- Design for efficiency
- Design for dismantling
- Reuse recycle and repair
- Control of the outputs and emissions.
- Knowledge of the material used
- The forms of construction

2.2.5 An Ecological Design Thinking Method

It is intended in this section, to integrate the idea of ecosystems and its properties with the design processes. For a sustainable design of human ecosystems certain measures or attitudes in the process of design have to be considered. Thus the method aims at creating design values considering the locational-structural and functional attributes.

The environment should be understood ecologically in terms of maximizing its ecological integrity and minimizing the catastrophic and negative impacts of the built environment and human activities. The ecological critique is then applied on any activity or aspect of the order, to be able to control the activity or the aspect or at least make way for it. This determines the scale of intervention. This scale corresponds to ecosystematic orders which are the l*ocation* (patterns and impacts) and structure (elements and relation), function (flows and processes). The locational-functional-structural approach is valid for human ecosystems from the global scale to the building design. So, the hypothesis of the thesis states that the biological and physical connection of humanity and nature is termed in locational structural and functional patterns. This is expressed in terms of integrity, dependency, disturbance and land impact, etc...

The ecological critique of such an attitude is to let the designer understand the ecological ways of doing things in terms of using a language of minimizing, optimizing and maximizing. This in actual terms means minimizing impacts and maximizing ecological integrity. Thus the scale is divided into five, as minimizing, optimization-minimization, optimization, optimization-maximization, maximization.

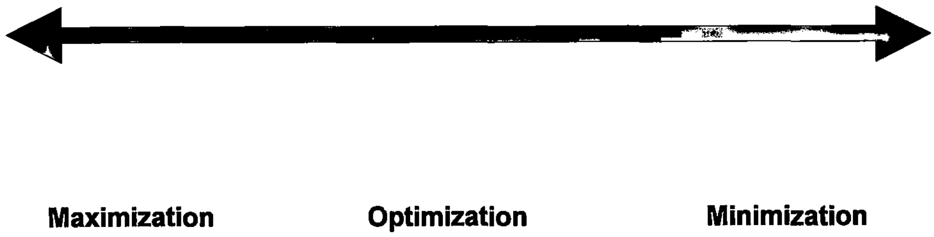

Figure 2-12. . The scale of intervention for the designer's concern

Maximization	**Maximization optimization**	**Optimization**	**Optimization Minimization**	**Minimization**

Figure 2-13. The operations in shaded scale.

The scale of the ecological criteria: Such a scale is found to be useful because in the real wold of economical and cultural structure, it is hard to have the changes occur as slowly as the changes in the natural world. Therefore Table 4 will show the locational, structural and functional attributes. The bar scale at the right tries to explain the process from the natural to the cultural evolution and vice versa with the notion of time. This hypothesis and its consequences can be applied to describe ecological architecture, which is different than ecological building. Building as a process and a product is in the broader scale of architectural process and product. Actually, it is architecture that links the scale of other human ecosystems to the ecosystem.

The following table, with its contents relating the basic design attributes to ecological factors, has been reformulated and itemized from various sources, by the author of the thesis.

Table 2-2. The locational-structural-functional attributes.

LOCATION (Locational patterns and impacts)	STRUCTURE	FUNCTION
Natural Ecosystem Integrity (Biotic)	Animal and plant Community (Wildlife and Vegetation)	Photosynthesis , Food, Nutrient cycles, Material Cycles
Natural Ecosystem Integrity (abiotic)	Soils, Hydrology (Surface and Ground Water)	Material Cycles
Climatic Patterns	Diversity Air, wind and.... Micro, and micro climates	Heterogeneity
Formation	Physiography (Slope and Elevation) Geology (Surficial and Bedrock)	Heterogeneity
Spatial Heterogeneity	Flora fauna diversity	Stability, dynamic stability, health
Spatial interaction of ecosystems	Movements of communities	Heterogeneity
Scale	Interrelatedness	Energy and material Transfer and flows
Disturbance of ecosystems Naturally	Natural disturbance, natural catastrophes,	Stability, repair, restoration
Human Ecosystem Integrity (Biotic)	Animal and plant Community (Wildlife and Vegetation) + Human Comminutes	Photosynthesis , Food, Nutrient cycles, Mineral Cycles
Dependency of Human ecosystem of Natural Ecosystems as Resources	Settlements Transportation etc Production and consumption	Linear Patterns Mineral resource depletion and problems of extraction and processing and production
Dependency of Human ecosystem on Natural Ecosystems as Energy	Settlements Transportation etc Production and consumption	Linear energy Paths Fossil Fuel Use, and pollution and waste
Dependency of Human ecosystem of Natural Ecosystems as Resources	Settlements Transportation etc Production and consumption	Cyclic Patterns Biodegradable or industrial in cyclic patterns

Table 2.2 Continued

Dependency of Human ecosystem of Natural Ecosystems as energy	Settlements Transportation etc Production and consumption	Biomass,
Spatial Disturbance by the Built Environment (Composition, placement)	Settlement transportation patterns	Increase in energy Flow
Ecological Disturbance by he built environment (Land Use and Activity Patterns)	Human Communities Diversity	Linear Flow of waste, material
Dependency on Natural resources (sun ,air, water)	Interaction of Human communities and natural communities	Renewable energy
Dependency of Ecosystem Communities of Plants and animals As natural Capital	Economic	
Human communities	Population	
Needs and demands	Production and consumption	Quality
Needs and demands	Production and consumption	Quality
Locational Pattern of 'place' and Genius Loci'	Natural and cultural surroundings	History, identity, dwelling

The human factor is always included in the ecosystem thinking also in Forman's study. The cultural, religious, social and economic activities overlapping over historical time is the main study of ecological design. This phenomenon is expressed by an example by Forman.

> "Some years ago an expert in forestry from a developed country was invited to advise in a developing country. A village leader welcomed the expert, and learned that productivity of the local wooded area could be tripled by gradually replacing the rather heterogeneous, scruffy-looking trees with a

high-quality eucalypti or pine plantation. Pondering the many ramifications of this profound change, the two leaders strolled through the wood more closely. The host observed, "This tree provides nuts in the dry season; this moist area protects our only clean drinking water; this grove provides the best firewood in the area; this tree is where I was married; this shrub is the only source of fibres for our unique dance; this vine provides the incense for our annual religious festival; this line of decrepit trees provides the children with flutes; this dense bushy area provides at least six major economic products; these virtually unburnable trees on the windward side are essential fireproofing; and these tall arching trees from the cathedral for reflection and inspiration". The two leaders embraced warmly, and the visitor returned home to take a closer look at the local tree plantationsthere (Forman, 1995:15)."

2.3. Ecology, Ecosystems and the Design Connection: Descriptions of Ecological Design

2.3.1. The Need for an Ecologist's View of Design Problems

The ecological criteria and critique for the design disciplines necessitate the ecologist view for the design problems. Actually designers are blamed not to have ecological insight or not enough motivation for protection or preservation of the ecosystem or not enough knowledge of ecological understanding of the environment. This is discussed by Yeang (1995) and he proposes that the designer should have the knowledge of the basic concepts of ecology, the structural, functional and locational patterns of ecosystems and the consequences of the designed system that he creates. So the designer should focus on the relations of the systems of nature and the designed systems.

"An immediate apparent discrepancy lies in the difference between the designer's understanding of the environment and the ecologist's. We can distinguish the end product of our design process as a designed system, which is the primary object of our endeavor, from its environment (those parts of the external world that interact with it). The validity of any model of a system and of the description of the system that the model provides will depend not only upon the character of the model, but also upon the assumptions that we make about the system's environment and the designed system, this will eventually result in some dissonance in the interface between the designed system and its environment (Yeang, 1995:4)."

Against the simplistic or missing knowledge or epistemology of the designer, the holistic and whole system view of the designer with the ethical concerns is a necessity as critiqued by ecological design.

> "The significance of taking design action based on a proper understanding of ecological criteria is obvious. Design and planning decisions are made at the present time not only have an immediate effect on human society, but also could influence the environmental quality for subsequent generations. However, assessment and guidelines for design should be provided on the basis of what is already known rather than on the ignorance or the exclusion of environmental considerations (Yeang, 1995:3)."

2.3.2. Shifts In Emphasis of Environmental/Ecological Design

There is a belief in design about the survival of the planet. This is apparent not just through modernism, but in the approach of some of the architects of modernism. Buckminister Fuller was one of these and for him the theory of design science was for the survival of the planet through design. On the other hand, he can be criticized for not being optimistic about the technological aspect of design. Although he did not use technology, he was the designer of future architecture.

The green design phase was in the late 70s and early 80s. Public awareness to environmental issues and critiques of the condition produced a green media within the society in the agency of production and consumption and politics and economics etc... The green products, green packing, green buildings and how –to-be-green books were signs of these (Madge,1997). Soon issues like energy efficiency, durability recyclability and acceptability were in the market place. Wann (1996) describes the nature of design process as pathways and scenarios such that each pathway strives to meet key criteria such as renewability, recyclability, and nontoxicity. The common theme of each pathway is the search for a more elegant approach in performing services and providing functions. As these divergent pathways reach their potential, they will converge in a sustainable, steady-state society. The path of sustainable design is very much parallel to the path of the environmental and the sustainability debate. Besides, ideas and methods and the terminology were borrowed from ecology and from environmentalism. The broader development of ecological ideas has caused shifts in ecological design thinking too. So the technological and ecological sustainability can be referred to as technological sustainable design and also as ecological sustainable. The dynamism is reflected in the design thinking too. There is a difference between the two sustainable critiques discussed by several authors. Enzio Manzini (1994) calls it the normalized ecological design, versus new radicalism, Pauline Madge (1997) calls it green versus ecological/sustainable design or light green versus dark green, and Wann (1996) calls it deep design and shallow design.

The 1980's phase was termed as *normalized ecological design*, which happened within the context of industrial society in which the world appeared to be wealthy, healthy and satisfied (Manzini,1994). This kind of approach under industrial cultural background viewed the environmental issues as political economic and engineering fixes in a technical manner. Therefore, it required a redesign of what was already at hand. Manzini explains redesign as the following.

> "Environmental impact is the result of a population which 'demand results' and the specific impact of the technologies employed to achieve those results. We can consider an environmental policy as tactical when, supposing that the results cannot be modified, one attempt to improve the technical eco-efficiency of the system. This is realized by improving the technologies employed to achieve the results. Following this path, changes in lifestyle are not required, and the role of design is that of effecting redesign of the existing products (Manzini, 1994:37)."

But this view, that is 'normalization' was found inadequate and was replaced by other more radical views. The same almost happened in the architectural and planning disciplines. The change was an overall design understanding of humanity, which had as the background the environmental issues, environmentalism, ecology and sustainability. The green phase followed the paths of the technocentric and the technological sustainability requirements. David Wann (1996) has described the understanding of this process as fine-tuning or tuning up and names it as shallow design. Its method was based on through command-and-control strategies and regulatory agencies dealing with environmental problems (Wann, 1996). Madge states that the green understanding of design was soon out of date and was replaced by the ecological/sustainable debate (Madge, 1997).

The basic differentiation between attitudes is how designers approach the design methodologies and ethical concerns. David Wann (1996) also calls the evolution of the sustainable design into phases; *Phase I* and *Phase II*. *Phase I* corresponds to the green or shallow, but though criticized, the act of fine-tuning is also seen as a starter. "Deep design is an ongoing process. Once we have "tuned up" individual products-what I call Phase I - we need to integrate them into a system (Phase II) that is capable of regeneration, and aligned with nature's momentum (Wann, 1996:xv)."

The first phase's primary concerns were primarily energy use, durability, recyclability and acceptability in the marketplace (Madge, 1997). The science of ecology had new concerns for the disequilibrium of natural systems rather than a stable system. With theories of Chaos and complexity the notion of unpredictable, dynamic and evolving self-adaptive systems understanding were influential on co-sensitive design thinking. The ecological sustainable debate brought product design, the ideas of ethical and social responsibility and the notions of time and time-scale to the fore (Madge, 1997) Design for Disassembly was a notion of this together with design for life-long and durable products.

So from authors of dealing with design ideas came the terminology reflecting this diversity of the movement within the design scheme. Manzini called this as normalized versus new radicalism. The evolution of the ecological design phases has necessitated more critical questions to be asked. First there was a criticism against the mechanical designs which did not fully consider the biological, ecological and human psychology. And the revolutionary post-industrial thinking about design problems is characterized by its being programmed to be nature compatible and like nature, that is flexible enough to adapt to changing conditions (Wann, 1996).

> "The best nature compatible new designs whether products, buildings, technologies, or communities-are sensitive to living systems which they come into contact, accomplishing hither missions without undesirable side effects such as pollution, erosion, congestion, and stress (Wann, 1996:xiv)."

The 1990s, with the international mediatic development of sustainability and more fierce critiques about the debates opened up a new terminology in the design disciplines. The criticism on social, economic, political, ethical and technological aspects was based on an increased thinking and there was also greater concern about the nature and natural systems. The former green movement was a fine-tuning case and improvement and change, but did not affect the essence of actual design thinking. There were needed essential changes in the overall production and consumption and lifestyles together with the design understanding. The former applications could not be sustainable in the long term (Manzini, 1994). The crisis had other linkages with the agents of society. The first was criticized as rather simplistic (not simple) in the idea of design and the environment. "Many of the current design approaches that claim to be "green" do not show a thorough understanding of the earth's ecosystems and their functioning (Yeang, 1995:5)."

The new age of design is characterized by being ecological in the sense that it is discussed within this chapter. In short, the new age of design is characterized by the ecological wisdom, global responsibility, conservation of ecological systems, using resources on a sustainable basis, and ideas of regeneration, autonomy and self-sufficiency, and interests in both metaphorical and analytical usage of biological systems which showed success in survival. There is also urgency for constructing a balanced relationship between the social and the natural world.

Manzini's proposal was to produce environmental policies. He described normalized ecological design processes as tactical actions. Differing from this notion, to achieve a higher social eco-efficiency, the policies may be stressed as *strategic,* placing the social demand for results in discussion.

> "In other words, an improved relationship between the individuals to be satisfied and their demands for results in relation to the available technologies. To make an environmental policy of this kind practicable it is necessary that significant changes in lifestyle take place. This along with socio-cultural innovation could lead to completely new consumption scenarios (Manzini, 1994:37)."

These scenarios, according to Manzini, could be 'from consumption to care, from consumption of product to utilization of services, from consumption to non-consumption which are applicable for almost all kinds of design interfaces.

Formulated by the 'strategy' principle, the second form of design phenomena which is more radical is named as deep, Green or ecological etc. The design idea is radical and innovative. "The idea, more modestly, is to propose solutions which contain some spark innovation, where innovation means a new way of behaving or of viewing the world (Manzini, 1994:37)." This innovative or creative idea also possesses an outlaw character in this sense.

The emergence of this debate was due to crucial facts. The ecodesign is influenced by deep ecology. It borrowed ideas from this and the visions it provided were the headlight of the ecological design, which is more critical to society and its structural formation. It was influenced deeply by nature, possessed an internal ethic related to living beings and the ecosystems.

> "This new model of development will not be born on a drawing board, around a conference table as a perfectly complete theorem. It will emerge from dialogue and conflict among a multiplicity of ideas, visions and proposals. It will come into being thanks to a widespread atmosphere of innovation involving all those active in society. Therefore designers will undoubtedly play a part in the process... The design of material and products, projects and systems environment communities which are friendly to living species and planetary ecology (Madge, 1997:48)."

This necessitated a systems approach rather than an approach to individual products and or product systems. Life-cycle assessment, which were also named as 'from cradle to grave' or 'womb to tomb' had their places in the language of ecological design. The ecological worldview definitely brought a critical approach to production, consumption and the designing scenarios of the society. "The unquestionable merit of ecodesign consists in having articulated concerns which put into question paradigms of design and industrial production and consumption that we took for granted (Madge, 1997:54)."

2.3.3. Ecological Design Thinking

The theory and the strategies of ecological design are actually constructed on basic facts. Firstly any design has an impact on the environment in some way, because both the structure and the function of the ecosystems will change and there will the energy and material as input and output through the system. According to basic physic laws matter will not be created or diminished but will change from one state to another, so that the usability of energy is decreased and some part of the matter or energy or matter is lost. Ecological design's task is actually answering these questions, by goals defined by minimizing the impact of the system on other systems and also counteracting the unavoidable effects by other ways of design intervention cooperated within the designed system itself. Here it is important to note the methodology of the ecological design, which is to use nature and the idea of ecology and ecosystems as a basis for design. The term design with nature, which is advocated by authors like McHarg (1964), Van Der Ryn & Cowan (1996), Orr (1992), Todd (1992), McDonough, has a consequence at this point. Ecological design proposes strategies to act. It is interesting that there seems to be not one single theory of ecological design and there exits usually interpretations.

The definition of ecological design by Van Der Ryn & Cowan (1996) is given as. "Any form of design that minimizes environmentally destructive impacts by integrating itself with living processes. By placing ecology in the foreground of design, it provides specific ways of minimizing energy and materials use, reducing pollution, preserving habitat, and fostering community, health, and beauty (Van Der Ryn & Cowan, 1996:8)".

For example, Van Der Ryn & Cowan (1996) puts his design strategies as,

- Solutions grow from place.
- Ecological accounting informs design.
- Design with nature.
- Everyone is a designer.
- Make nature visible.

Another author Todd looks at nature and its processes as metaphor and reality and filters the knowledge of ecosystems and natural processes into the knowledge of design. Nancy and Todd John (1984), in their book, "Bioshelters, Ocean Arks, City Farming, Ecology as the Basis of Design" propose precepts for *biological design*.

- The living world is the matrix for all design.
- Design should follow, not oppose, the laws of life.
- Biological equity must determine design.
- Design must reflect bioregionality.
- Projects should be based of renewable energy resources.
- Design should be sustainable through the integration of living systems.
- Design should be coevolutionary with the natural world.
- Building and design should help heal the planet.
- Design should follow a sacred ecology.

One of the most important contributions ofTodds was the 'Living Machines' which meant the 'Advanced Ecologically Engineered System for Sewage Treatment.' The process of 'Living Machines' process is as such: the sewage is screened and degritted, and bacteria breaks down organic compounds in an anaerobic bio-reactor. The next stage is a continued breakdown by bacteria in aerated tanks. Diverse ecosystems of algae, protozoa, snails, fish and plants make natural and ecological purification processes in fluidized bed tanks. Accumulations are cleared and the waste reaches to marshes. The marshes as the last stage filter and clean naturally. The water purifies almost to a level of drinking water (Zeiher, 1996) Photo 2.1 shows an example of the 'Living Machines'.

Photo 2-1. An example of 'living Machines' (Source Zeiher, 1996)

Another architect and designer, William McDonough defines ecological design as the following:

> "If we understand that design leads to the manifestation of human intention, and if what we make with our hand is to be sacred and honor the earth that gives us life, then the things we make must not only rise from the ground but return to it, soil to soil, water to water, so everything that is received from the earth can be freely given back without causing harm to any living system. This is ecology. This is good design William McDonough (1993)."[10]

He has prepared a set of principles for sustainable design named 'Hannover Principles' and prepared for the Hannover, EXPO 2000 that is given in the last chapter. He also proposes an ecological theory of products. The products, building design and community design defined by McDonough should have three modes. These three modes are *consumable*, *industrials* and *toxic* products. Consumable refers to worn out products, which return to nature (natural, biodegradable material). Industrial means product that does not biodegrade so they must be in a closed loop system of recycling and reusing. The third category, toxic substance must not be produced.

Therefore, McDonough set principle of the redesign manufacturing as processes and products.

- Waste Equals food, which eliminates the concept of waste and the product with all its parts itself become food for future processes and products.
- Rely on current solar income
- Respect diversity. The notion of impact is crucial for ecological integrity and health of ecosystems and its component must be protected. "For a product, it means, where will I go and what will it do when it gets there?"[11]

John Tillman Lyle's interpretation of ecological design is the idea of regenerative design. He metaphorically and systematically makes use of ecosystems. He postulates the principles of regenerative design as the following (Lyle, 1994:37-40):

- Letting nature do the work
- Considering nature as both model and context

- Aggregating, not isolating
- Seeking optimum levels for multiple functions, not the maximum or minimum level for any one
- Matching technology to need
- Using information to replace power
- Providing multiple pathways
- Seeking common solutions to disparate problems
- Managing storage as a key to sustainability
- Shaping form to guide flow
- Shaping form to manifest process
- Prioritizing for sustainability.

Under the light of the varied 'approaches to the description of ecological design, we can form ecological design principles:

1. Understanding Ecosystems (Natural with relation to Human Communities)
    - Carrying Capacity
    - Understanding the notion of scale
    - Notion of place idea of human ecology
    - Community and cultural sensitivity. Diversity, equity
    - Ecosystem repair-, restoration or produce. Ecosystems.
2. Whole system thinking.
    - Cycling Systems
    - Multitask
    - Full-time lifetime of the product.
3. Understanding the design system as an environmental impact.
    - Minimization the impacts. On natural environment and larger community

- Principle of least effort
- Appropriate technology or needed technology.
- Energy efficiency, renewable energy…
- Resource efficiency, recycling etc.
- Questioning the need and demand
- Design for recovery of the impact at the same time

4. Design with nature:

- Use the technology of nature
- Working with the climate, soil, water and geology
- Notion of place as an idea of human ecology
- A sacred ecology, or ecological wisdom
- Healthy environment
- Manifest in the form
- Nature's geometry as a source for design
- Nature processes as a source for design
- Integrative and adaptive capabilities of nature are a source for design with nature
- Natural ecosystems as a basis for design
- Ecosystem processes as a basis for design
- Natural protection through design
- Naturalness and wilderness life is important
- Scale linking processes

2.3.4. The Notion of 'Design with Nature'

The notion of 'design with nature' existed as a myth for centuries but at the present time the phrase has artistic and scientific connotations and is a motto for ecological design principle. Design with nature as a modern principle of designing with an ecological consciousness and environmental responsibility first appeared with Ian McHarg's renowned book 'Design with Nature'. Later in the 1990's two known and practicing architects Van Der Ryn & Cowan (1996) and Yeang (1995) have also used the term extensively.

We see that the notion sometimes existed for a regional design process or for a building design and was also present before modern and premodern times. Organic design was another example of this, metaphors of nature were used descriptively and organic natural forms were imitated. Designing with nature meant to use nature or wilderness directly, or it meant to conserve the naturalness of an area or to integrate it with the surrounding environment. It also meant imitating natural forms within a design process. Ian McHarg brings a deep understanding of nature and man's actual place in nature and how this can be designed *with nature*.

In short, he summarizes his theory in the Preface to the 1992 edition of the book as fitness of the environment. The fitness of the environment involves two conditions.

- Syntropic-fitness-health
- Entropic-misfitting-morbidity and death

Between these two conditions there exists an oscillated phenomenon. The interaction of the users in any scale is evaluated in this theory. If the maximum needs of the users are compensated by the environment as found, bringing no changeable effect to the cycles then it is named as a fit environment. The contrary of this situation, where nature is disregarded with its values provides morbidity, which is to say unfitness. It can be noticed that the objectives of the theory of McHarg bring together a mutual understanding of man-environment phenomena. The fitness-health and unfitness-death conditions are both valid for nature and man in his own being and living and in his being and living together. Syntropy defines the continuity and adaptation of nature's use of energy and resources with no degradation but with recycles therefore providing sustainability. On the contrary, entropy points out a discontinuity and degradation. The phenomena are again valid for both man and environment individually and together. It is to this togetherness that McHarg has brought some definitions and propositions.

The first proposition is on the *preposition* used in the name of the book: **with**. "This preposition **with** implies human cooperation and biological partnership (McHarg, 1992:8).", writes Lewis Mumford in the Introduction of the book in the first edition in 1969. '**With**' defines the fitness of the environment and the mutual relation of man and nature as stated above. Design with nature for McHarg is to find the place of nature in man's world and a plan for man in nature. The attempt is clearly stated here again with its mutual understanding of nature; how nature and man can live together without harm. This phenomenon is an oscillating one. If nature is damaged or changed out of its normal paths and cycles, whether through impact or gradually, the effects bounce back at humanity in time.

From an ecological and evolutionary point of view he describes the earth as composed of four elements: carbon, hydrogen, oxygen and nitrogen and the recirculating cycles of these elements. Plants play the most important role in the cycles, he even claims that man is not a vital element in the cycles. Photosynthesis entraps sun energy and transforms it into material where the energy is degraded (entropy) but utilized in another life form or material (negentropy). This he calls creation. Plant eaters and the decomposers are the other elements of the cycles.

McHarg classifies any ecosystem in the world according to its evolution and retrogression state. From the beginning of the earth the state of life forms and cycles have evolved from a primitive state to complexity. On the world there are innumerous kinds of states, some of which are simpler than others and some more complex. Take the case of a tropic forest and the desert. The desert involves a simpler kind of ecosystem, which have less elements in the cycle and the process. On the other hand forests provide a more complex ecosystem with millions of life forms and elements in the cycles. The processes happening in the forest are different than those happening in the desert and the processes are revealed in form. Form in itself provides all the characteristics of the creation process.

McHarg is inspired especially in the process and form phenomena for the design of the nature with human beings, that is design with nature. The notion of design with nature implies the place of man in nature. The human beings can either be a permanent inhabitant, urban or rural or he can be a temporary visitor. If human beings can understand his phenomenological place in the world like the astronaut in the capsule in which the world is situated, then he will be fit in the environment and will be true-from maker or creator like nature itself. He names the last chapter 'Prospect' which is the *prospectus* for humans to live in the world. From the ecological viewpoint, every creature in the world, including man is physically linked to the origins of life and to all life and is ecologically defined as home or *oikos*.

> "In the quest for survival, success and fulfillment, the ecological view offers an invaluable insight. It shows the way for the man who would be the enzyme of the biosphere-its steward, enhancing the creative fit of man-environment, realizing man's design with nature (McHarg, 1992:197)."

A partnership with nature as explained by Van Der Ryn & Cowan (1996) design with nature is explained as such:

> "Evolution generates many levels of wholeness simultaneously, from the metabolic dance of a cell to the vast cycles maintaining the biosphere. These nested levels of integrity are sustained by their own characteristic patterns of health. By designing with nature, by working with these patterns of health, we may aspire to designs that are compatible with the living world (Van Der Ryn & Cowan, 1996:103)."

Van Der Ryn says "In order to successfully integrate ecology and design, we must mirror nature's deep interconnections in our own epistemology of design (Van Der Ryn & Cowan, 1996:8)." "...Ecological design is a result of our constructive engagement with nature. It reflects nature's underlying integrities, finding within them a new context for design (Van Der Ryn & Cowan, 1996:104)."

> "Nature is a matrix within which designs find an identity and a coherence that contribute to the health of the whole matching flow of material to the assimilative capacities of the ecosystem reserve critical habitat in every possible way respecting the patterns responsible for its continuing vitality (Van Der Ryn & Cowan, 1996:105)."

It is not just ecosystem protection but a cultural design that incorporates the value of nature in a culture be this culture a culture of community or of design.

David Wann's book 'Biologic' also is a concept of 'designing with nature'. "Biologic is applied ecology, and there's no way we can design things correctly without understanding the fundamental dynamics of natural systems (Wann, 1990:9)."He uses the term "biologic in order to denote learning from nature as an endless and multifarious practical information.

> "From an ecological perspective, it's also inevitable that we will progressively become more organized, more cooperative, and more ingenious because that's the way nature works. Natural systems move from disorganization and inefficiency toward balance and stability, and we're part of a natural system (even though we sometimes pretend we're above it all) (Wann, 1990:xi)."

Wann(1990) proposes several stages of the process of design in the overall sense ***knowing, choosing, designing*** and ***implementing.*** Thus **knowing** phase can include according to Wann:

- The functioning of biological, geological, chemical cycles to be able to predict where a given chemical released into the environment will end up.
- The limits and capabilities of ecosystems, including the limits of sustainable resource extraction. Sensible, sustainable design mandates that 'nothing lives at the expense of the source.'
- Knowledge of immunology, to prevent the catastrophic collapse of our overworked maintenance systems.
- The capabilities of microbes, which process most of the earth's "waste products". We need to confer with them before we invent anything, to get their approval.
- The functioning of the planets' vast weather systems, to predict rainfall, wind, and the dispersion of pollutants.
- The requirements and eccentricities of each individual species, for use as biological "road signs."
- How specific material behave under environmental conditions, such as moisture, pressure, heat and on so on (Wann,1990).

The second criteria of ecological design which is **choosing** could include the notion of desirability, such as:

Desirable	**Unacceptable**
Uses renewable resources	Energy, materials glutton
Little or no pollution in use or manufacture	Waste accompanies product use or manufacture
Reversible, recyclable materials and processes	One-time use, one-way processes
Diverse solutions to technical and social problems	Singular inflexible solutions.
Increases access to nature	Isolates from nature
Leaves natural systems intact and functional	Disrupts natural balance, causes ecosystem collapse
Increases social options	Decreases social options
Easily understandable	Understandable only by experts
Emphasis on quality, durability, specificity	Emphasis on quantity, brute force, appearance
Empowers indigenous cultures	Eradicates indigenous cultures

Designing phase includes imitating or learning and applying the nature compatible strategies from nature and he gives examples like strategies of cactus, compost, apples, rat, butterfly etc… The last phase implementing how the idea of biologic design could be infused into the cultures (Wann, 1990).

An Example: Architecture on the Dunes:

This example demonstrates the idea of designing with nature, where the concept of ecosystem and a response to its existence and importance is vital. The second chapter of the book provides an example of how nature can be recognized as a valuable source for man-environment relationships. He gives the examples of dunes (sand hills by the coast) and grasses which hold the dunes in place. When dunes exist, any harm from the sea in case of a tornado is decreased, so a natural protection is provided. He writes: "... and here is the first lesson. If you have dunes protect you, and the dunes are stabilized by grasses, and these cannot tolerate man, then survival and public interest is well served by protecting the grasses (McHarg, 1964:9)." People who use the land will go to the coast and may wish to built there, but if use for recreation and living is the subject, then there will be a basic code of prohibitions for human use.

The studied environment can be investigated for the tolerance and intolerance of various parts of the environment to human use. The formation and dune protection is both for its ecological characteristic, and for the protection of the terrestrial environment. McHarg demonstrates the formation of dunes and other ecosystems in relation with them and he defines human activities (Figure 2.14). McHarg states that the importance of the dune ecosystem and its integrity must be preserved. The fragility and the importance of the ecosystem and the passage through the dunes are a design problem. The ecologically sensitive design approach is formulated by a walkover design that responses to the natural environment. Designed by Jersey Devil Partners, The Natchez Street Pavilion, Seaside Florida is a 185-foot walkover that cross over dunes without interrupting the dune grass and sea oats, which hold the dunes in place (Photo 2.2. and Photo 2.3). Other features include using fallen trees from the region and self-sufficient lighting by photocells (Crosbie, 1994).

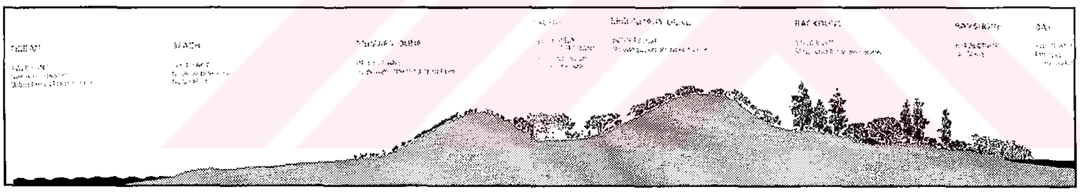

Figure 2-14. Dune Formation schema in 'Design with Nature' (McHarg, 1969)

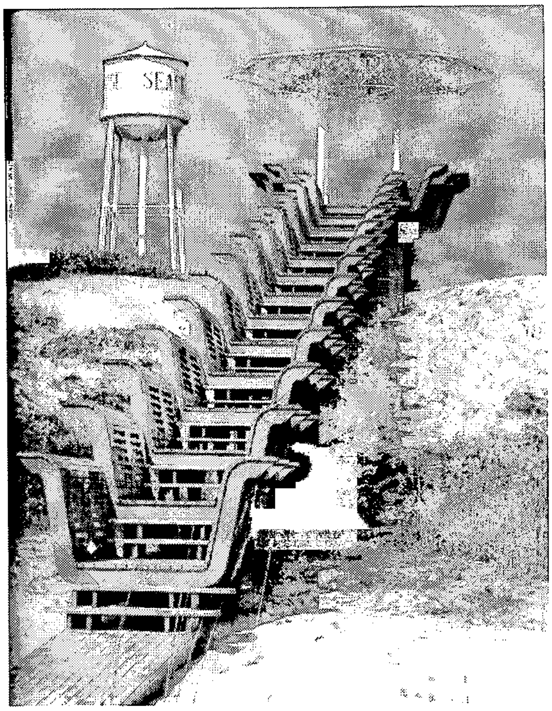

Photo 2-2. The construction of the Natchez Pavilion (Crosbie,1994).

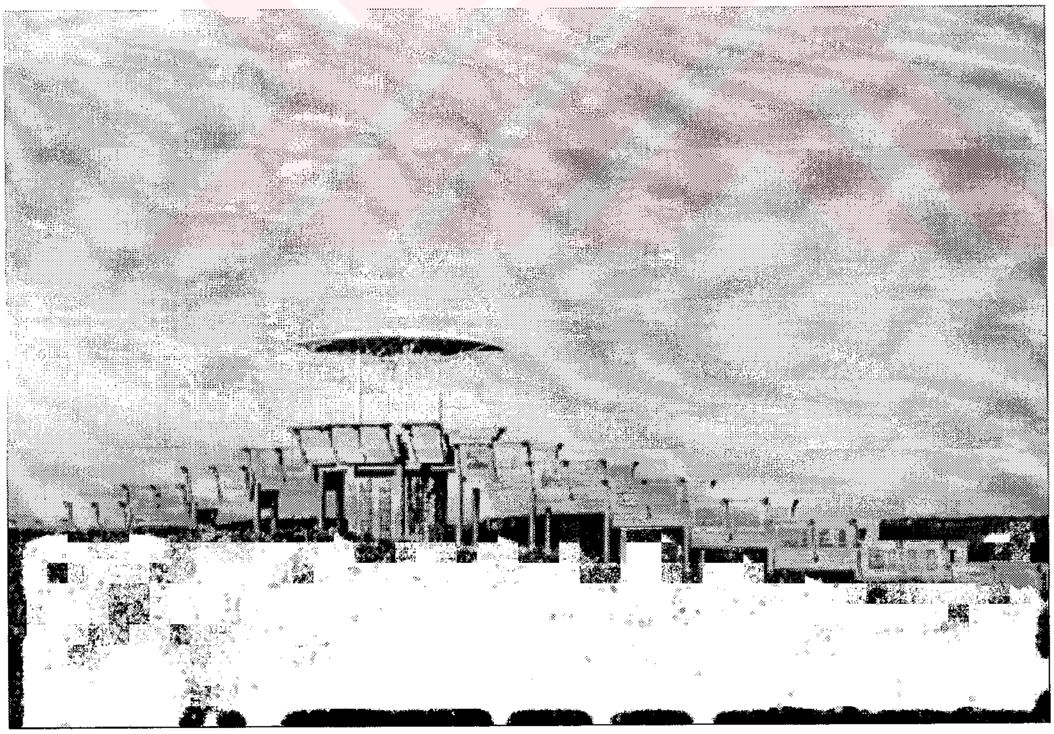

Photo 2-3. The Natchez Pavilion crossing over dune (Crosbie,1994)

2.4. Human Ecosystems

In order to understand and solve the conflicts and negative impacts of the duality of man-nature relations Lyle proposes a new definition of approach as 'human ecosystems'. Lyle bases his description of human ecosystem as an argument of Eugene Odum (Lyle, 1989). Odum compartmentalizes the total landscape into areas according to basic ecological roles, stating that "the most pleasant and safest landscape to live is the one containing a variety of crops, forests, lakes, streams, roadsides marshes, seashore, and waste-places- in other words, a mixture of communities of different ecological ages (Odum, 1969:267)."

Odum here presses the importance of the diversity of ecosystem or heterogeneity on the health of the environment and the aesthetic quality. Lyle(1985) adds to these arguments, houses, gardens, parks, playing fields, offices shops, etc. and classifies all land into four categories.

- Productive area where succession is continually retarded by human controls to maintain high levels of productivity.
- The protective, or natural areas where succession is allowed or encouraged to proceed into mature, and thus stable if not highly productive stages.
- The compromise areas where some combination of the first two stages exists.
- The urban industrial, or biologically non-vital areas. (Lyle,1985:15)

The third category which is described as *compromise areas* is what Lyle has named human ecosystems where nature and human ecosystems are integrated and the operation of life-support systems depend on the working of the two (Lyle,1985).

> "Our creation of new ecosystems has almost always been unintentional-that is, without conscious understanding of how natural processes work and therefore without any of predicting how the new e ecosystem would work, even without any comprehension of the fact that it was actually a system. Not suprisingly, then, without conscious control, new systems usually do not work very well (Lyle, 1985:16)."

Lyle argues that designing of human ecosystems must take into account ecological processes and find its interaction with human ecosystems.

> "The point is that if we are going to design ecosystems (and continually do whether we want to face all of the implication's or not) then it will be best to design them intentionally, making use of all the ecological understanding we can bring to bear. Only then can we shape ecosystems that manage to fulfill all their inherent potentials for contributing human purposes, that are sustainable, and that support non-human communities as well. Not every landscape can fully accomplish all there of these goals, of course, and thus Odum's term, "compromise There will always be conflicts to be resolved and priorities to be assigned. Intentional design means carrying out conscious choices. What are we trying to do, then is to gain a measure of control, not in order to dominate nature but to participate creatively is in its processes (Lyle, 1985:16)."

To participate creatively in the natural process and to do so with reasonable hope of success, we need to include as subjects of design not only the visible form of the landscape but its inner workings, the systems that motivates and maintains it. Natural systems are continuously self-organizing and we can draw upon the principle by which human ecosystems tend to be sustainable. Such an aim requires knowledge of these systems.

Design of human ecosystems is explained as giving form to physical phenomena at every scale. Lyle prefers design rather than planning to emphasize the physical form-shaping power of design. In any event, the term "design" carries the connotations of intention, precision, and control including emotional involvement (Lyle, 1985).

The ecosystematic orders are the components, locational patterns, structure and function of the ecosystem. Prerequisites for the human ecosystems' sustainability can be understood from Forman's model. It requires understanding the time scale and the spatial scale, keeping ecological integrity and finding the balance of basic human needs. Ecological integrity according to Forman depends on productivity, biodiversity, soil and water. Productivity refers to the productivity of natural habitats and related attributes such as biomass, animal production, length of food chains, herbivory and decomposition, etc. Biodiversity refers to community types, keystone species, rare species and genetic diversity. Soil is a measure according to the amount of soil erosion. Unsustainable land depends on wind and erosion. Water is the quality and quantity index.

Basic human needs are divided by Forman into six parts. Food, Water, Health, Housing, Energy and Culture. The matrix table below shows the ecological integrity and the basic human needs relationship (The direction of the arrow indicates that increasing one attribute has a major effect on the second attribute) (Forman, 1995:500).

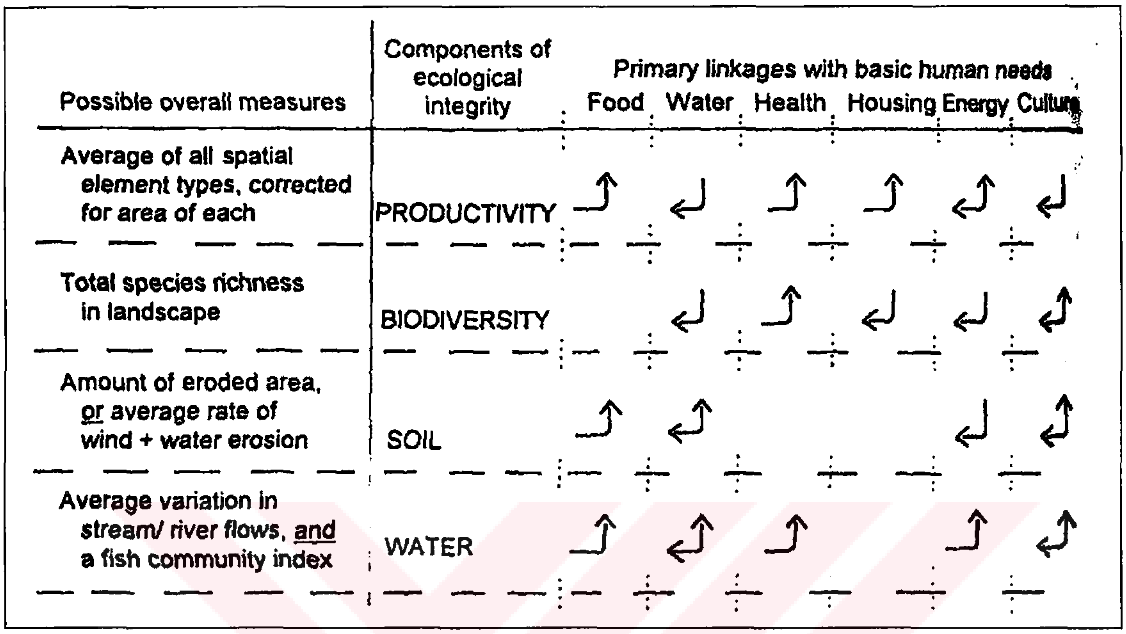

Figure 2-15. The Sustainability Matrix Provided by Forman (Forman, 1995:500).

Notes to Chapter 2

[1] Cicero, De Natura deorum (1st century BC) quoted in Crowe(1995)

[2] Anne Chislom, Philosophers of the Earth. Conversations with Ecologist (London, 1972), quoted in Bramwell (1989), p.6.

[3] Harriron, C.M. and Burgess, J. (1994) 'Social constructions of nature: a case study of conflicts over the development of Rainham Marshes", Transactions of the Institute of British Geographers, New Series, 19, 291-310; Quoted in Pepper (1996).

[4] Jeans, D. (1974) 'Changing formulations of the man-environment relationship in Anglo-American geography, *Journal of Geography*, 73(3), 36-40; Quoted in Pepper, 1996, p.6.

[5] Ibid.

[6] Pirages, Dennis,(ed.): The Sustainable Society, New York 1977.

[7] Tekeli, İlhan, Sürdürülebilirlik Kavramı Üzerine İrdelemeler, Unpublished Conference Report, 1997, translated by the thesis author.

[8] Hardin, Garret, 1968, "The Tragedy of the Commons", Science, 162, 1243-1248.

[9] Churchman, C. West, 1979. The Systems Approach and Its Enemies: New York: Basic Books.

[10] Quotation from Design, Ecology, Ethics and the Making of Things
A Centennial Sermon delivered by William McDonough at The Cathedral of St. John the Divine in New York City on 7th February 1993.

[11] McDonough, William, Article from the Greenmoney Journal-Summer 1997 Issue.

CHAPTER 3

ECOLOGY, SUSTAINABILITY and ARCHITECTURE

According to the theoretical background formulated previously, architecture as a discipline has a key role in the survival of humankind and of the earth. Such a proposition of sustainability brings us to understand the ecology of architecture and creates the need for the adjustment of design to ecological premises. This chapter includes the discussion of the architecture of ecology or sustainability and refers to both historical (unself-conscious and self-conscious[1]) architecture and to the present designed world. Actually the unselfconscious and the self-conscious still go side by side.

The first section of the chapter makes a survey of the history and the present, with the denotations of the future, and brings out the positions within which society and designers stand against the ecological critique. The second part tries to define the characteristics of the architecture of ecology with the basis of the discussion made in the theoretical background and the survey of the architecture of ecology. The third part includes the case studies discussing the related issues and notions.

The products of the architecture of ecology usually different and varied in different places. This is primarily because of its special characteristics of the cultural and technological constructions of the design issues which will be discussed in this chapter. One may view these differences within the movement of ecology in achitecture as differences of attitude or one may see them as several stages of development of design. As previously stated by David Wann (1996), this is interpreted as 'fine tuning' to design and deep design. The architecture of ecology is an experimental architecture and these experiments are conducted by many architects around the world. These experimental atitudes and the characteristics of the architecture of ecology and/or the architecture of sustainability is the basis of this chapter.

3.1. Ecological Problems of Architectural Design

The environmental design phenomenon is not a new thing. It is as old as man is his history. The link between nature and human culture will always exist. Basically it is the form and the processes which have changed. Just as the problems of sustainability, architecture also has its own problems or crisis too. The problem of architectural design and sustainability relates to technical as well as a philosophical understanding. The scientific understanding of ecology and systems theory together may help to create an architectural language of ecology and sustainability together with the cultural necessity of constructing the links with nature. So the architecture of ecology is a matter of technical, economical, social as well as aesthetical, phenomenological, philosophical and ideological issues.

To be practical in thought, seeing the crisis of sustainability in architecture having close relationships and links to the crisis of sustainability in the total structure of humanity is not a wrong attitude. The general crisis was discussed in the 'Theoretical Background'. Architecture also as a phenomenon of its own and as part of the specific and total design discipline of humanity has reasons of its own ecological crisis. This is not a single unique phenomenon and the occurrence of the architecture of ecology is due to the technological, economical, cultural, aesthetic attitudes of society and due to ethical attitudes of different societies, groups and professionals.

However, most historical developments and current practices reveal that architecture generally follows an unsustainable path. The problems of architecture in relation to ecology and ecosystems appear in various scales from global to micro levels. Architecture which is termed as human ecosystem in this thesis, by nature of this new description constructs a relationship with the broader and finer ecosystems and ecologies. The concept of ecology stresses the cultural social and political aspects in architectural design.

The notion of impact is of crucial importance in the design of the built environment. The impacts of the stages of development in the built environment are listed in Appendix A. All the physical impacts may have functional and physical constituents but for the systems view, these designed systems produce cultural correspondences which have been called designed abstract systems. It might be wrong to differentiate amongst these because they are interwoven. Therefore although architecture may posit problems for building and construction, these nevertheless have cultural, aesthetic social and economic responses.

The architecture that has ecological implications or which is eco-sensitive has three main categories according to the book 'Green Development' (Wilson, et.al.,1998). These are:

- environmental responsiveness (respecting the site and the living inhabitants that is altogether the ecosystems in relation and contact)
- resource efficiency(energy and material contents)
- community and cultural sensitivity.

The notion of human ecosystems is a valid term. The earth can nowhere be devoid of humanity. If not physically (that is visibly out of scale), it is ecologically tied. At the beginning of such an age, architecture as one of the main catalysts of society is seen as the saver of the situation humanity has pushed itself into. The problem of letting living beings become extinct from local and global earth, the housing of the increasing population and the hard world of creating the awareness of the environment and its limitations and the adaptation and integration of humanity and nature is the overall task of the architect.

The existence of architecture has inevitably an impact on nature. But what is important is to adapt human communities to natural surroundings or in other words create a 'second nature', in which all scales of concern have sustainable qualities. The conflicts that are created will be solved within the systems own regulative and assimilative capacities. But the relationship between architecture and nature has not always been problematic. For example vernacular architecture stands in a position that has a positive value of environmental design. Thus vernacular architecture is a product of pre-industrial society where the dilemma of man-environment relationships were not in great scales. But traditional knowledge is place dependent and has evolved through time; this long experience is valuable for design decisions.

Architecture as another aspect of environmental crisis is also caused by the problems within the profession itself. As stated by Robert Berkebile, the profession of architecture is not coherent with ecological world. "We have gradually reduced what we do, the service we provide, to making images; building as object, divorced from its neighbourhood, from its environment, ignoring the fact that it is, in fact, a part of nature[2]."

One other problem of architecture is observed in its being a product of the global culture, which neglects the local values of communities and natural surroundings. :

> "In so far as they help to shape the environment, all development plans involve an element of global design. In the same way, the general form and quality of a region's architecture is also largely shaped by favored development strategies, having direct and lasting effects on the choice of settlement patterns, building types, technologies and modes of production. The personal and social alienation associated with the introduction of unsuitable building forms and methods in developing countries is accordingly symptomatic of a wider loss of local control over the economic and cultural forces that presently affect all aspects of the environment in those regions. It would be unrealistic, therefore, to expect a general improvement in the quality of building without prior changes in these influential factors (Abel, 1997:202)."

According to the book 'A Primer On Sustainable Building', that architecture can play a sustainable role by sustainable building against the problems of the environmental dilemmas, which some of its common rules are listed below. (Barnett and Browning, 1995:5):

- Make appropriate use of land.
- Use water, energy, lumber and other resources efficiently.
- Enhance human health.
- Strengthen local economies and communities.
- Conserve plants, animals, endangered species, and natural habitats.
- Protect agricultural, cultural, and archaeological resources.
- Be nice to live in.
- Be economical to build and operate.

3.2. Precedents of Ecological Architecture

Throughout the history of architecture and within patterns of human settlements, the dilemma between nature and humanity is always apparent. On the other hand, we also see the partnership of nature and humanity in various places and buildings. Ecological design, by its nature and as stated by Orr (1992), is also dependent on past knowledge. One important character of this knowledge is that there is always a mutual dependence and interrelatedness with nature and natural surroundings. Whether existing as a myth and/or a functional, economic, social or aesthetic necessity, a relation with nature in terms of protection for survival (bioethic theme) or mutual, material and cultural dependence (self-reliance theme) is observed. So in some way ancient people were the early intuitive ecologists of human history, and have left a considerable amount of knowledge to be observed and taken for granted. The ecological design conception of organicism also has strong ties with organic architecture. The third is the idea of regionalism, which is also extended, in ecological theories as bioregionalism. The bioregional patterns and scales are of importance.

This part of the chapter will somewhat concentrate on the history of ecological architecture. Ecological architecture or the architecture of sustainability has relations with primitive and vernacular, organic and regional architecture and environmental art. Among these, organic architecture has its roots within the organic tradition of 19th century and extends to the Modern period especially with Frank Lloyd Wright and Alvar Aalto. The organic legacy continues with hi-tech architecture, which finds a related ecological statement. Also the emergence of environmental art, which is more concerned about and critical with ecological relationships of the whole earth, the landscape and human beings, therefore of human ecosystems, has important consequences. The first one is that most environmental art is landscape architecture that has a spatial interaction with the environment for the use of human beings, secondly it focuses on the critical relationships of perceptual and aesthetic value systems of human ecosystems. So the study of this section will involve the historical relationships of ecological architecture with the following titles for a goal of producing knowledge for ecological designers of sustainability.

> "The overall goal of green building design is quite simple: you want to design a wonderful building – a building that is bright and well-lit, that is warm in winter and cool in summer, that is as comfortable as it is healthy, that is energy- and resource efficient, that is functional and long-lived, and that promotes the well being of its occupants and the earth (Barnett and Browning, 1995:13)."

3.2.1. The Legacy of the Primitive and Vernacular Architecture

This section makes an inquiry into the characteristics of primitive and vernacular architecture, into both the indigenous architecture or architecture without architects and the interpretation of the vernacular that architects have designed. Again the two concepts, the bioethical theme and the self-reliance theme can be traced within history. The inspiring character of the vernacular house is due to the simple functionalism that it incorporates.

The primitive or vernacular architecture observed from the critical ecological view reveals certain qualities that are ecological. The relevance of vernacular architecture is both to understand the universal relationships of the environment and the habitat and the hidden systematic approach of unselfconscious design. The qualities of the vernacular in terms of considering the built environment can be interpreted as in the below items.

I. The balance between the density of human use and the natural systems' assimilative capacities. As an example to this we can cite the settlements in Anatolia, where density is obvious in fertile or habitable regions and where settlements are spread less densely in difficult zones.

2. The understanding of the relationship between the climate and the configuration of buildings and settlements. Again examples from Anatolia would be the roof terraces in hot arid zones, for night use, or the elevation of the buildings from the ground where there is humidity, like the old Greek houses in the Aegean coast of Turkey.

3. The use of natural materials and their assemblage methods. The use of natural materials such as earth-adobe, plants-reed, straw and wood are examples in their biodegradable and ecological character.

4. Environmental knowledge exists as myth and regulates unselfconscious processes. Feng-Shui, the Chinese knowledge of placement of buildings and settlements and the natural environment, is an example of this.

3.2.2. The Legacy of Organic and Regional Architecture

In the building activity the relation to nature and to the environment is a permanent fact. In certain periods this relationship has emerged as a design approach through interpretations of some architects or architectural movements

The main examples can be cited as Wright's **organic architecture** or Steiner's antropomorphic architecture. In the history of such an architecture realized consciously, Bruno Taut, John Ruskin, Victor Horta, and Henri Van de Velde, and Gaudi were examples who tried to interpret the phenomena and building design in corresponding terms. Victor Horta, Van de Velde, Gaudi and Mackintosh were also part of the **Art Nouveau** movement, which expressed values, related to nature. They used forms of organic processes, usually metaphorically. This always had ecological implications, especially from material and aesthetic aspects.

Besides organic architecture and Art Nouveau, **Regional Modernism** such as expressed in the work of Alvar Aalto, has also conveyed values that are congenial ecologically. Regional architecture's ecological qualities are derived from its care for the environmental values of the sun, light, wind, heat, material etc. Also the cultural and traditional values of the region is reflected.

One important thing to note here is Forman's description of the relationship of human perception and the regional scale. Forman states that the regional scale is the scale that human communities are able to conceive and interpret. According to Forman, human beings are not capable of fully comprehending and coping with broader scales (Forman, 1995)

3.2.3. The Importance of Environmental Art and the Critique of Environmental Perception.

With the emergence of a new consciousness about the ethical dimension in human or culture/nature relations the aesthetic perception of the environment took on new meanings and developed new relationships. For example, the concept of the ecosystem considering the abiotic constitutents of the environment as crucial for the system, has created the attitude that the forms and qualities of non-living matter such as stones have both aesthetic and existential value. This has opened the way for artists to respond to environmental issues.

One claim is that even the artists follow the path of the two assumptions of this thesis, the idea of being ecological (the bio ethics) and the functionings of the systems, or the emergence of the self-reliance theme. As an example one can cite Beuys' sweeping of the city of Berlin as a criticism of the functioning of the city.

There are also examples which take architecture as an environmental critique, such as the Herb Greene House. This House built on the plains where once the buffalo lived and the form of the house takes the form of the buffalo, where it is the symbol of an environmental critique over humanity's abuse of the environment.[3]

Artists have taken the position of critics but also through their constructive efforts, such as creating environments to attracts birds that have deserted a place, or cleaning up a river by giving it new forms, or restoring destructed habitats, have assumed a builders role. [4]

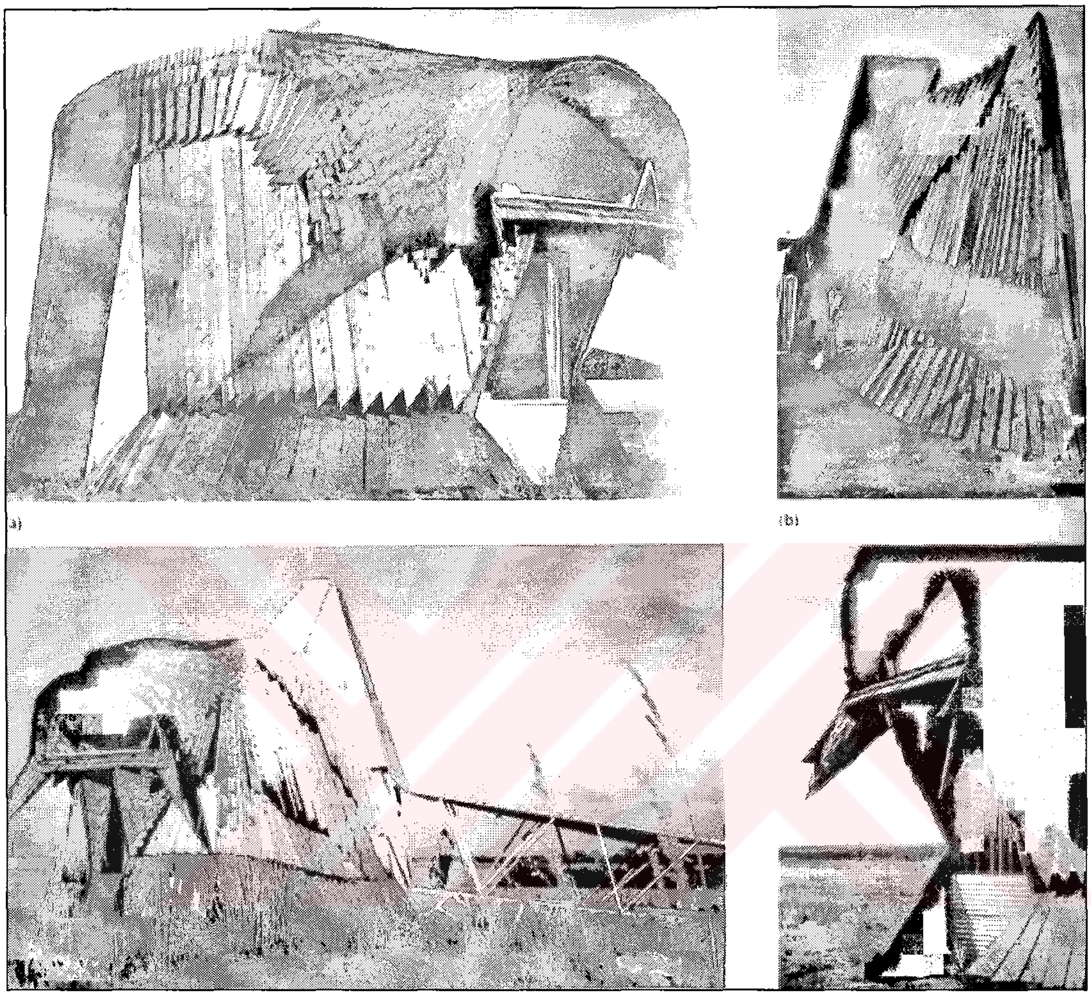

Photo 3-1. Views of the Herb Greene House

3.3. Current Positions of the Architecture of Ecology

The concern for sustainability in architecture has formed one of the main contemporary responses to environmental problems and environmentally conscious architects have taken critical positions that can be categorized in the following statements:

Although contemporary architecture has taken a self-conscious issue with ecology, one should not forget that for primitive and vernacular architecture ecology was intuitively a primordial care.

1. More concern for human well being to be effective in the design of the built environments (health, participation, equity, and community sense).

2. More concern for nature in design, (wildlife, flora and fauna, natural forms and processes to be safeguarded and aesthetisized).

3. New ecosystems to be created with new technologies, (Biosphere II, in Arizona and Nicholas Grimshaw's Eden Project St. Austell, England can be cited as important examples)

5. To create an architecture appropriate for the green/Green movement, (Audubon House, Rocky Mountain Institute, The Body Shop, Natural Resource Defence Council in New York) It is seen that architecture too, like other design disciplines has a parallel path with the environmental movement, that it shows the two basic attitudes, technocentricism, and ecocentricism. Besides that it provides some important signs of evolution strongly related with the spirit of environmentalism.

6. Architecture that strives to be part of a broader context of environment that is physically interconnected and interdependent.

7. Architecture that challenges social and cultural values, which, under modern conditions can be detrimental to ecological balance. (e.g. the culture of consumerism)

8. Architecture and art which is used to teach environmental awareness,

9. Reveals the particular ecological attitudes of different cultures, (each culture and people will create a design appropriate to their social and environmental values)

10. Rethinking nature – as building element – James Wines and SITE's projects that infuse natural environment and the building environment to each other.

11. Nature as basis for architecture – New Organi-tech (Santiago Caşlatrava's architecture, such as Lyons Airport TGV)

12. Architecture as restorer – revitalizer (Audubon House, N.Y.)

13. Architecture as part of a larger whole (The Real Goods Center, Ca.)

3.3.1. Global and Institutional Responses To Ecology of Architecture (Sustainable Architecture Politics)

The Global responses to architectural design first came from the Agenda 21, the document of the 1992 Rio Summit, a complex document with 40 sections, 120 program outlines ad 1000 proposals.

> "Humanity stands at a definition moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health, and illiteracy and the continuing deterioration of the ecosystems on which we depend for our well being. However, integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own, but together we can in global partnership for sustainable development (Steele, 1997: 8)."

Steele summarizes the subject areas from the report:

- The quality of life on the earth
- Efficient use of the earth's materials
- The protection of our global commons

- The management of human settlements
- Chemicals and the management of waste
- Sustainable economic growth. (Steele, 1997).

Corrective measures of report implemented by Steele (1997) against the problem of the development of the built environment include:

- The use of local materials and indigenous building resources.
- Incentives to promote the continuation of traditional techniques, with regional resources and self-help strategies.
- Recognition of the toll that natural disasters take on developing countries, due to unregulated construction and use of inadequate materials and the need for improvements both in use and manufacture of materials and in construction techniques as well as training programs.
- Regulation of energy-efficient design principles
- Standards that would discourage construction in ecologically inappropriate areas.
- The use of labor-intensive rather than energy-intensive construction techniques
- The restructuring of credit institutions to allow the poor to buy building materials and services
- International information exchange on all aspects of construction related to the environment, among architects and contractors, particularly about nonrenewable resources
- Exploration of methods to encourage and facilitate the recycling and reuse of building material, especially those requiring intensive energy consumption in their manufacture.
- Financial penalties to discourage the use of material that damage the environment
- Decentralization of the construction industry, thorough the encouragement of smaller firms.
- The use of "clean technologies".

The responses of these global actions for sustainability affected architectural institutions such as UIA. In 1994 UIA presented a declaration for the sustainability in the UIA/AIA congress of Architects, in Chicago, 1993 [5] The Declarations is in Appendix B.

One interesting point of the debate was that several architects and architectural firms have put forth their own guidelines and their own declarations. William McDonough is one example, whose Hannover principles are given in Appendix C[6].

3.4. Characteristics of the Architecture of Ecology

It is the affordances of the environment with the physical qualities that has created meaning through time by its inhabitants that the ecological designer has to know. This requires a dialogue between the designer and the land, the designer and the culture. "An ecological solution always is very specific answer to the needs and the resources of a specific area. Wind, water, sunshine, soil, plants, buildings, settlement pattern, history, social preferences, cultural heritage and others (Kennedy, 1992,48)."

> "A broader health concept, increasing environmental awareness and the wish to formulate one's life individually and organically is at the heart of ecological building. The demand that architecture shall look after and promote the health, comfort and well-being of people by using environmental and resource -saving design forms part of the program of ecological building (Eble, 1992:50)."

Eble states four lines of development towards a humane and environmental architecture.

- Environmental building takes account of natural, material living conditions by protecting the environment. This means that building shall be in harmony with the natural cycles.
- Building biology primarily promotes people's health. The building is regarded as man's third skin.

- The sensory motive for building studies sensory experiences and the human organism on the basis of an anthropological approach. Architecture is regarded as a source of sensory experience and mental development.
- Finally, the organic motive for building, whose architecture is oriented towards artistic building, addresses our bodily-mental spiritual existence. It places man's perception of himself at the center of architectural understanding.

According to Eble it will be new architecture but it will preserve regional, historical, and cultural features.

> "It must be based on the insight that it is impossible to distinguish between ecological and social responsibility. Art is an element, which unites these. It must architecture as a meeting place in the human sensory world. Its building blocks are nature, culture, the environment, and building which, when examined from different angles, are realized to constitute a single entity to be perceived through and by the senses as a living diversity. This is essential in order that we may through our everyday experiences again become " ecological" without being forced to it (Eble, 1992:50)."

Architecture has an important place in the idea of the ecological world, with its physical, biological and cultural realities. If architecture chooses the way of ecological understanding, with the bioethic and self-reliance themes varying according to places, landscapes and people, but their ecological integrity being kept as premium. Then architecture can function as an ecological system, which can be termed as "ecological functionalism".

> "Today ... I cannot imagine any other desirable view of the future than an ecologically adapted form of life where architecture returns to early Functionalist ideals derived from biology. Architecture will again take root in its cultural and regional soil. This architecture could be called Ecological Functionalism ... this view implies a paradoxical task for architecture. It must become more primitive and more refined at the same time: more primitive in terms of meeting the most fundamental needs with an economy of expression and mediating man's relation to the world ... and more sophisticated in the sense of adapting to the cyclic systems of nature in terms of both matter and energy. Ecological architecture also implies a view of building more as a process than a product. And it suggests a new awareness in terms of recycling and responsibility exceeding the scope of life. Is also seems that the architect's role between the polarities of craft and art has to be redefined ... After the decades of affluence and abundance, architecture is likely to return to aesthetics of necessity in which the elements of metaphorical expression and practical craft fuse into each other again; utility and beauty again united (Juhani Pallaasma,1993:pp.74-9)."

3.4.1. Choice of Technology

As in the following criticism made by Rayner Banham, the history of architecture generally ignores architecture's dependence on technology.

> "Yet, however obvious it may appear, on the slightest reflection, that the history of architecture should cover the whole of the technological art of creating habitable environments, the fact remains that the history of architecture found in books currently available still deals almost exclusively with the external forms of habitable volumes as revealed by the structures that enclose them (Banham, 1969:12)

The current practice of environmental design follows two paths. These two paths more or less follow the description of Orr's (1992) definition. Sustainable design's two paths are, in a way, determined by technology. The question of which one is more ecological is left to the conclusion, but we see that the language of environmentally sensitive has both the tech-driven and nature driven approaches (Figures 3-1 and 3.2). This kind of differentiation runs parallel with Orr's separation of technological and ecological sustainability. The definition of ecological architecture is then used to denote which uses the nature driven method and which is trying to act more passively.

> "Ecological building means applying technical aids sparingly and making the mot of all passive means provided by the building's fabric. Here, developments in structural engineering and construction in urban areas building form and orientation play important roles. To help better understand certain climatic, aerophysical, and technical processes and functions, the basic principle of these fields are made easily accessible, laying a foundation of information to begin drafting new designs. The measures employed in ecological building are complex and derive from several specialized disciplines – from urban planning, architecture, construction, and façade design to active technical building services and their applications. Planted surfaces, indoor and outdoor, fresh air, soil, water, and rainwater all contribute to an integrated design as does the management of building services and utilities that use the abundant resources of the environment (Daniels, 1995: 7)."

He is right at one point that ecologically, the ecosystem has to find out to a balanced energy and material flow, while the mechanical systems have to be hardware dependent. Passive does not mean that what it does is 'passive'. But that it tries to adapt to the activity of nature with less effort and minimized interruption than other systems.

Therefore a maximization minimization optimization of active and passive systems is dependent on the environmental values given by the exterior environment and in relation to the choice of the hardware. The implications of this hardware understanding were given in the design of the spaceship. The motives behind the choice of technology are thus ethical and social and also aesthetic in this sense. The economical issue is also as important as the technical. The green buildings most critical point is that it necessitates a high income at the initial part but pays back in the later period.

Here the problem of the so-called tech-driven ecological architecture, which runs with the flows and natural process, is thus economical benefiting from the economy of nature. One more hardship of ecological design is that it asks for a greater analysis of the environment. The design system in turn cannot watch the problems of ecological designs, because the economic social structure runs through a fast moving mobilized star. But nature is slow and cultures of ecological significance like the vernacular are slow and long evolving. This is a dilemma that architecture has to answer for the future. And this dilemma will continue to be one of the major problems of architecture.

The two modes of sustainable architecture or the architecture of ecology are categorised and illustrated in a magazine article[7] by Croxton Assoc., which is an architectural firm that makes sustainable practise extensively (Figure 3-1 and 3-2).

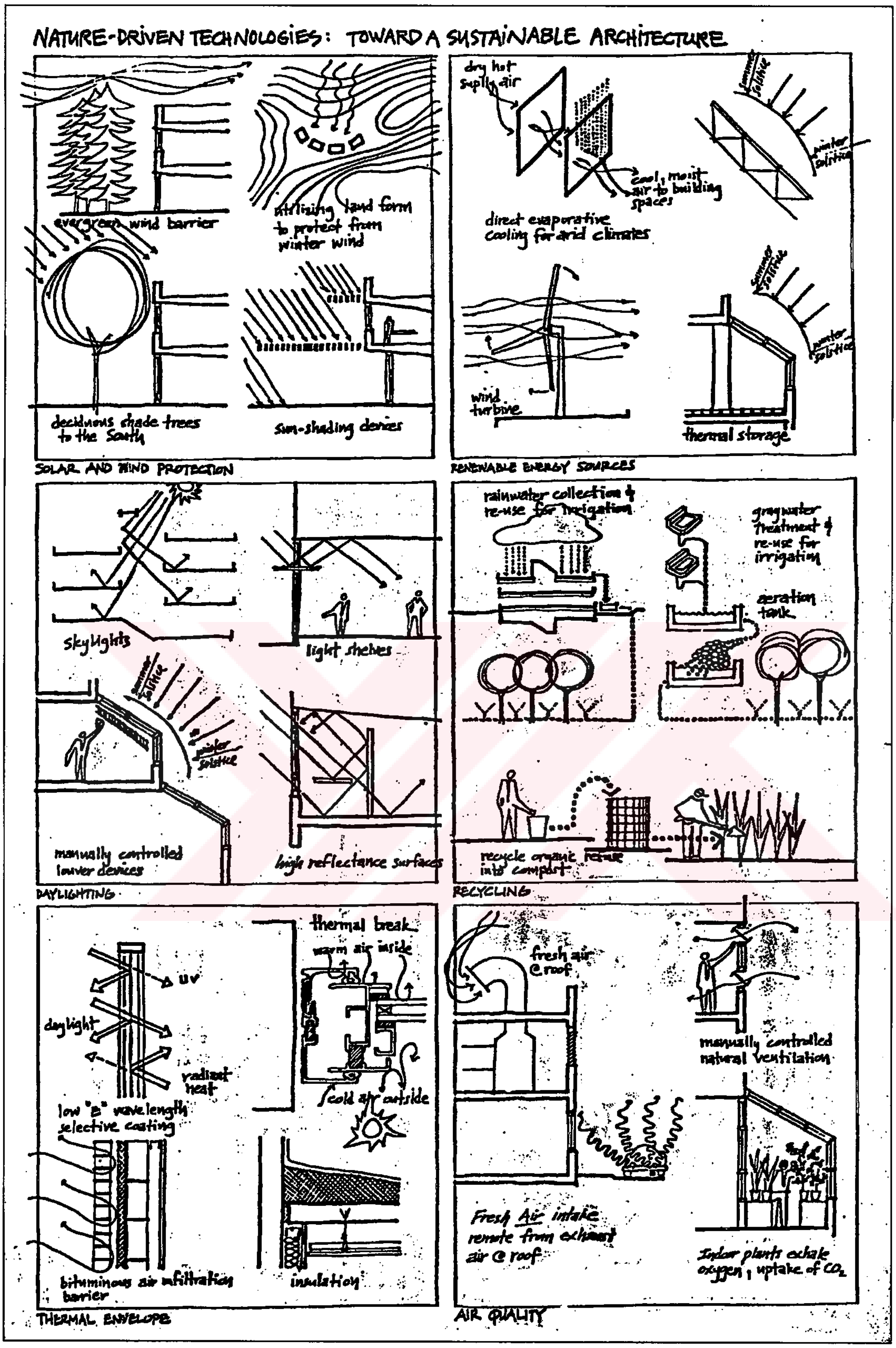

Figure 3-1. Nature Driven Technologies

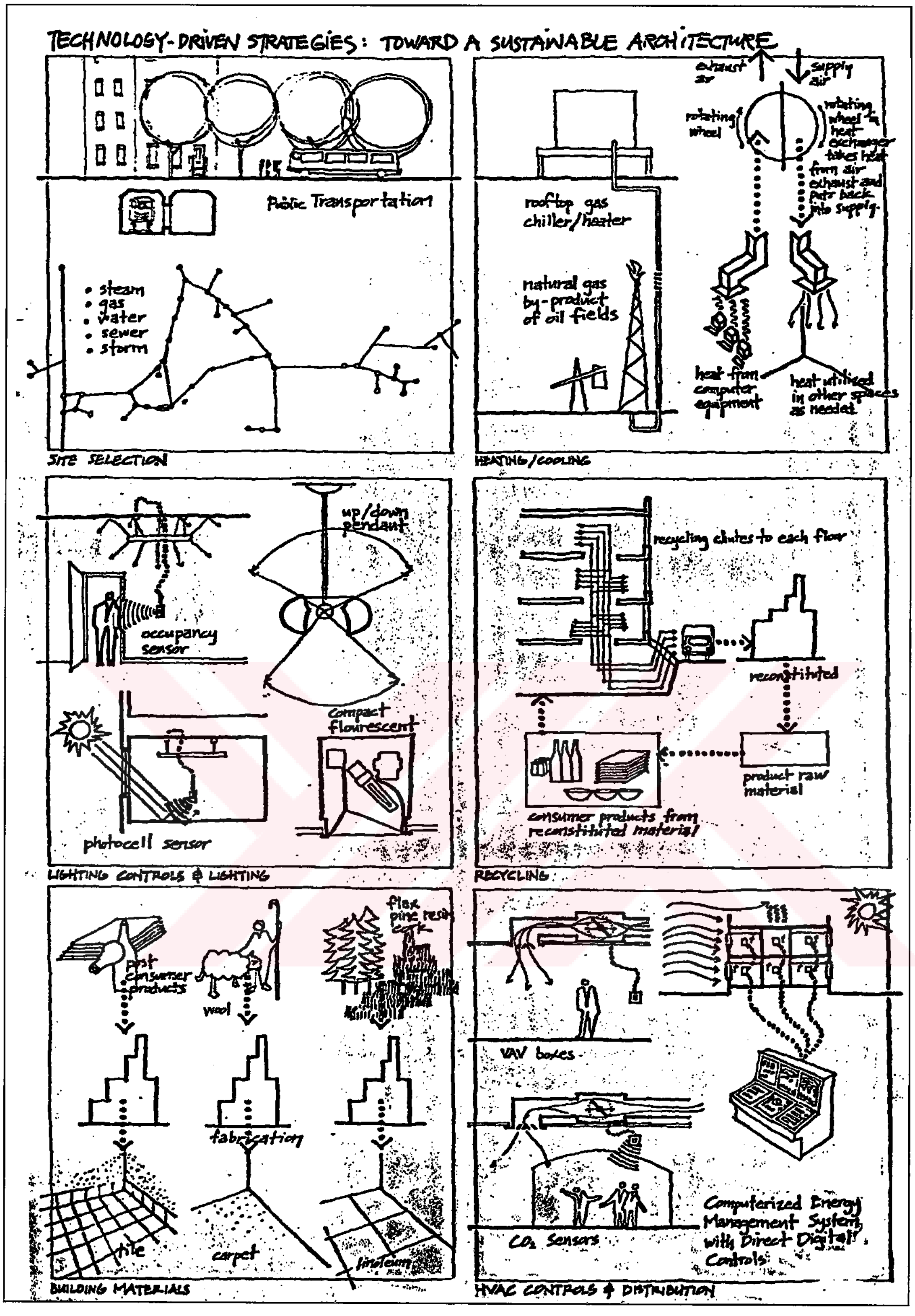

Figure 3-2. Technology Driven Strategies

3.4.2. The Climatic Imperative

The climate as a context and a locational pattern is valid for all ecosystems and its determinants. The climatic approach is also valid for the human ecosystems naturally and the importance of the climatic approach for architectural design is well known. The climatic imperative for ecological design in architecture is crucial. Therefore this chapter will try to explain the climatic dependency of the buildings and architecture as human ecosystems and try to show the structural, functional and locational relationships.

Climate first can be interpreted as the climate can be explained in terms of scale of the ecosystem. These are the macro, (meso (rural or urban) and microclimate levels. While at broader levels the intervention of humans may be to adapt and at the microclimatic (outdoor spaces and indoors) levels to modify. The climatic design needs to involve with the locational patterns of sun's radiation, wind pattern, topographical formation, water and air bodies and other natural ecosystems' effects on the climate.

For human ecosystems the bioclimatic chart (Figure 3-3) is the representation of the human comfort measure and the extent of his need for shelter and comfort. It determines the mechanization and other energy issues; it is vital to note here its ecological importance. The climatic response is a product of human metabolism where it is a function of physiognomy but at the same time, of delight.

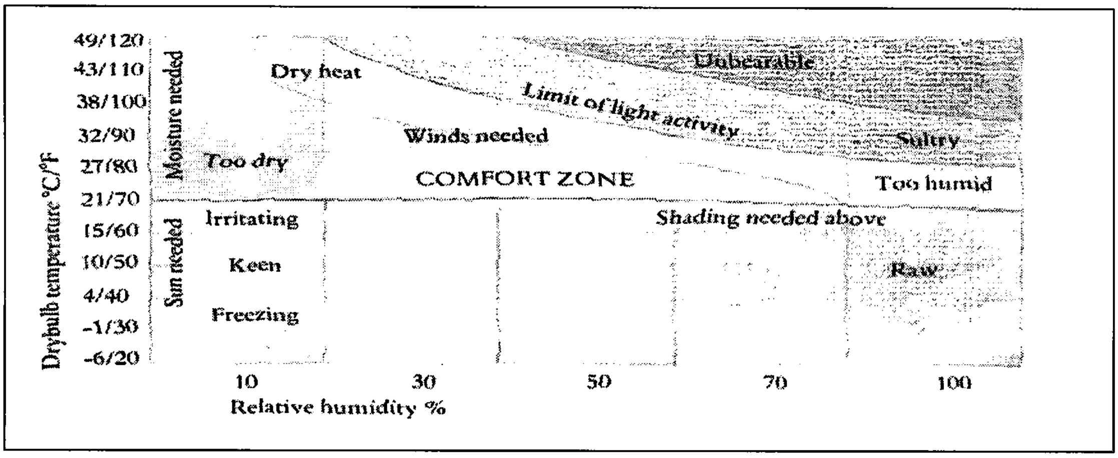

Figure 3-3. The bioclimatic chart

The explanation of the climatic dependency and characteristic is well formulated by Yeang (1995) and shows the structural, functional and locational relationships. Yeang starts his climatic analysis for the global scale, which are determined by four climatic zones: tropical; arid; temperate and cool (Figure 3-4). The methodology of Yeang refers to the study of these four characteristic climatic zones and is derived out of the structural and functional relationships between these zones and the building (or designed system in general). Figure 3-5 also gives the annual precipitation in the global context.

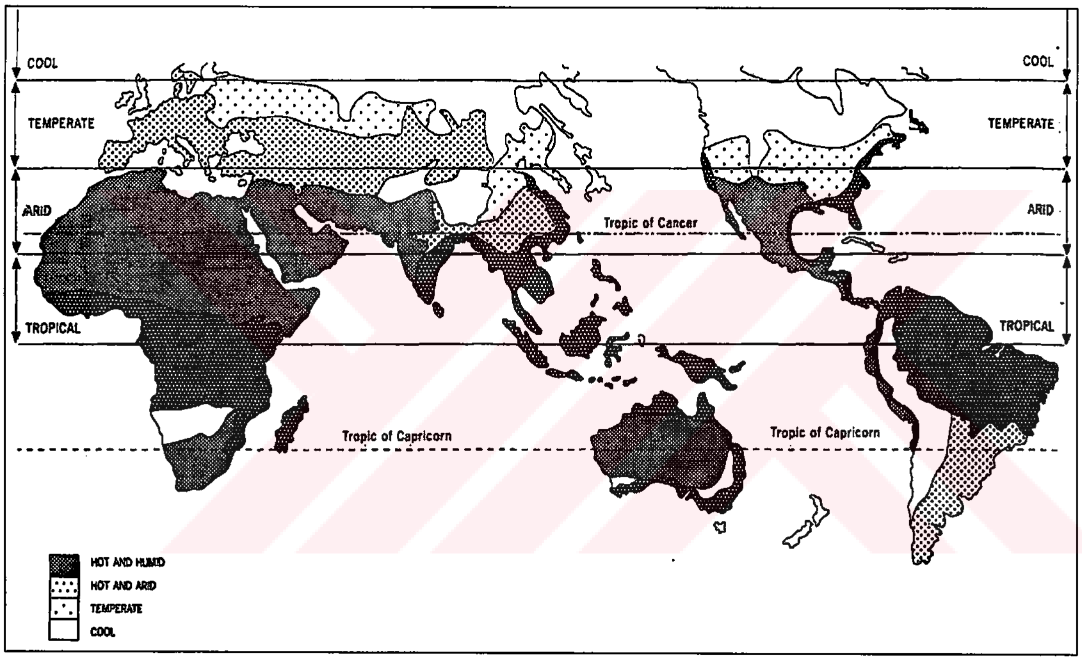

Figure 3-4. Four major climatic zones

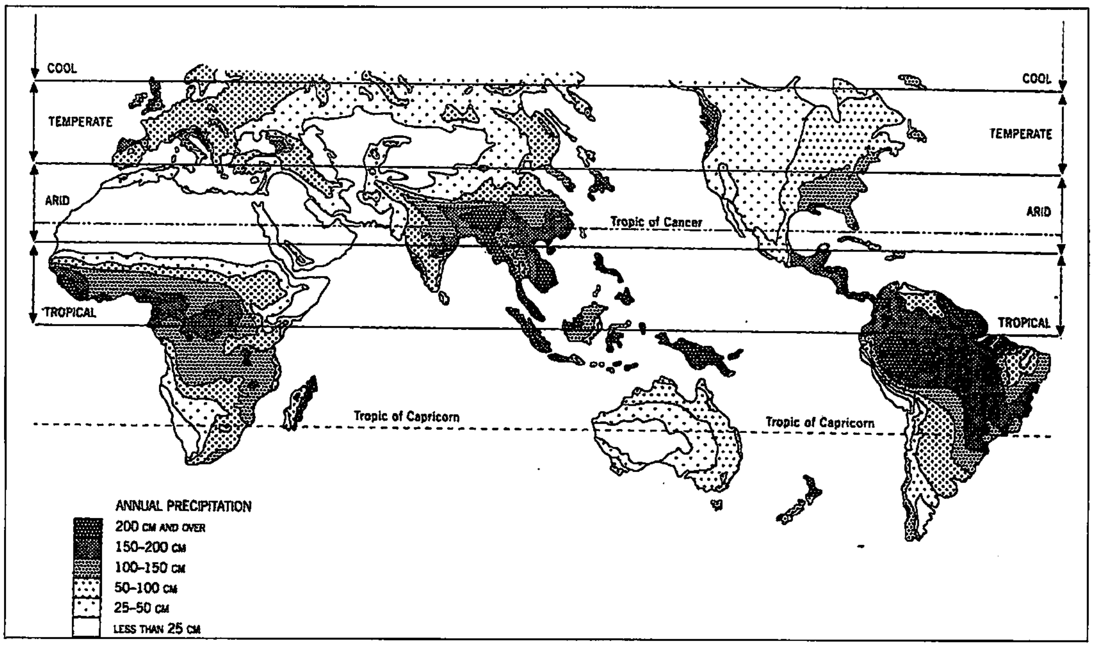

Figure 3-5 Annual Precipitation

After determining these four basic zones, in Figure 3-6, Yeang makes an overall influence of sun on local climates (Insolation) In this figure, according to the sunpath diagram, solar paths requiring shade (1), sunshade analysis –vertical (solid line) and horizontal (dotted lines) (2), Insolation with the shape of the sunpath (3), and sun requirement during winter (4) is shown.

In Figure 3-7 the traditional regional dwelling type (1) and typical occurrence of indigenous roof types, building forms and materials are shown. According to the typical characteristics of the climate and building form, certain measures have to be taken climatically.

- In cool regions, increasing heat production, radiation absorption, decreasing radiation heat loss and reducing conduction and evaporation is the functional attribute.
- In temperate regions a balance of reducing or promoting on a seasonal basis in the heat production, radiation and convection effects.
- In arid zones increase heat production, reduce and promote loss of radiation, reduce conduction gain and promote evaporation
- In tropical zones, reduce heat production, reduce radiation gain and promote evaporation loss.

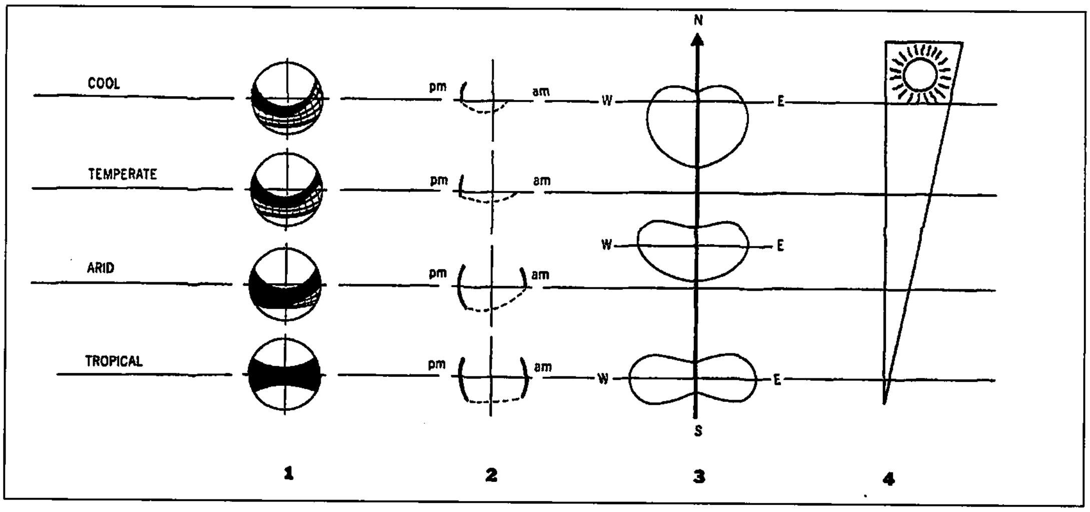

Figure 3-6 Insolation

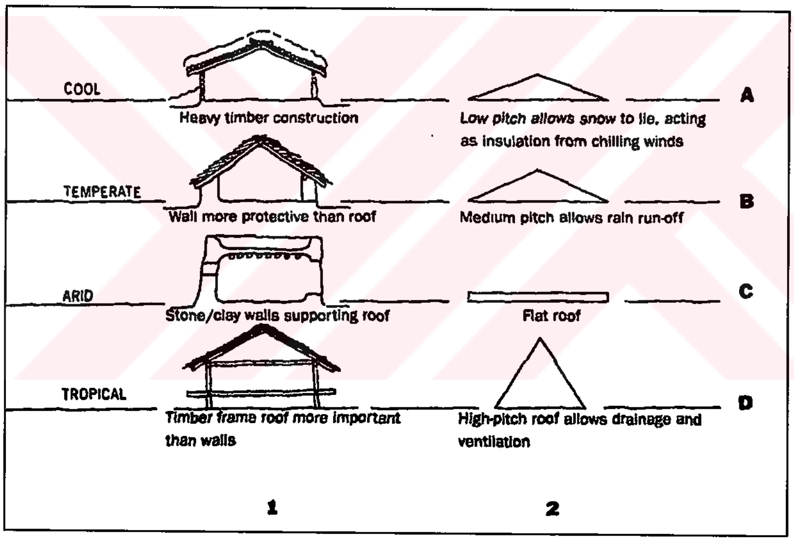

Figure 3-7 Traditional Regional dwelling types

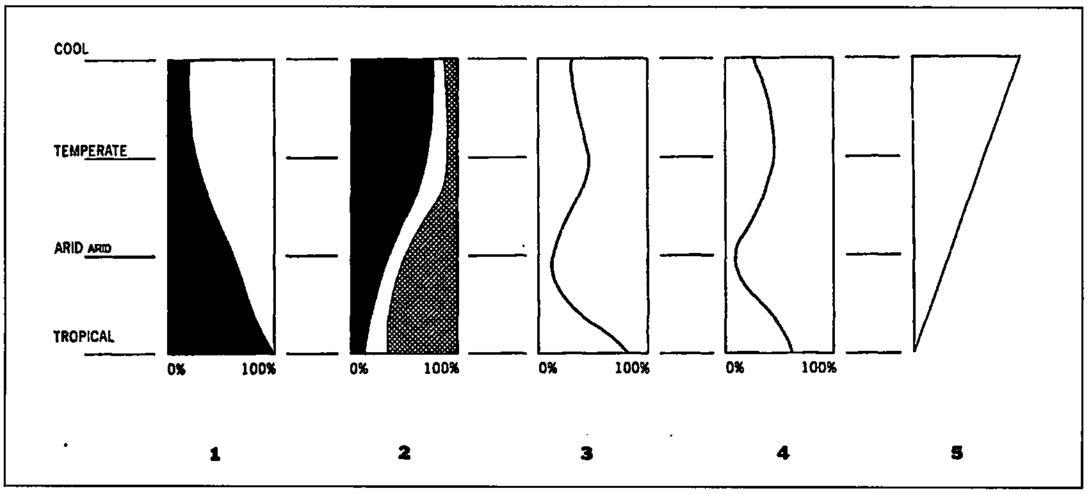

Figure 3-8 Shading, heating and ventilation requirements

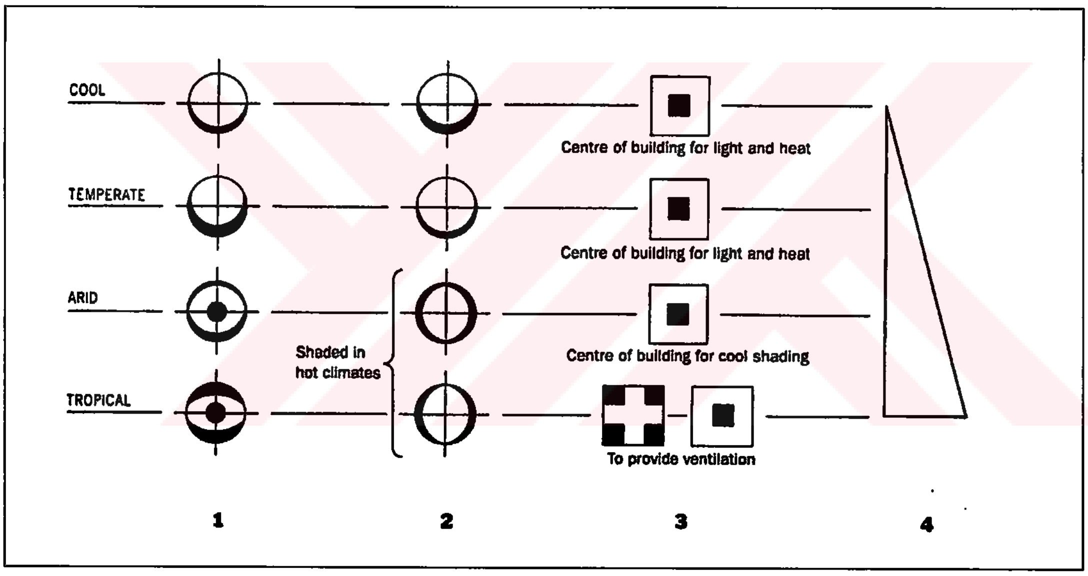

Figure 3-9. Influence on built form

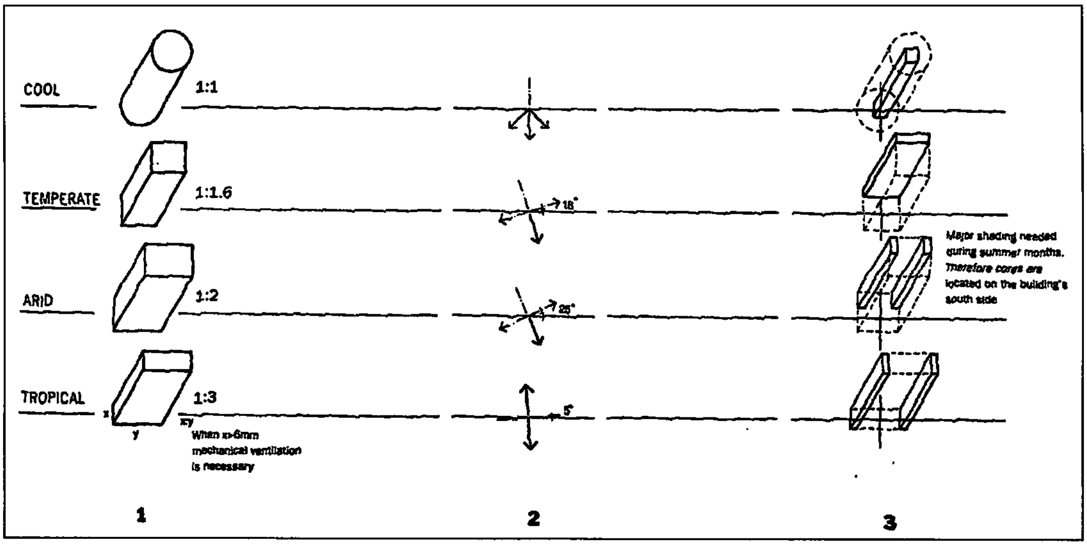

Figure 3-10. The influence of climate on design of form

Figure 3-8, (1) represents the annual percentage of required solar shading (black area) and required solar heating that the white area represents. (2) represents the annual & of required wind screening is determined by the structural or functional attribute of wind screening (black) and the need for breezes (dotted). Annual average level of relative humidity is determined by the curve in (3). (4) shows the annual average level of rainfall in the climatic zones and (5) shows the annual seasonal variations.

As influence on built form Figure 3-9, (1) shows the zoning for transitional spaces, (2) the zone for solar gain, (3) the use of atrium spaces, (4) show the potential of roof ground plane as usable exterior space.

As influence of climate on design of form, as a second category in Figure 3-10, (1) shows the optimum form for the climate zones, (2) the orientation relation and (3) shows the vertical cores and structure.

In Figure 3.11, the requirement of cross ventilation according to zone (1), the relation of wind direction (2) and the building form-response for natural ventilation (3) is shown.

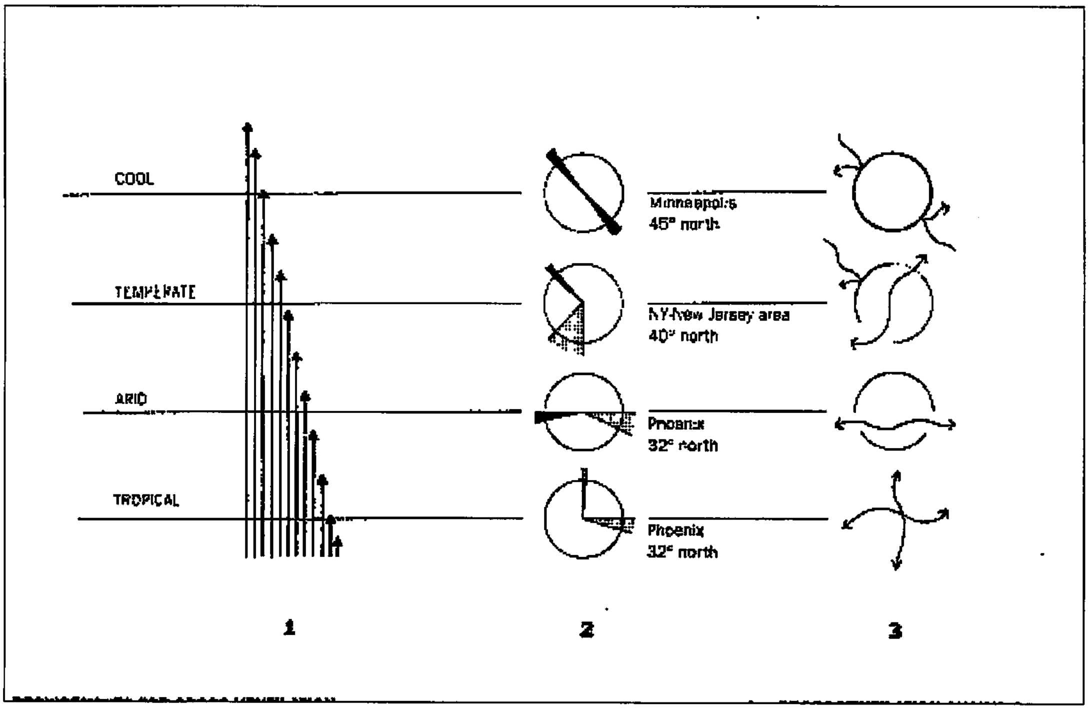

Figure 3-11. The requirement of cross ventilation according to zones

Ken Yeang explains the bioclimatic rationale of design that is economical despite the problems of initial costs of building. Yeang's theory and practice of bioclimatic approach claims a 40 percent of decrease in energy consumption in the life cycle. There is also an aesthetic challenge of the ecological approach to the built forms like one of the buildings of Yeang. Figure 3-12 shows the structural relation of the built form according to the locational patterns of the climate. The application of principles is practiced by Yeang himself in a building, Menara Mesiniaga, in Kuala Lumpur, Malaysia (Photo 3.2). This architecture is named as 'bioclimatic architecture' by himself.

One important point is that the study of the climatic properties and its relations with the building design demonstrate the locational-structural and functional relationship of building design *and* building. Note that Figure 3-12 shows the climatic influence on the building components and spaces. Plantation is also considered as another component of the building.

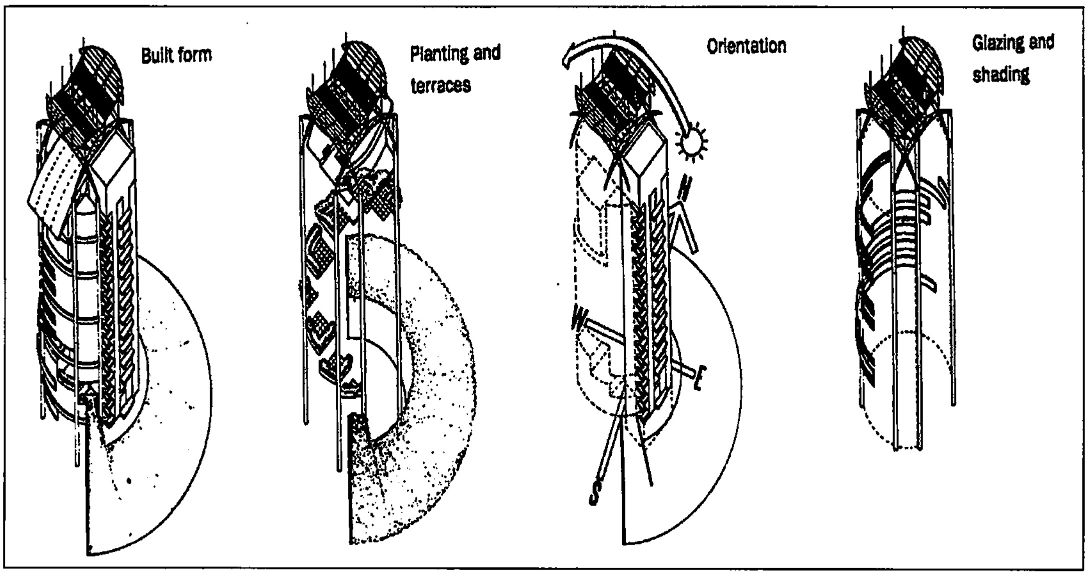

Figure 3-12. A locational*structural and functional example by Yeang (1996).

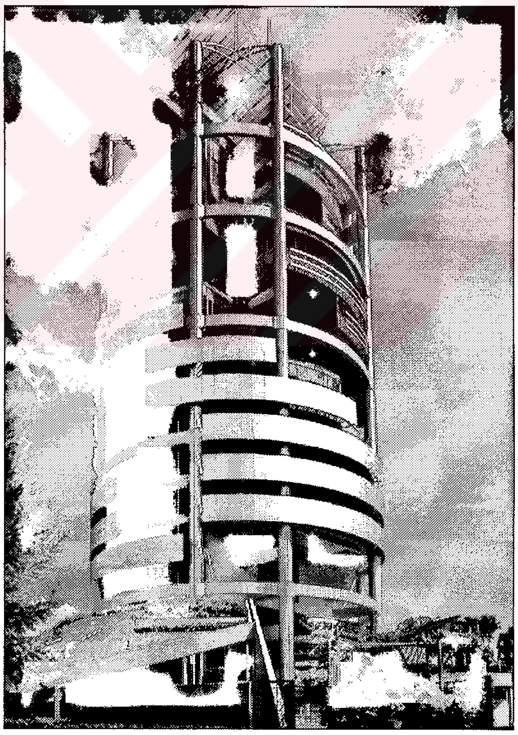

Photo 3-2. Menara Mesiniaga, in Kuala Lumpur, Malaysia, its analysis is on Figure 3-12.

3.4.3. The Energy Imperative.

The climatic approach is the core of the subject but the imperatives of energy is another asset. Actually energy is to be discussed as a function for all levels of human ecosystems. Energy problems are the most severe problems of climatic approach especially in processing opportunities of passive solar design and daylighting and as well as in the transfer of energy from one state to another mechanically. In the ecological approach it is the sun, that is the primary source of energy and its byproducts as wind, water, etc...

Therefore it is important to give priority to solar energy and the possibility of providing energy from various energy sources, which are, called renewable energy or alternative energy in general. Daniels (1994) classifies energy gained from the environment as the sun, water, soil, air, fauna (conditional) and flora (conditional).

The energy content of the environment is from natural sources and its methods are given in Figure 3-13:

In a building, these functional, locational and structural relations are represented by the bioclimatic chart and the outside is represented by the activities of human communities within the context. The climate is not just a form of building design imperatives, but it also effects human being's placement and human activity so it is a factor that affects the locational patterns, and therefore the structure. E.g. the Mediterranean metropolitan city, İzmir, Turkey, which is usually very hot in the summer, used to have its cooling effect for the city by the sea breeze in the afternoon. The whole city utilized this effect but now it is not permitted by the row of high apartments running along the coastline of the city. But still the recreational coastline area can be utilized with climatic concerns in mind.

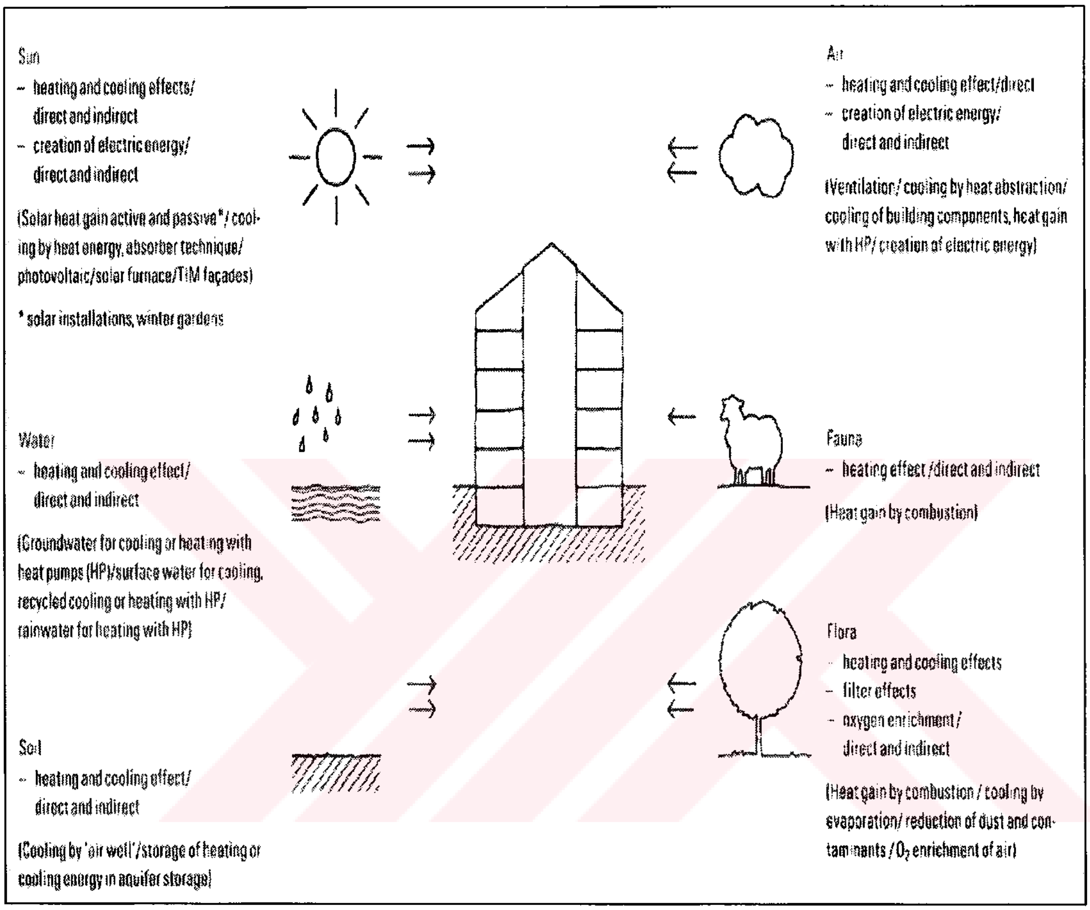

Figure 3-13. The energy content of the environment

3.4.4. The Design of the Site

The concept design of the site differs from the contemporary understanding of site design. The design of the site,with the ecological approach involves a more holistic approach to the site, thinking of it together with the land. There is an imperativeness of ecological architecture that it thinks the site as a totality with the buildings and other things at hand. The methodology of the site then goes to thinking the site as a whole. One example of such an attitude came from Andropogon Association and their preparation of 'Ecological Design of Site' Checklist (Figure 3-14)[8].

Primary deed of a designer should be the restoration of the site as Christopher Alexander states in his pattern language as "the repairer of the site"

> "It is only human nature; and for a person who lacks a total view of the ecology of the land, it seems the most obvious and sensible thing to do. Buildings must always be built on those parts of the land which are in the worst condition, not the best (Alexander, 1977:509)."

The ecological implications of site repair by building is put forth by Alexander in the following quotation:

> "If we always build on that part of the land which is most healthy, we can be virtually certain that a great deal of the land will always be less than healthy. Id we want the land to be healthy all over-all of it-then we must do the opposite. We must treat every new act of building as an opportunity to mend some rent in the existing cloth; each act of building gives us the chance to make one of the ugliest and least healthy parts of the environment more healthy-as for those parts which are already healthy and beautiful-they of course need no attention. And in fact, we must discipline ourselves most strictly to leave them alone, so that our energy actually goes to the places which need it. This is the principle of site repair ..."No accept place buildings in the places which are most beautiful. In fact, do the opposite. Consider the site and its buildings as a single living ecosystem. Leave those areas that are the most precious, beautiful, comfortable, and healthy as they are, and build new structure in those parts of the site which are least pleasant now (Alexander, 1977:510-511)."

For en ecological designer, as scientific and perceptual criterias, Forman states a group of elements that are useful. Firstly, in order to understand a site development it is important to link it with a larger context, that is the neighborhood context of the lot. Besides, a building lot can be designed ecologically according to maximizing or optimizing a number of ecolgoical components.

- Species: focusing on characteristics of species themselves, such as germination, growth rate, defense mechanisms, behaviour, adaptations, coevolved mechanism and other species interactions. "Such approaches could be targeted to produce: high species richness; an abundance of nature species; maintanence of an unusual species; attraction of some nearby target species; 'flags' to attract migrats; a minimum of pests; or avoidance by domestic animals(Forman, 1995:471)." The benefits of native species for environmental purposes are given in Figure 3.15[9].

- Special habitats: focusing of habitats, whether natural or artificial that affect particular species. Birdhouses, walls and rock piles, logs and snags, slopes and exposures, still and moving water, wetland zonation, and distinctive exterior surfaces and structure on a house.

- Flows and movements: sensing of active movements in a building lot, swimming fish, flying birds or butterfiles, mammal movement, moving sand or seeds, flowing scents, moving sounds, 'sensitive plants', waving branches, and fulttering leaves.

- Change: diurnal, lunar, or tidal fluctuations, seasonal time, unidirectional or cyclic succcession, paleoecological change, evolution, and coevolution.

The designer may maximize one of these issues, that is, may focus on one of these themes and may optimize the other. One important aspect of the building lot and site design involves connecting the lots in a larger commons in order to create habitats or created habitat that have ecological functional properties . A third approach of the site design with the building is the permaculture, where the house serves a shelter of an integrated agricultural facility in a site where self-sufficiency and economic benefits are provided by the site and the building. This is a traditional way of rural life but putting these ideas in the design of sites in cityscapes or even within buildings can be innovative today.

Ecological Site Design Guidelines

- *Create a participatory design process.* Participatory design is an ongoing process of education and communication. It involves a broad spectrum of users and managers who will ultimately promote stewardship of the landscape.
- *Preserve and reestablish landscape patterns.* Rebuilding whole systems requires connecting landscape fragments and establishing networks beyond a site.
- *Reinforce the natural infrastructure.* Ecological design respects and works with the large-scale processes, adapting the site development components—building, utilities, circulation—to the patterns of the place.
- *Conserve resources.* The natural hydrologic patterns, terrain, and native plant communities represent the fullest and most efficient use of resources.
- *Make a habit of restoration.* Each site intervention presents an opportunity to encourage recovery and to promote the ecological health of the larger environment.
- *Evaluate solutions in terms of their larger context.* Site interventions should look outward to the larger context and confront potential impacts to the community.
- *Create model solutions based on natural processes.* Sustainable solutions modeled on natural processes reflect the efficiency and elegance of biological systems.
- *Foster biodiversity.* Preserving and enhancing indigenous landscapes fosters biodiversity by helping nature reestablish the functions that support a rich complexity of species.
- *Retrofit derelict lands.* Today the choice is often between restoring and reusing neglected lands or destroying the few remaining rural or natural areas. Much of the work of the future will be "pioneering in reverse."
- *Integrate historic preservation and ecological management.* Renewing historic landscapes integrates many overlapping and interrelated values with contemporary use and ecological management.
- *Develop a monitored landscape management program.* Creating sustainable landscapes requires a revolution in landscape maintenance. A monitored management program ensures that policy and practice are informed by science and fulfill long-term goals.
- *Promote an ecological aesthetic.* A place that is understood, preserved, repaired, and celebrated as an integrated whole can become a powerful and memorable work of art.

Figure 3-14. Ecological Design of Site' Checklist

Integrating Natural Plant Communities into Conventional Landscape Areas: Benefits All Around

Environmental

- Promotes long-term landscape stability and sustainability
- Increases biological diversity
- Enhances groundwater recharge through increased absorption
- Regenerates organic soil layer with decomposition of above ground growth
- Reduces soil erosion with soil-holding root systems
- Reduces downstream flooding by virtually eliminating surface water runoff
- Preserves and/or restores existing plant and seed banks; maintains genetic memory
- Improves air quality through permanent carbon fixing in the soil
- Improves water quality through filtering of dirty water and slowing of surface water velocities
- Reduces maintenance impacts through reduction or elimination of herbicide, pesticide, and fertilizer applications, mowing emissions, and irrigation

Social

- Creates a strong sense of place and regional pride
- Promotes a sound development ethic
- Provides public education and interaction opportunities
- Develops aesthetic richness
- Provides emotional and physiological relief from the built environment
- Promotes stewardship of the earth's plant and animal communities

Economic

- Significantly reduces maintenance costs
- Significantly reduces infrastructure costs
- Offers comparable installation costs
- Creates new markets for related services
- Promotes environmental responsibility with improved public relations

Figure 3-15. Benefits of Natural Plant Communities

3.4.5. Whole Systems Design Thinking

For the ecological success of creating or transforming natural or designed environments to human ecosystems, the ecosystematic approach is crucial. This necessitates to see the links (pyhsical, biological, economic, social, aesthetic, etc...) or relationships of the designed artifacts (buildings, roads or settlements) as a whole. Thus human mind may not comprehend all of the complex relationships but striving to solve as many problems as it can through design is the goal of the ecological design process.

The examples in the case studies show how the architecture of ecology strives to solve as many problems as it can referring to many scales of human ecosystems. This is due to its whole system design thinking. The focus of the design change with the context of the design.

3.5. Case Studies

Case studies demonstrate the varied approaches to the design ideas of the discipline. The case studies show the holistic approaches to design in various environmental contexts, or in other words ecological contexts. They include;

- Audubon House.
- Dewees Island and Reeves Residence.
- Eco-Mart.
- Real Goods Trading Center.
- Center For Regenerative Studies.

3.5.1. Audubon House

The Audubon House (Photo 3-3), which is located in Broadway 700, NewYork City, is a renovated building which seeks for an environmental solution in a dense, urban area. It is a restored building which focusses on 'recycling' and 'reusing' principles. It is the headquarters of the 'Audubon Society', the environmental organization, whose mission is 'to conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity and the earth's biological diversity'.

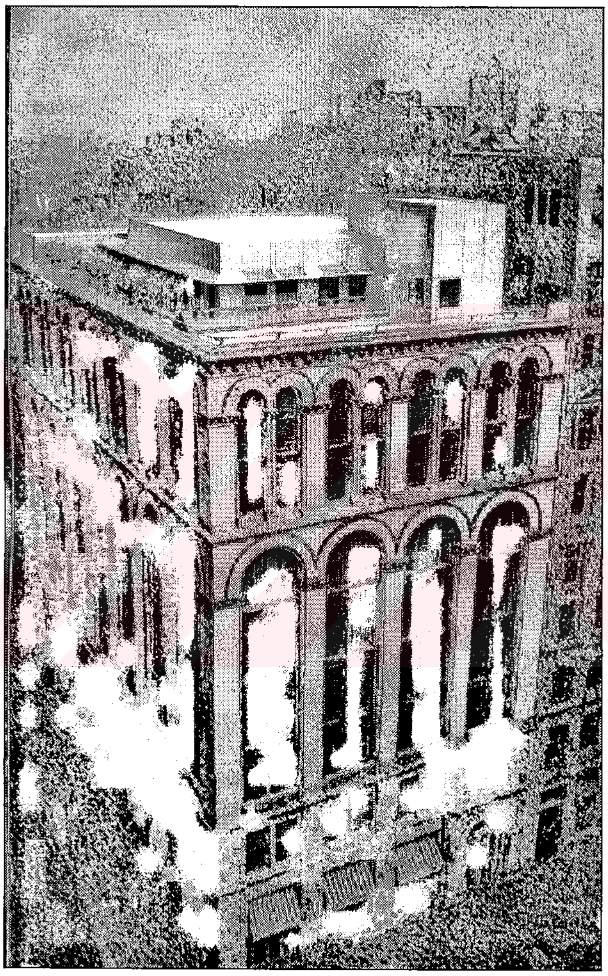

Photo 3-3. Audubon House (Zeiher, 1996)

A knowledge of environmental concern which favors doing more with less has an inherent economic charater, long term success seeking, seeking and bringing indoor health, energy efficiency, CFC avoidance, pollution avoidance, solid waste management, water conservation, visual, thermal comfort, light quality and comfort, and also tries to bring to the inhabitants the course of the natural phenomena like the sun, weather and seasons. The building's design also contributes to global issues like resource conservation and ozone depletion. Because of the context and the restaint the project is termed as an *optimization.*

The primary goals of the project can be summarized as follows:

- Energy Conservation and Efficiency.
- Direct and Indirect Environmental Impact
- Indoor air quality
- Resource Conservation and Recycling
- With economic consideration, intregrated design
- Teamwork

In the analysis of energy computer models were used: (DOE-2 developed by U.S Department of Energy and the Electric Power Research Institue in San Francisco, California that can calculate the systems , heating loads, plant economics).

The phenomena of recycling is considered extensively in five different area.

- Recycling the building: renovation in an existing structure
- Recycling materials from demolition
- Finding building materials made with recycled contect
- Programming and designing a physicalin-house recycling system to capture office waste
- Establishing guidelines for the purchase of recycled and /or recyclable supplies (as well as waste reduction and reuse)

The materials and products criteria in the Audubon House are:

- Toxicity: minimization of toxic content is a primary objective
- Manufacturer's environmental Impact: The manfacturer who employs methods which result in maximum resource conservation (recycling) of all resource

materials and minimum upstream and downstream environmental impact is preferable.

- Embodied energy: The product sold require a minimum of inherent energy in the transport and manufacturing.
- Performance: Each material or product must have been on the market for at least two years or longer in order to ilustrate a succesful record.
- Economy, aesthetics, comfort.

3.5.2. Dewees Island and Reeves Residence.

The Deewes Island and Reeves Residence together give an example of two environmental designs linked to each other. The Deewes Island Project is a limited development in the 1,200 are Island Deewes Island (Photo3-4), South Carolina, the main theme is the preservation of the natural habitat. Existing on the island, are highlands, lakes, slate marshes, sand beaches. The development masterplan was designed by the architectural firm, Burt Hill Kosar Rittleman Architects and the main theme of the architects were to provide guidelines for the balance of low impact development-preservation scheme and regulate building processes (Wilson, 1998).

Photo 3-4. Deewes Island ((Source:Internet site of Deewes Project))

The underlying principles of Deewes are:

- Development and environment are natural allies.
- All development & building should occur in the context that all resources are limited.

- Communities and buildings can be resource providers not just resource users.
- Land is a stewardship role for future generations.
- It is less expensive, short and long term, to build in harmony with the environment.
- Communities are planned for people and technologies are to be supportive, not dominant.
- Environmental education is an essential "first step" in the re-discovery of our intuitive sense of integrating with the environment.

The Island is accessed by boat, the transportation is done by electric golf carts and foot or bicycle. It possesses a wetland waste water treatment system for sewage treatment. “Site design is intended to minimize disturbance of the natural environment , protect the island’s resources, and capitalize on the advantages of the coastal climate to help conserve energy.”[10]

Before construction beings any new home site, representatives from Dewees Island’s Architectural Resource Board review plan to guide homeowners through sustainable development practices. Homes are required to “nest” within their habitat and to take advantage of winter sun, summershade, prevailing breezes, and natural lighting in order to minimize energy use. The absence of impervious (paved) surfaces on the island means that rain and runoff will feed into the island’s underground aquifer. Sewage is treated with a biologically based, closed loop waste water system that keeps discharges out of local waterways.

> “Letting the land and nature do te site planning is always less expensive, says Knott who claims that the buildings and other infrastructure on the island will last longer as a result of climatically appropriate siting and material choices (Wilson,1998:127).”

Instead of a golf course as the main attraction, Dewees Island Project boasts miles of nature trails and shoreline to explore, extensive salt marsh estuaries that are rich in wildlife, freshwater lagoons with alligators, superb birding opportunites (including several elevated observation platforms), and forests that are home to bobcats and foxes. Sixty-five percent of the island including a 200-acre tidal lake, stand as a refuge-to be left forever wild. The master plan was a collaboration of experts from different fields like wildlife consultants, beach and dune management engineers, representatives of Department of Natural Resources and Wildlife, a soils engineer, a civil engineer, environmental consultants and architects. The design with nature notion is quite predominat in the design stated its planners. “Dewes Island told us what should be done with her. We have just have to respect what Dewees says about herself (Wilson, 1998:127).”

The Reeves Residence: A House Design on the Dewees Island

The Reeves Residence is a house designed in Dewes Island with the guidelines of the Deewes Island development scheme. The guidelines included:

1. Develop the site with as little disturbance as possible.

2. Site and construct the house in a way that moves the fewest trees possible.

3. Establish and maintain good indoor air quality.

4. Be resource-efficent with respect to both available site resources and product/material/system selection and production.

5. Reduce transportation energy use by using regionally available products and materials.

6. Reduce construction waste.

The house is located on a east-west axis, to maximize protection from winds. Necessary measures for energy efficiency with passive and heating cooling, glazing and daylighting is well provided. Air quality is kept maximum and toxicity is avoided. Composting of organic waste and food were considered and these are carried to the community composting area weekly. Water conservation in the area is done carefully.

The important idea here is that the two projects go hand in hand and effect each other. Where architecture treis to adopt itself to a broader scale. This broaderscale involves design intervention which affects the finer scales.

3.5.2. Wal-Mart: Eco-Mart

The Wal-Mart, Eco-Mart example again wants to put architectural design in a design of a greater context of thought oriented environmentally. The project is a series of conception and development studies for Wal-Mart's experimental store in Eco-Mart,in Lawrence, Kansas. David Wann (1996) gives Eco-Mart as an example both featuring green/Green thoughts as he states in the explanations of Phase I and Phase II.

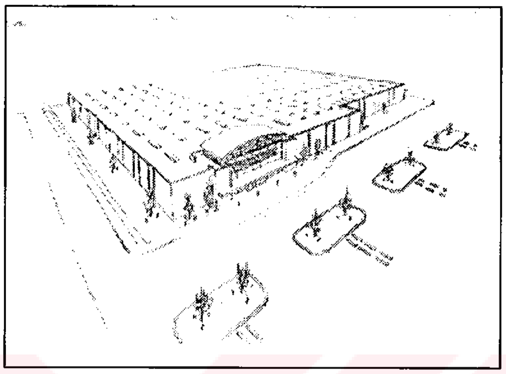

Figure-3-16. The drawing of Eco-Mart.

To remind, Phase I was about improvement of the quality and performance of the current designs so they deliver more service per resource unit and per "unit of stress (Wann,1995). Wann states that it also incorporates Phase II criterias. Wal-Mart is a supermarket chain and have negative impacts on small towns trade, capitalist corporate structure, promotes urban sprawl.

The change of shift in Eco-Mart design is found as a good start by Wann (1996). Wal-Mart open three stores every week, and experiment with the idea of ECO-Mart where green products would be sold and environmetal interaction would be provided under an 'environmental' building (Figure 3-16).

> "We realized that if we could envision, design, and construct a new kind of store, we could help change the way we Americans think about the environment. The Wal-Mart Store could become a model for others to follow, reported in both technical and mainstream media. The leverage that Wal-Martcan exert on both its costumers and its suppliers is staggering. For example, if Wal-Mart request green product from their vendors, they'll get them. Really, it's models like these that move the whole society toward a new environmental norm (Wann, 1996, 143-144)."

A brain storming phase of the board of management brought out design concepts and design criteria to be formulated within the design process.The goals to achieve with such a structure and organization was low energy use, minimal waste production, sustainable development, and recycling by employing recycled material, energy efficient architectural design, low-input landscaping and iintegrated solid-waste management. Within the study, design principles for such a development were also produced (Figure 3-17 and 3-18 from Wann (1996)).

DESIGN CONCEPTS

- *Ecological Wisdom* Live within the ecological and resource limits of the planet. Apply technological knowledge to the challenge of an energy-efficient economy. Build a better relationship between urban and rural America. Guarantee the rights of non-human species. Promote and respect self-regulating natural systems.
- *Respect for Diversity* Honor cultural, ethnic, racial, sexual, religious, and spiritual diversity of all beings within the context of individual responsibility. Respect and maintain biodiversity, or a diversity of living species.
- *Global Responsibility* Maintain awareness of the impacts of our actions on global, ecological, economic, and social systems.
- *Focus on the Future* Help institutions and individuals think in terms of the long-range future, not just short-term selfish interests. Make quality of life, rather than merely open-ended economic growth, the focus of future thinking.
- *Inter-relatedness, Interdependence, and Natural Process* Learn these lessons from the ecosystems we are a part of.
- *Soft-Energy Production Alternatives* Work with the cycles of the sun, water, wind, and geothermal energy rather than depleting finite resources that can be more effectively used elsewhere.
- *Select Appropriate Technologies, Regenerative Agriculture, and Minimal-Impact Waste Strategies for Radiation By-products and Unrecyclable Wastes* Use the right tool for the right job. Less waste means less cleanup, less conflict, and fewer costs.
- *Trace the Origins and Future Destination of Each Store Component/System* Don't let actions taken in the present leave a gaping hole in the future.
- *Incorporate Biology and Physics into Designs*

Figure 3-17 Design Concepts of Eco-Mart (Wann, 1996)

DESIGN CRITERIA

- Use design solutions that accomplish three or four things at once. For example, plants conserve water, reduce erosion, soak up greenhouse-forming carbon dioxide, and have a cooling effect on urban landscape all at the same time.
- Account for costs with the full lifetime of the product in mind. What environmental costs are not accounted for, we'll pay for in taxes, poor health, or a deteriorating quality of life.
- Design for the future. Think about future use, reuse, or disposal requirements of a given material when designing it. In the area of disposal, design for natural processes like decomposition and nutrient cycles.
- When designing, think about whether the user will be able to understand the result, maintain it, and feel satisfied with it.
- Design to increase, rather than limit, people's options.
- Design to enhance users' self-reliance and self-worth, rather than creating dependency and insecurity.
- Design to take maximum advantage of existing infrastructure and recyclable resources.
- Design to enhance creative thinking.
- Design to accommodate household hazardous-waste products.
- Design to allow point-of-sale recovery of packaging materials.
- Design with consideration for the specific site—existing ecosystems, location relative to transportation systems, proximity to community environmental infrastructure, etc.
- Design to enhance the educational possibilities of the store.
- Design using systems and materials that are flexible enough to accommodate improvements and retrofits.
- Design to avoid groundwater and surface contamination.
- Minimize the use of off-site electrical energy for heating and cooling, with efficient design, load reduction, and on-site production of energy.

Figure 3-18. Design Criterias of Eco-Mart (Wann, 1996)

- Reduce "embodied energy" costs, or life-cycle costs of materials and systems, including extraction, manufacturing, shipping, and disposal costs.
- Compensate for negative impacts created by the store by developing off-setting positive systems.
- Limit painted surfaces as well as surfaces requiring adhesives, carpet, or solvent-based maintenance with floor wax, polish, cleaners, etc.
- Minimize construction waste by finding recycling markets.
- Develop vendor partnerships to ensure the ecological manufacture/supply of packaging, building materials, and store merchandise.
- Increase daylighting systems and reduce electrical lighting requirements.
- Minimize transportation-associated energy use and pollution (both customer and operations).
- Reduce impervious surfaces that also retain heat. Reuse heat where possible, and use alternative surfaces for parking, roof surfaces, etc.
- Landscape using native species, xeriscaping, and low-maintenance species.
- Create opportunities for energy savings through passive design such as building volume, geometry, footprint, etc.

Figure 3.18 Continued

The architectural firms of Wal-Mart consulted an advisory board from an archietct and eco-philosopher William McDonough, Amory Lovins, physicist and systems engineer, Hal Levin building ecologist. The holistic group was after the design of a societal action. Proposal of this group as design ideas were:

1. Adaptive use: If function changed the building could still serve. So a design that could handle two stories and concrete wallspace according to future fenestration and then the structure could change to an apartment building.

2. Life-cycle of the material were studied carefully. Regional and local materials were kept on priority. Wood was chosen to cover the roof but with a prequisite: wood from sustainable forestry.The HVAC system was chosen keeing in mind.

reducing carbondioxide emmissions, meeting or exceeding regulatory standards for indoor air quaility. Achieving energy efficiency and providing thermal comfort was maximized.

3. The site plan of the building, integration with the parking lot, signs and landscaping was provided. Rainfall was kept and together with tolerated waste water was used for irrigation of the site.

4. Natural light by skylights were designed to allow daylight maximization both for energy efficiency and the ambiance of natural light.

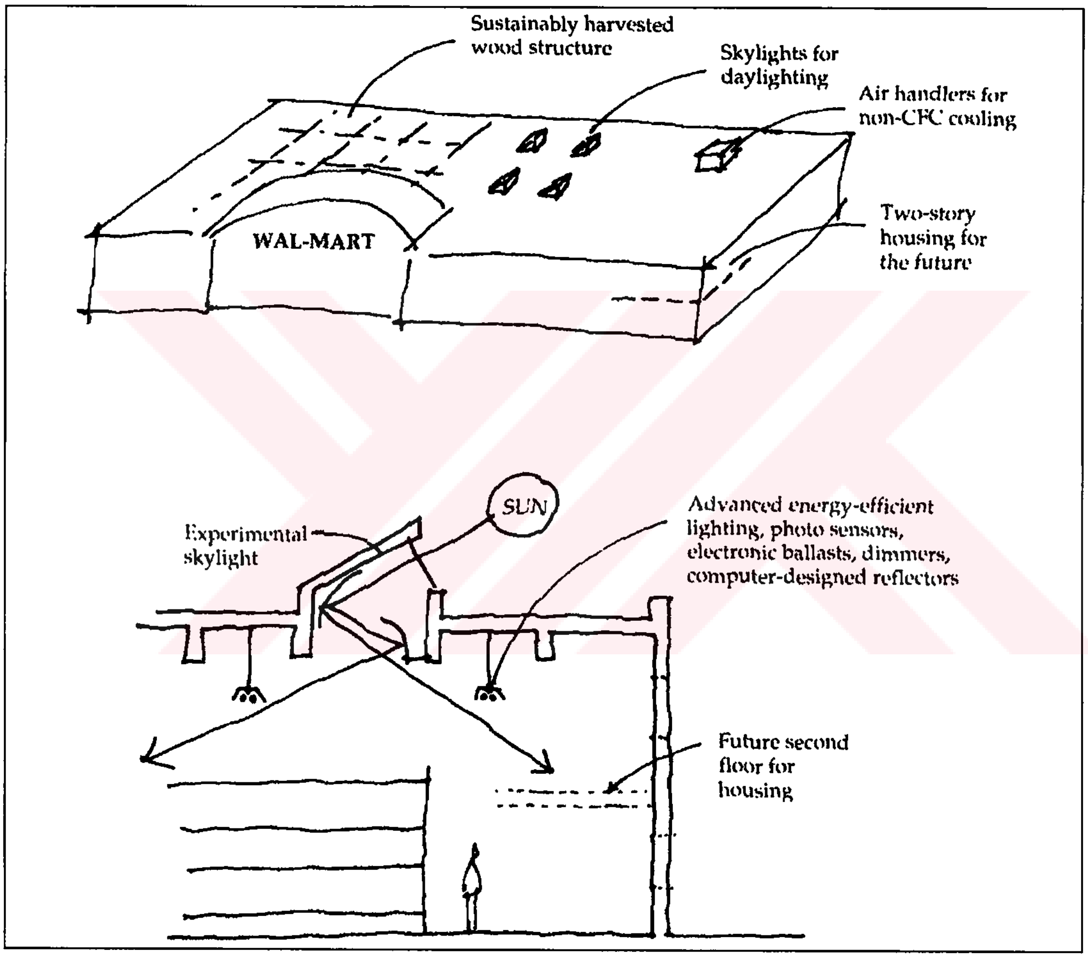

Figure 3-19. Design Sketches of Eco-Mart by McDonough (Wann, 1996)

The architecture of a mall could have also implication for the business like Eco-Mart. This shows the Eco-Mart's broad view of environmental design.

"What began in the boardroom as a loose collection of good intentions, a green store,ultimately evolved into a thriving operation. But the significance of Eco-Mart extends beyond documented reductions in the consumption of energy, water,and toxic materials, and beyond increases in recycling. The project is an educational statement as well as a testing ground for innovations. The important point is that the store helps change the way people think... What Wal-Mart attempted to do with the Eco-Mart store is the single most exciting approach to environmental-problem solving in American business today.The market has arrived,asking for these products and innovations, and Eco-Mart supplies them. When the decision is made to move forward in design, not just sideways, the only way the innovations will be available is if they've been field tests, as at the Eco-Mart (Wann, 1996:163-164)".

3.5.4. Real Goods Trading Center

The Real Goods Trading Company's Solar living Center in Hopland, California is designed by Ecological Design Institute with wholistic approach. Its ecological efforts are multiple and show an integrated design.

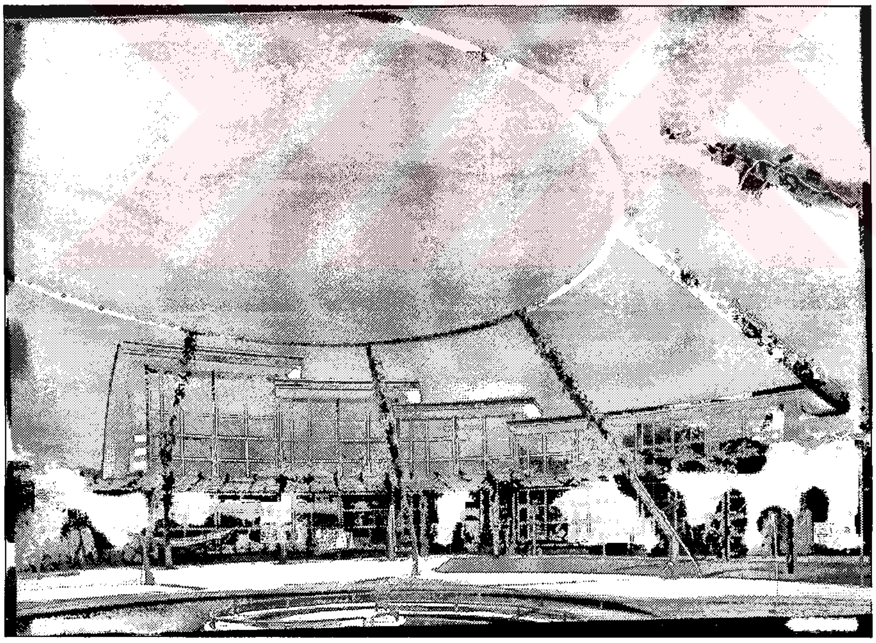

Photo 3.5 The Real Good Center (Postcard picture obtained bythe author)

The design phase and principles and ecological successes are as follows.

The program: Real Goods Company is a company that sells green products. The program includes a showroom for ecological technologies and supporting facilities. Together with the building, a demonstration landscape and garden is to be designed to show the company's products and ecological vision.

The site: The site consists of twelve acres on an agricultural floodplain. It is an old industrial site with a damaged stream. Site analysis sketch is in Figure 3-20 and a view of the site is in Figure 3-21.

The program and the site: It is important to see the relation with the program and the site. The stream is restored to its near original qualities. The floodplain will be filled with the constructed wetland, ponds and gardens.

Ladscape Design: Designed with the original flora and with the seasonal changes and also provides orientating clues to the sun's daily and seasonal paths. Water is a primary element on site, it is recycled from the copious on-site aquifer providing summer cooling for outdoor, background sounds and animated paths for visitors.

Building design: The design follows the sun paths. The natural daylight and solar heat gain is kept maximum by the study of model in heleidon. The sun path's determine the form of the building as described by Van Der Ryn "The south -*facing building steps down in segments as it moves from west to east, allowing the morning sun to stream into high cleretory. The curved roof form is designed evenly distrbute daylight. The complex arrangements of building and landscape are designed constantly remind people of the sun's path through the play of light and shadow and a host of orienting elements." (Van Der Ryn & Cowan, 1996: 170).

Energy: Photovoltaics and a wind-powered energy and passive heating and cooling strategy.

Materials: The walls of the building are straw bale construction. The choice of straw bale construction eliminate straw bale burning and therefore CO2 input to the air, and provides a high level of insulation. They are also non-toxic, natural and return to nature with no harm. The glue-laminated beams of the sustainably harvested Douglas fir were cut, milled and manufactured within 40 miles of the site.

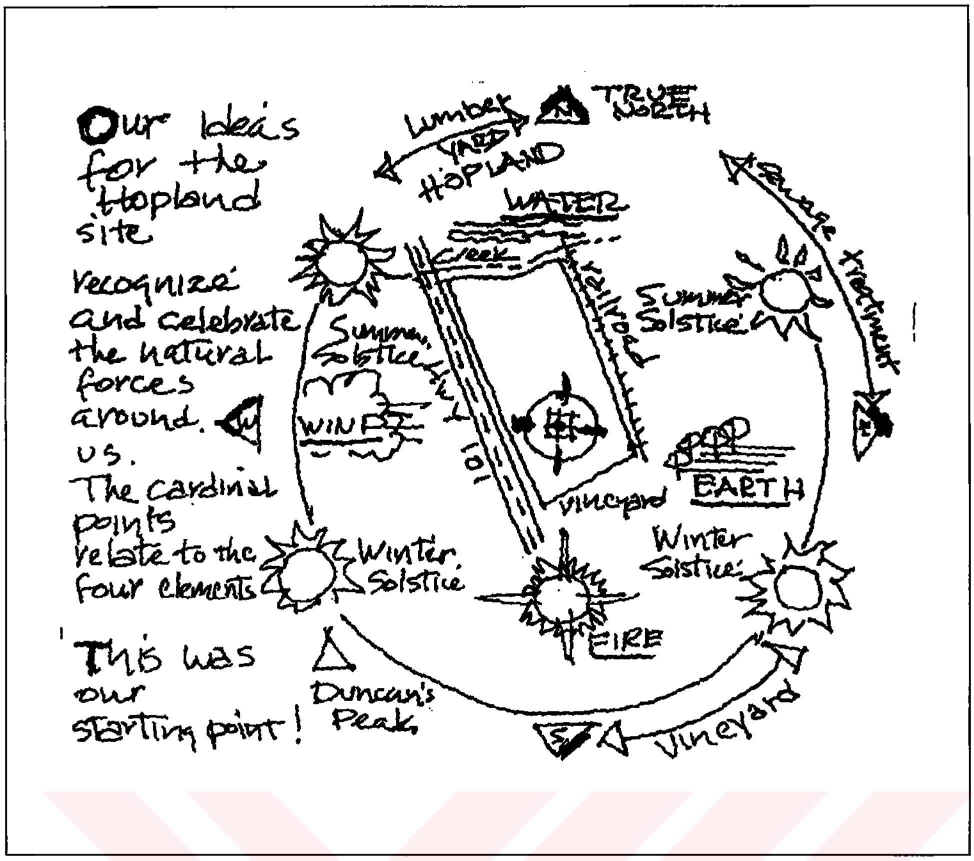

Figure-3-20. Design ideas and sketches by Van Der Ryn (Van Der Ryn & Cowan, 1995)

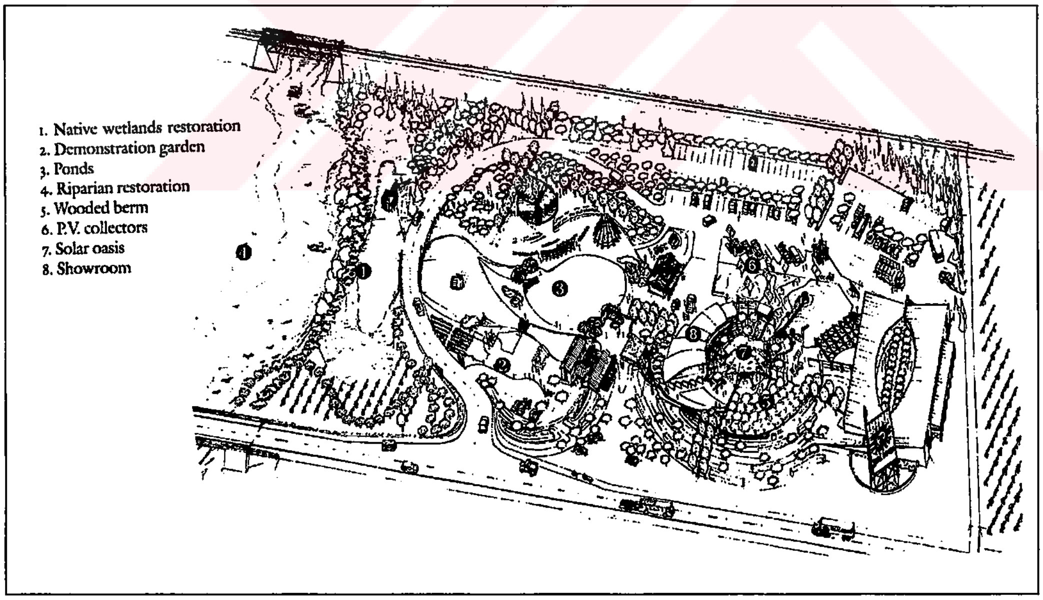

Figure 3-21. Design of the site with ecological values as a total system (Van Der Ryn & Cowan, 1995)

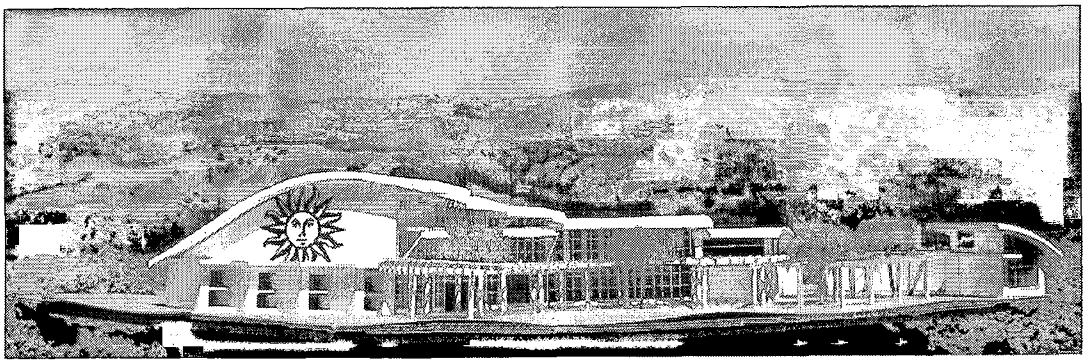

Photo 3-6. The model of the building on site (Zeiher, 1996)

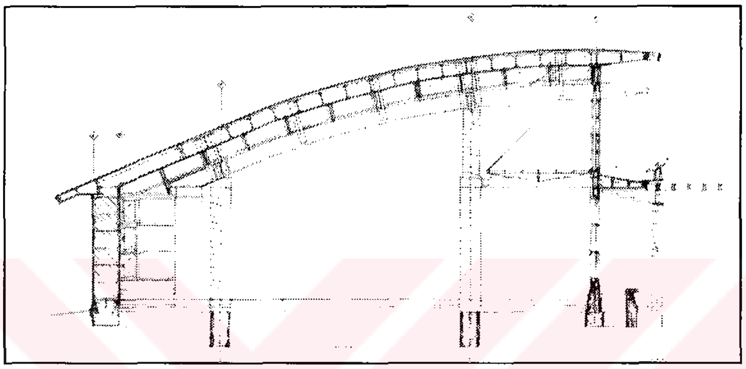

Figure 3-22. The construction details of the building (Zeiher, 1996)

***Afterword*:**

> "In Real Goods project, all elements-architectural forms, building materials, ecological restoration efforts, water, landscaping, pathways and public areas- provide subtle, ongoing lessons in sustainability. Like other effective ecological designs, it sets in motion processes that will continue to teach us year after year." (Ryn, 170).

The center provides an integrated design intervention to the built environment. It is also in Ryn's terms 'a form of visual ecology'. *Visual ecology* is described as a new kind of aesthetic for the built environment to provide cognitive links between culture and nature in general, or in other word human beings and the ecosytems through design. The visual ecology can achieve helping to see and become aware of the abstraction superimposed on the land, make complex natural processes visible and understandable.

3.5.5. Center For Regenerative Studies (CFRS) as an Example of Ecological Design Process.

The idea of regeneration in the design of this whole system project (CFRS) is an effort very similar to the bioregeneration idea of Odum that was discussed in the example of the design of the spaceship.

The locational-structural approach is applied by Lyle(1994). Considering it from an ecological criteria, The Center For Regenerative Studies building complex acts as a process and a product giving out basic clues of how such a holistic system idea is cooperative and environmentally responsive and regenerative. The metaphorical and physical relationship of locational patterns, structural and functional relations in the ecosystematic approach is explained in the book. The Center is constructed with these principles. It is an educative organization at the same time and it serves as a catalyst of ecological education for multidisciplinary studies.

Lyle defines the three components of the regenerative human ecosystems as:

- Structure: development includes a wide range of biological and cultural activity. The complex topography of the site allows five distinct different cropping systems, and within each of these are polycultural combinations of species growing at different levels from soil to tree level. A range of animal species will also be included.

- Functional Flows are described very similar to the spacecraft model; all the inhabitants and their functions are included.

  "Within the complex structure of diverse species, the elements are connected by the network of energy and material flows. In its essential general operation, this network is identical with the functional pattern of a natural system. The species involved, however, are quite different, and human management regulates most of it. As the Center evolves, the network will develop in complexity and cohesion. The working concept and preliminary hypothesis are sow in the diagram showing flows of energy, water and nutrients among major elements of the Center's structure (Lyle 1993:32)."

The Center's multipurpose system includes:

Alternative Energy Production: Designed as a Solar park (Photo 3-8) involving photovoltaic converters, A Dish-Sterling engine-driven electric generator heated by reflective parabolic dishes, Roof-plate collectors are mounted on the building roofs and heat

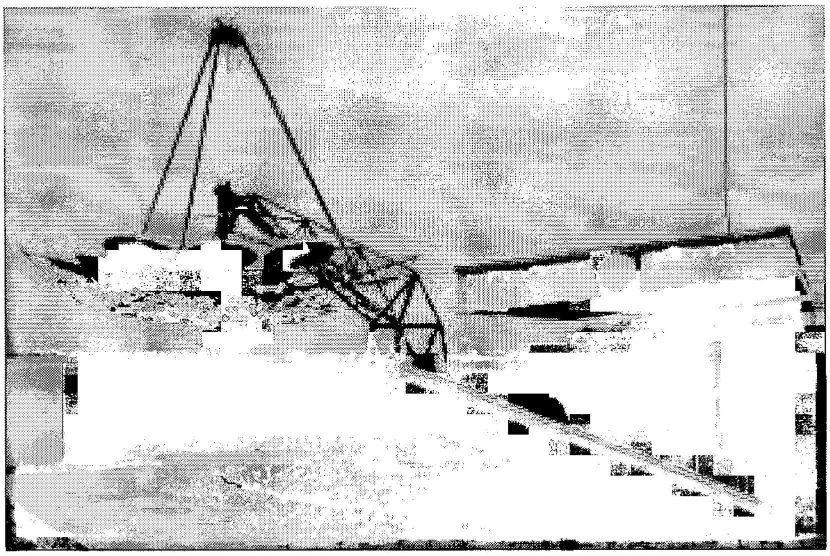

Photo 3-7. Solar Park in CRFS (Source:Internet site of CFRS)

"The Center will rely in the beginning on public utilities for a major part of its electric service, gradually weaning away from these as regenerative technologies are added. The Solar Park is intended to be a place where earth, sun, people, and technology meet in a simple and undemanding way. The location of Solar Park is the top of a knoll where access to sun and wind is greatest, and where vistas stretch out over the Center and the surrounding landscape. The integral community role of energy technology demands that it be seen, experienced, and understood. The Center makes use of a broad range of technologies from simple and basic to highly sophisticated. The Center's purpose, which calls for experimentation, allows for wide-ranging exploration and comparison".[11]

Integrated Waste Management:

The policy of recycling is done in three ways.

- Recyclable materials (paper, metals, glass, and plastics) collected for a nearby recycling facility.
- Agricultural wastes, including plant trimmings and other organic matter, are returned directly to the soil.
- 3. Kitchen wastes that cannot be fed to animals, along with agricultural wastes that cannot be returned directly to the soil or digested, go to compost bins.

Human and Social Systems:

Community shares the reception room/kitchen/dinning room complex, otherwise known as the Commons.

"In the operation of the Center, as in its design, the network for interaction and exchange of information is a fundamentally important factor, The design of the Village attempts to build the setting for such a network into the physical environment. The buildings accommodate groupings of various sizes to facilitate different levels of communication."[12]

Aquaculture Ecosystems Development:

Sustainable models of complex, ecologically integrated aquaculture are experimented.

"The aquaculture ecosystems program at the Center is attempting to evolve alternative approaches - integrated land/water/energy, social and economic approaches - that will point the way towards evolving sustainable aquaculture systems at both household and commercial levels." (Photo 3-8)[13]

The application of the human made ecological processes on the land is at the same time a landscape intervention and creates a new aesthetic.

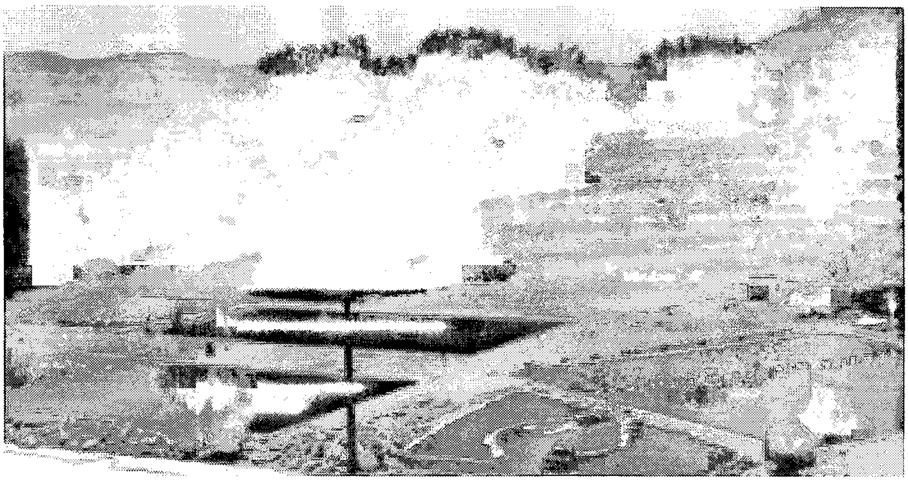

Photo 3.8. The cultivated areas in CFRS (Source:Internet site of CFRS)

Built Form:

The characteristics of the Center's building form possesses the qualities of sustainable design. These are:

- The south-facing hillside lends itself to three energy-form archetypes.
- The raised structure
- Taking advantage of the potential cooling effect of evaporation
- The earth-sheltered forms
- The subspace forms direct solar radiation can be allowed in when desired.
- For minimizing solar gain during the summer, the use of plants as integral parts of the buildings is essential.

Photo 3-9 The building of the Center (Source:Internet site of CFRS)

The Architecture of the CRFS as a Whole:

The architects of the Center express their themes about environemntal design of the building (Crosbie, 1994).

> "Environmental design is the fundamental basis for our work. We continually balance those interdisciplinary aspects of architectural practice

> that have drawn us to the profession: creativity, technology, planning, social responsibility, sociology, and a commitment to shape the future. Environmentally responsive design is an integral part of each of these disciplines (Crosbie, 1994:101)."

Thus the architects define their modes of aspects as:

- Creativity: "The creativity to conserve and respond to natural resources is our current challenge."
- Technology: technology is more that the structural, electronic, and utility aspects of nailing design. It is also expanded consideration of low-tech methods for responding to the natural environment."
- Planning: "any planning effort should consider site, orientation, and climatic features."
- Social responsibility: "as inherent patriot of this philosophy is the conservation of material sources and the preservation of healthy and happy quality of life for everyone.
- Sociology: "architecture has the power to influence social behavior and interaction" within the concern of the dilemma of man and nature.
- Commitment to shaping our future wellbeing: Integration of art, technology and human factors to cerate a built environment with qualities of beauty, responsiveness, safety and preferred future.

To conclude, these examples have provided actual realisations where ecology as an approach to living or value of life creates a multi-dimensional concern not only for architecture in its conventional sense but for design as a global concern for education, landscape, production, economy. Architecture houses not mere people, but ideas and hopes for the future of the world in the architecture of ecology.

Notes To Chapter 3

[1] This discussion as a design concept is made by Christopher Alexander in 'Notes on the Synthesis of Form', Harvard University Press, Cambridge, MA, 1964.
[2] Berkebile, Robert, 'Architecture:The Endangered Profession', Micro, Metro, Global: Architecture and the Environment, The Royal Architectural Institute of Canada,Ottawa, 1994,pp.3-20.
[3] Farmer, John, Greenshift, Butterworth Architecture, London 1994,pp.159-165.
[4] These examples are given in 'Fragile Ecologies', ed.Matilsky, Barbara C.,Rizzoli, New York, 1992. This book includes contemporary artists' interpretations and solutions to the ecological consequences of the environment.
[5] Information obtained from internet site of the UIA.
[6] Information found at the internet site:www virginia.tech.edu
[7] Blueprint for a Green Future, Architecture, June 1993 pp.47-56.
[8] Wilson, et.al. (1998), p.129.
[9] Wilson, et.al. (1998), p.143.
[10] The internet site of Deewes Island, www.deweesisland.com provides information.
[11] Information obtained from the internet site of CFRS.
[12] Ibid.
[13] Ibid.

CHAPTER 4

ECOLOGICAL STRATEGIES FOR ARCHITECTURAL DESIGN

4.1. The Locational-Functional Structural Approach in Building Design

Architecture's primary object and subject is building, both as product and process. Building therefore as a spatial organization and systematic production can be, observed and studied and also practiced as an ecosystem. In fact it is also a human ecosystem. The locational-structural-functional approach of human ecosystems is also helpful to see architecture as one of the scales. The systems approach covers the whole site (in its broader and finer scales), the building and its overall processes, approaching them with an ecological context for architecture of sustainability. The prerequisite of ecological design is the systematic understanding of the overall phenomena interpreted as a self-reliance or self sufficiency theme, and its being supported with the bioethical theme by the designer.

Therefore the ecological integrity of the environment in all of the scales, from the physically intervened scale to the global responsibility, is to be rethought. This process was defined in the 'Theoretical Background' chapter. Architecture, which causes spatial disturbance to ecosystems, has a continuous material flow and energy flows have impact on systems in various and quite complex ways. Current practice of human activities does not only disturb living organism and ecosystems but they even have impact on human life and health like indoor pollutants. Building and construction in the terms of Lyle (1985) take their place as scales of the human ecosystem; the notion of impact must be understood in its stages. This is no easy task, but institutions and practitioners of architecture produce several methods. The planning, design, activities and buildings interpreted as development and its impacts are given in Appendix A as 'The Impacts of Development'. The impact of development criteria and checklist of the impact of development are adapted from the Book of National Park Service. Another impact study for buildings is provided by the BREEAM's environmental impact statements.

This impact analysis method can be seen briefly as covering three main environmental issues, such as 1) Global issues and the use of resources, 2).Local issues, 3) indoor issues.

Locational patterns, structural elements and the functionalist approach, in similar analysis are defined in Daniels' book as exterior space, technical installation and building fabric (Figure 4-1).

Exterior space

Air
- Free air
  - Natural ventilation
  - Wind force
  - Energy content
- Stack effect
  - Solar energy, diffuse radiation
  - Solar energy, direct radiation

Soil
- Aquifer
  - Heat storage
  - Cold storage
- Groundwater
  - Cold energy
  - Heat energy
- Earth/rock
  - Geothermal cooling
  - Heat energy

Water surfaces
- Lake
  - Pump water or greywater
  - Heat energy
  - Cold energy
- River
  - Pump water or greywater
  - Heat energy
  - Cold energy

Technical installations

Heat energy
- Direct
  - District heating
  - Boiler (gas, oil, coal, biogas, condensing)
  - Electrode boiler (with storage)
- Indirect
  - Active solar technology
  - Combined heat and power plant (CHP)
  - Heat pump (absorber, solar, bore holes)
  - Flue heat exchanger

Cooling energy
- Direct
  - Electrically driven chiller
  - Absorption chiller
  - Gas-motor driven chiller
  - Cooling towers (free cooling)
  - Tandem systems
- Indirect
  - Cold storage in building
  - Cold storage in terrain
  - Bore holes

Electrical energy
- Mains supply
  - Commercial power supply utilities
- Self supply
  - Combined heat and power plant
  - Emergency generator
  - Photovoltaic
  - Tandem system
  - Wind generator

Water
- Pure water
  - Public supply (drinking, cooking)
- Greywater
  - Waste water (condenser water, flushing, cleaning)
- Rainwater
  - Flushing, cleaning, cooling

Building fabric

Façade and roof
- Transparent insulating material
- Photovoltaic
- Absorber surface
- Storage masses
- Planted surfaces
- Rainwater
- Daylight elements
- Collectors

Construction
- Storage masses
- Passive solar absorber
- Heat exchanger elements
- Night cooling by outside air

Atria
- Green zones
- Evaporative cooling
- Passive solar energy
- Heat buffer

Figure 4-1. A similar method of the phenomena of the building and its environment proposed by Daniels (1994)

Daniels, in his book proposes an ecological circle showing the basic correlation of exterior space, technical installation and building fabric, in which the location, functional and structural correlation is found (Figure 4-2). The line within the circle takes a phenomenon (here cooling strategy and its interactions) and tries to define the interactive mechanism and working of the locational-structural and functional aspects of the building ecosystem (Daniels, 1994).

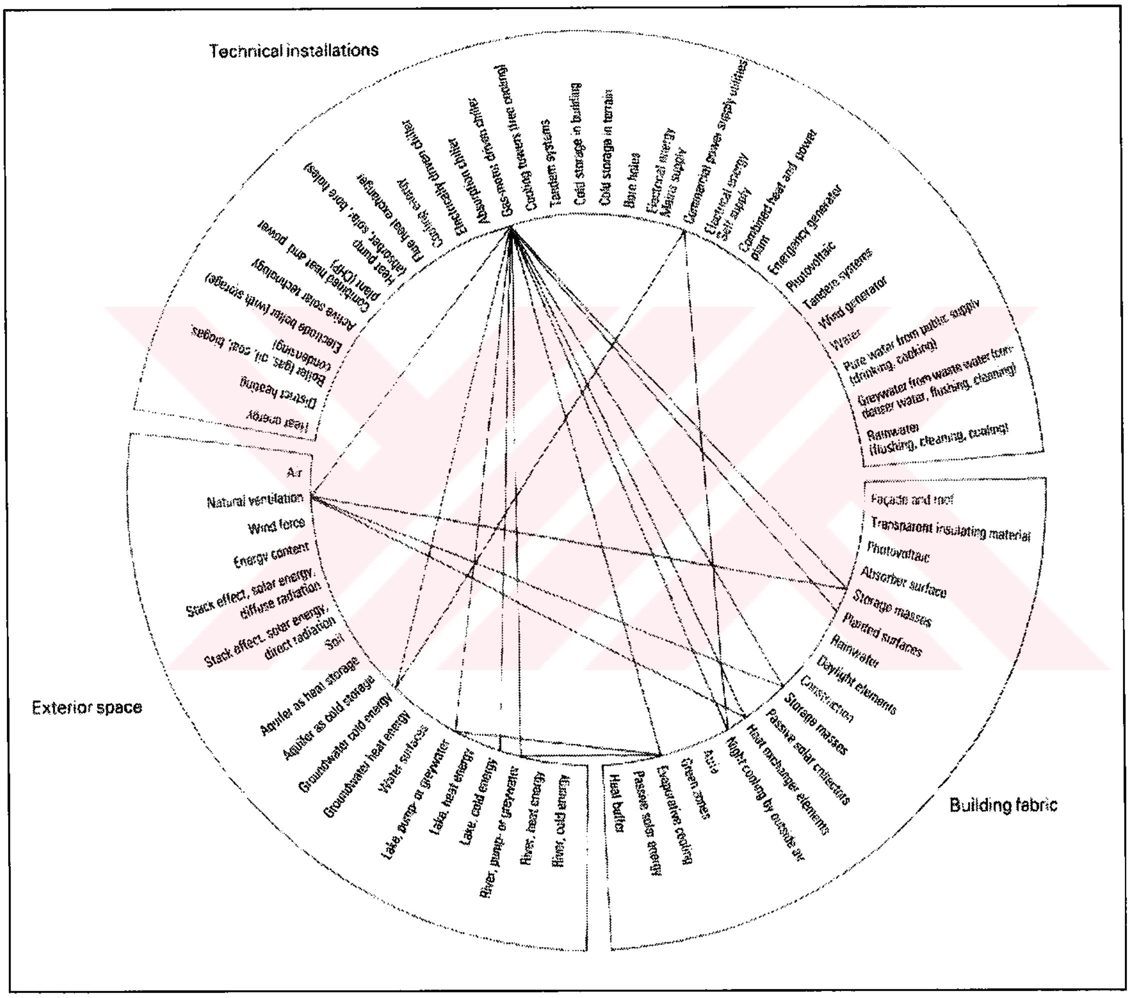

Figure 4-2. The Ecological Circle (Daniels, 1994)

One important factor here is to denote the impact statement also from the technological viewpoint; the success and efficiency of being ecological is interpreted as being less damaging.

1. The primary characters for ecological architectural design in the locational processes:

- The bioethical theme and understanding the site of develoment as an ecosystem so as to design it as a human ecosystem.
- View buildings in broader and in finer contexts (physically, biologically, socially, economically).
- The climatic Imperative
- Minimization of use of inputs and outputs by efficiency, reduction and reuse.

2. The Structural Attributes

- Use of natural phenomena, plants, and geology as building components.
- Emphasize natural materials.
- Design components for reuse and reduce.
- The choice of technology.

3. Functional Attributes

- Use of natural phenomena, plants, geology as building components.
- Choice of Technology.
- The system design.
- Input-output context and design.

Most of these were discussed through but a discussion need to be concentrated as in;

1. Site Design and Construction
2. Building Design and Construction
3. Building Service systems (Health Issues, Indoor Air Qualty, Systems,)
4. Materials

In many studies, which investigate the principles of ecological architecture, certain guidelines concerning the site and building design and construction are given. These are useful as broad concepts and they contain the definitions and categories of locational, structural and functional attributes. This thesis has preferred to make a synthesis of these guidelines and the locational, structural, functional method of ecological design thinking proposed in the theoretical background.

The locational-structural-functional matrix constructing the relationship of the elements of building design issues incorporate the sustainable measures of site and building design and construction. These include basically the technical attributes that can help for architecture of ecology.

4.2. Site Design and Construction

4.2.1. Site Analysis

For an ecological approach, all the specificities of the site have to be taken into consideration for the design of spaces, the provision for functions and for a proper adaptation to the locale. The following analysis itemizes the elements and issues to be taken into consideration. In order to make an intervention on the site, for understanding the opportunities and limitations of the site, a site analysis and assessment checklist is crucial.

Table 4-1. Site Analysis

Locational Patterns	Structural Elements and Relations	Functional Attributes
Geographical latitude (solar altitude) Microclimate factors, such as wind loads	Building layout Solar orientation Location of entrances, windows, and loading docks	Energy Efficiency Heating and Cooling Strategy
Topography Adjacent landforms	Building proportions, Wind loads, drainage strategies, Floor elevations, and Key gravity-fed sewer-line corridors	Water Runoff Waste Aesthetics
Groundwater characteristics Surface runoff characteristics	Building locations Locations of runoff detention ponds Natural channels for diverting storm runoff	Water Runoff Waste
Air-movement patterns (annual and diurnal)	Siting of multiple structures to avoid damming cold moisture-laden air blocking favorable cooling breezes during periods of overheating.	Designing interior air-handling systems Use of passive solar cooling strategies
Soil texture and its load-bearing capacity	Capacity building location on the site Capacity-type of footing required. Site-grading processes by the soil's potential for erosion by wind, water, and machine disturbance.	
Parcel shape and access	Affect a site's capacity to accommodate a proposed development, even if its size and environ-mental factors are favorable. Potential access points should not burden lower-density or less compatible adjacent land use. Zoning setbacks and easements can affect development potential	
Neighboring developments and proposed future developments	Affect proposed project and may lead to requisite design changes.	
Analyze specific characteristics of climate zones.		
Analyze the site's existing air quality.	Assessment of the existing air quality of the site to deter-mine the presence of noxious chemicals and suspended particulates, and (2) projection of the negative consequences (if any) of the proposed development on existing air quality	Ecological Integrity Indoor Air Quality Natural Ventilation

Table 4.1 Continued

Perform soil and groundwater testing.	Identify the presence of chemical residues from Past agricultural activities (arsenic, pesticides, and lead); Past industrial activities (dumps, heavy metals, carcinogenic compounds and minerals, and hydrocarbons); Any other possible contamination both on or in the vicinity of the subject site Possibility of water con-tamination, in areas where the native rock and substrata are radon-bearing deserves specific attention	Ecological Integrity
Test soil suitability for backfills, slope structures, infiltration.	The native soil should be tested to determine bearing, compactability, and infiltration rates, and, in turn, structural suitability and the best method for mechanical compaction	Ecological Integrity
Evaluate site ecosystem for existence of wetlands and endangered species.	Attention to vegetative-cover removal, grading, drainage alterations, building siting, and stormwater runoff mitigation Preserve specific plant and animal species	Ecological Integrity
Examine existing vegetation to inventory significant plant populations.	Specify vegetation that is susceptible to damage during construction So that protective measures to be developed and implemented.	
Map all natural hazard potentials (such as winds, floods, and mudslides).	Historic flood data Wind-damage data Subsidence data Annual wind Precipitation data	
Existing pedestrian and vehicular movement and parking	Relation to proposed building design and site circulation patterns.	

Table 4.1 Continued

Potential of utilizing existing local transportation resources.	Transportation	Site efficiencies
Local soil condition, geology, earth-moving constraints, and other site-specific factors and constraints.	Construction restraints and requirements	
Site's cultural resources for possible restoration.	Historical sites and features for preserving the area's cultural heritage.	
Architectural style of the area for incorporation into building.	Community integration.	
Explore use of historically compatible building types.	Building types that are historically matched to the region	
Existing utility and transportation infrastructure and capacity.	There may be insufficient existing infrastructure for the proposed project. The cost for required additional capacity and associated disruption to the surrounding area could make the project unfeasible. Existing infrastructure should be analyzed for integration into the building and facilities.	

4.2.2. Site Development and Layout

Site development and layout is the first phase of design process, which places the designed environment in several contexts with sustainable measures.

4.2.2.1. Infrastructure

Table 4-2. Infrastructure

Design the site plan to minimize Road length, Building footprint The actual ground area required for intended improvements.	Such planning decreases the length of utility connections. Let natural habitat growth.	Ecological Integrity Energy Efficiency Material Efficiency Cultural Integration
Use gravity sewer systems wherever possible Avoid pumped sewer systems because of ongoing power consumption.		Energy Efficiency Material Efficiency

Table 4.2 Continued

Reuse chemical-waste tanks and lines.	Existing chemical-waste tanks and lines should be inspected, protected, and reused to avoid creation of additional hazardous-materials problems.	Ecological Integrity Material Efficiency
Aggregate utility corridors when feasible.	Where possible, common site utility corridors should be consolidated along previously disturbed areas or along new road or walk construction, both to minimize unnecessary clearing and trenching and to ensure ease of access for ongoing repairs.	Energy Efficiency Material Efficiency

4.2.2.2.Transportation

Table 4-3. Transportation

Support reduction of vehicle miles traveled to the site.	Foster mass-transit use. Foster the use of bicycles, and pedestrian traffic	Energy Efficiency Cultural Integration
Use existing vehicular transportation networks to minimize the need for new infrastructure.	Site efficiencies associated with reduced ground coverage, parking requirements, and related costs.	Material Efficiency
Consider increased use of telecommuting strategies.	Telecommuting and teleconferencing can reduce commute time	Energy Efficiency
Consolidate service, pedestrian, and automobile paths.	Improve efficiency, and centralize runoff, the pattern of roads, walkways, and parking should be compact	Energy Efficiency Material Efficiency

4.2.3. Building and Site Requirements

This matrix proposes sustainable methods of designing the relationship between the land and the building.

4.2.3.1.Land Features

Table 4.4 Land Features

Develop previously disturbed sites such as unused urban lots and commercial sites.	Affecting the environmental quality of neighboring properties, the watersheds, and other features, redevelopment requires minimal disturbance of natural systems	Ecological Integrity Energy Efficiency Material Efficiency Cultural Integration Redevelopment is likely to improve the immediate community, Potentially create jobs, and Increase land values that have been affected by the abandoned or blighted property.
Avoid stream channels, flood plains, wetlands, steep erodible slopes, and mature vegetation.	Preserve important visual and ecological features, resources.	Ecological Integrity Energy Efficiency Material Efficiency Avoid high site-preparation costs Cultural Integration

4.2.3.2. Building and Site Orientation

Table 4.5 Building and Site Orientation

site clearing and planting to take advantage of solar and topographic conditions.	Solar orientation, sky conditions (cloudy versus clear), and topography are interrelated. A site's latitude determines the sun's altitude and associated azimuth for any given time of day, each day of the year.	Energy Efficiency solar access

Table 4.5 Continued

Take advantage of shade and airflows	Orientation of the building Placement of solar collectors or photovoltaic systems are proposed, cooling ponds and wind generators	cooling in summer passive solar energy for heating and wind protection in winter
Minimize solar shadows	Prevent the creation of solar voids and cold-air-drainage dams especially for cold and temperate climates.	Energy Efficiency
Minimize earthwork and clearing	Aligning long buildings and parking lots with landscape contours; Take up excess slope with half-basements and staggered floor levels.	Ecological Integrity
North Orientation.	Provide a north-wall design that minimizes heat loss. Provide entrances with airlocks, and limit glass to prevent heat loss in human-occupied areas.	Energy Efficiency Large buildings in cold or temperate climates require air-handling system.
The building should be positioned on the site so that its entrance provides maximum safety and ease of access, as well as protection	Provide a building-entrance orientation that maximizes safety and ease of access	Energy Efficiency Cultural Integration

4.2.4. Landscaping and Use of Natural Resources

Table 4-6 Landscaping and Use of Natural Resources

Harness Solar energy, Airflow patterns, Natural water sources Insulating quality of land forms for building temperature control.	Existing water sources and landforms can be used to create winter heat sinks in cold climates, and temperature differentials for cooling air movement in hot climates. Existing streams or other water sources can contribute to radiant cooling for the site. Color and surface orientation may be used to favorably absorb or reflect solar energy.	Ecological Integrity Energy Efficiency Material Efficiency Cultural Integration

Table 4.6 Continued

Use existing vegetation to Moderate weather conditions Provide protection for native wildlife	Vegetation to provide shade and transpiration in the summer and wind protection in the winter. Additionally, vegetation can provide a natural connection for wildlife corridors.	Ecological Integrity
Design access roads, landscaping and ancillary structures to	channel wind toward main buildings for cooling Or away from them to reduce heat loss	Ecological Integrity Energy Efficiency

4.2.5. Public Amenities

Table 4.7. Public Amenities

Modify microclimates to maximize human comfort in the use of outdoor public amenities such as plazas, sitting areas, and rest areas.	Modulate sun and wind in planning outdoor public amenities, the designer needs to consider seasonal weather patterns and climate variables Introduce structures and plantings that provide shelter from harsh elements and highlight desirable features. Modulation of tree-canopy heights and inclusion of water fountains and other built structures can fine-tune an exterior site by accelerating or decelerating site winds, casting shadows, or cooling by evapotranspiration or evaporative cooling.	Ecological Integrity Energy Efficiency Cultural Integration
Consider sustainable site materials for public amenities.		Energy Efficiency Material Efficiency
Specify sustainable site construction methods.		Energy Efficiency Material Efficiency
Develop sequential staging to minimize site disruption.		Energy Efficiency Material Efficiency

4.2.6. Construction In the Site

What will follow in itemized form, has already been presented in the previous table as design conceptions; however, with the intention to make more definite, the applications of these design comceptions as constructions on the site is provided below.

4.2.6.1. Water Issues

Preservation of Soils and Drainage Ways

- Emphasize preservation of mature vegetated soils and lowland areas.
- Minimize pavement area.
- Install silt fences to hold sediment on-site during construction.
- Minimize use of landscape irrigation, herbicides, pesticides, and fertilizers.
- Porous Paving Materials
- Consider use of permeable paving materials
- Use permeable vegetated surfaces for occasionally used vehicular surfaces and similar areas.
- Build pedestrian surfaces, such as walkways and patios, with loose aggregate, wooden decks, or well-spaced paving stones.
- Drainage of Concentrated Runoff
- Consider disconnecting pre-existing downspouts and storm sewers from sanitary sewers.
- Discharge downspouts into an earthen depression or gravel-filled pit for infiltration.
- Moderate and treat runoff from roofs and unavoidable impervious pavements, and, to the degree possible, return it to its natural path in the soil
- Construct infiltration basins.

4.2.6.2. Water Efficiency and Conservation

Water Harvesting

- Collect and use “harvested” water.
- Collect and use rainwater.
- Consider quality of rainwater.
- Design an appropriate harvesting and storage system.
- Filter and/or treat rainwater to use it as an irrigation source and with additional treatment potable water.

Landscaping

- Plant native or well-adapted species.
- Preserve native plant populations through careful site planning and protection of existing vegetation.
- Restore the native landscape.
- Minimize use of high-maintenance lawns.
- Minimize use of annual plants.
- Establish high and low maintenance zones.

4.2.6.3. Soil

- Obtain and evaluate the chemical and physical characteristics of site soils.
- Amend the soil in planting areas according to professional advice.
- Protect the soil during construction.
- Carefully design for grading and excavation.
- Follow all applicable erosion-control regulations.
- Stabilize soil during and after construction.

- Use bio-engineering.
- Schedule soil-maintenance tasks.
- A site-specific schedule of soil-maintenance tasks, in parallel with planting-maintenance tasks, should be developed.

4.2.6.4. Plants

- Preserve existing vegetation, especially native plants.
- Protect existing plants during construction
- Design new plantings as diverse communities of species well-adapted to the site.
- Follow Xeriscape principles.
- The seven basic Xeriscape principles for conserving water and protecting the environment are: planning and design, use of well-adapted plants, soil and climate analysis, practical, reduced turf areas, use of mulches, appropriate maintenance, and efficient irrigation by grouping plants with similar water needs. Coordinate plantings with water harvesting systems.
- Use plants to mitigate climate conditions.
- Use a reputable nursery or contractor to supply and install plants.
- Employ integrated pest management (IPM) against insects and weeds.
- Use mulching, alternative mowing, and composting to maintain plant health.

4.2.6.5. Paving Materials

- Limit paved areas to the strict minimum for their intended purpose.
- Carefully distinguish between light-vehicular, heavy-vehicular, and pedestrian paving .

- Use water-permeable or “porous” paving.
- Design paving to serve dual purposes.
- Design to minimize runoff.
- For light-duty roads and paths, stabilize without pavement.
- Locate pavement where solar heat gain is desirable.
- Reduce material use, reuse, and recycle—in that order of priority.
- Use new materials thoughtfully; consume the minimum for the purpose; avoid waste.
- Perform an environmental-impact and cost analysis of all materials based on life-cycle principles.

4.3. Building Envelope

The building envelope relates the location, and the structure in order to function with minimum energy consumption and site impact. This includes primarily focusing on the building shape and orientation and the relationship of doors, windows and openings, which are explained briefly below.

4.3.1. Building Shape and Orientation

- Choose the most compact building footprint and shape that work with requirements for daylighting, solar heating and cooling, and function.
- Site and orient the building so as to minimize the effects of winter wind turbulence upon the envelope.

4.3.2.Doors, Windows, and Openings

- Size and position doors, windows, and vents in the envelope based on careful consideration of daylighting, heating, and ventilating strategies.

- The form, size, and location of openings may vary depending on how they affect the building envelope. Shade openings in the envelope during hot weather to reduce the penetration of direct sunlight to the interior of the building.
- Use overhangs or deciduous plant materials on southern orientations to shade exterior walls during warmer seasons.
- Select the proper glazing for windows, where appropriate.

4.4. Building Service Systems

The building service systems, that is the functioning of the building incorporates two stages of design. The goal of the architecture of ecology is to supply the functioning of the system requirements (ventilation, heating, cooling, and lighting) by natural phenomena but in most sites or building configuration this is not enough to supply the required levels of human comfort and design. At this point the mechanical equipment for building service systems are required. The sustainable measure of this category of building design includes the below issues when the use of building service systems is inescapable.

4.5. Materials

The material section focuses on the selection of the material thinking and the life-cycle of the materials in the building process and the environmental impacts during this lifetime process. The subject of the influence of material selection in the design of buildings is one of the most critical issues of the ecology of architecture.
Sustainable practice of the material design in buildings refers to concentrating on two main issues;

- Material selection
- Material impacts

Consider the following criteria in materials selection:

- Resource quantity.
- Reused materials.
- Recycled content.
- Renewability and use of sustainable management practices.
- Local content and reduced transportation.
- Regional appropriate materials.
- Life-cycle cost and maintenance requirements.
- Resource Recovery and recycling.

Review emission levels from building products at the following stages:

- Installation.
- Building occupancy.
- Maintenance and removal.

4.6. Conclusion: The Imperative of Ecological Strategies

The above issues presented both as matrixes and guidelines, provide in a way the grammar and the vocabulary of the language of architecture of ecology. Thus, the production of this architecture is very much based on architects' approach and how they relate the building program and the above measures.

CHAPTER 5

CONCLUSION

The thesis has primarily researched the function and the place of ecology in architectural design. Such an inquiry places architecture in a different context than that of contemporary architecture. Thus architecture of ecology means more than a style and is rather an already known (by tradition) and a reinvented (by science) and perpetually revalued (by aesthetical, social, economical and technological changes) process to describe the imperatives of future architecture.

The architecture of ecology and/or sustainability necessitates the use of and/or the interpretation of the natural phenomena within the metabolism of the building. Buildings are not merely machines but they are metabolisms both affected by their own physical and, biological dynamics and the dynamics of human culture. Thus the built environment or in other words architectural production can also be defined as a human ecosystem. The most important aspect of this human ecosystem is that it is the subsystem of a larger system, of the whole real-world complexities.

From a systems viewpoint, sustainability and its architecture can be described as a feedback in the following way. The signaling and the reaction of environmental crisis in biological and physical terms as well as cultural and spiritiual terms is the effect of a feedback of the system. Thus such a negative feedback necessitates the emergence of an architecture of sustainability. Then the architecture of sustainability is a new concept even though most of its practice has long existed. The current practice of architecture mostly moves along the path of global culture, upon faith in technology, and with high cultural attitudes. There are also breakdowns in the production of ecological knowledge for architectural practice and theory in institutions of education and of legislation. So that, until recently ecological architecture or the architecture of sustainability has been the architecture of the few, either as individual designers or as community dwellers. It has been supported especially by radical thinkers. Ecology, intiutively and/or scientificaly (as a developing discipline) has been the motto for the whole phenomena such that it constructed the base for the relationship of human activities and nature (bioethics and self-reliance).

The thesis concentrated on aspects of the sustainable relationships for the design of the environment with the intention of viewing architecture as a human ecosystem and analyzing it with the ecosystemic method belonging to the locational-structural-functional approach. With this methodological approach to design, the role of the technological dimension is investigated. Integration and adaptation of design to the environment which is the ecological prerequisite, is to be achieved with the locational-structural-functional approach. In this way the appropriate technology can be chosen, because technology is determined by the limitations and potential of the environment. It is asserted that at the end of such a process proposed by the ecological approach, the buildings and the designed environments are integrated and adapted to their broader and finer contexts.

Technology is actually a cultural phenomenon. In this thesis cultural analysis has been implicitly discussed, so that here it can be put forward more explicitly as a concluding statement. The effort of the thesis to describe the technological aspect is then also an effort to describe one of the keystones of culture. There are other dimensions of cultural analysis, which are inseperable from each other like economics, politics, ethic, aesthetics. These various aspects are manifested concretely in the production of architecture and in the design of the environment.

It is clear that ecology and design cannot be evaluated from two totally polarized views, as has so far been the case in the technological and ecological sustainability approaches. The assumption and claim of this thesis is that for the possible solutions for the ecological dimension of human activities in nature a reconciliation of the two divergent views is imperative. This thesis makes an inquiry into the theory and practice of such a reconciliation by its proposed method.

Some of the cultural points having ecological implications are interpreted by authors like Kevin Lynch, Christopher Alexander, Amos Rapoport, Paul Oliver, Ian McHarg. For example, the approach of Alexander was ecological in terms of his interpretations of architectural forms and processes as patterns and his relating these patterns with each other in order to form coherent designed environments. In an interesting way, he uses both a systematric thinking of patterns for architecural production and an understanding of a sustainable life-style approach. His approach is influenced both by traditional architecture and its ecological (bioethical and self-reliance) qualities and by the modern methods of design analysis.

Therefore at the end of the thesis such conclusions can be taken.

1. Architecture (building) has to be regarded primarily as impact (upon the environment - by its processes of production).

2. It is a symbol which reflects the present situation of the nature-humanity relationship.

3. It is a symbol which shows that each society in different locations perceives nature differently.

4. It also shows that the current state of architectural production is in friction with nature and with humanity. Furthermore architecture being inherently a production of the ecumen, most recent architecture falls in conflict with itself.

The thesis has tried to bring to attention the various discourses of environmental critisism and the reactions to the design of the built environment. The general perspective of sustainability reveals a dynamism within itself and the various forms of sustainbale architecture can be seen as the reflection of this dynamism.

This thesis stresses that whatever the case or mode of approach may be, any ecological or sustainable design should take into consideration Forman's method. (Forman, 1995). Forman focuses primarily on ecological integrity and the supply of basic human needs. Forman's assumptions provide the foundation for the survival of nature and humanity together and for the ecological design premises as stated in the chapter concerning the theoretical background. As stated before, the ecological approach defines the potential of the environment for survival, drawing the limitations for human intervention. It is these limitations that provide the opportunies for the innovative mind of humanity. This understanding was one of the main contentions of the thesis, which tried to demonstrate that the ecological qualities of vernacular architecture were derived essentially from the awareness of such limitations and also that today ecological approaches also make use of these limitations in their solutions.

The main aspect of ecological architecture is that it is not merely an architecture standing alone but it lives with its environment with both the natural phenomena and the people.

Is there an ultimate ecological architecture?

The idea of perfection and permenance belongs to humanity. Human beings construct their environments with ideals and with utopias. In other words, they search for the ideal. Contrary to common opinion, ecological architecture tries to deal with the real conditions and its idealism consists in its effort to perceive environmental dilemnas and concentrate on them. Thus ecological architecture can never be idealistic in a utopian way. The architecture of ecology aims to solve as many problems as it can as effectively as possible. In this way, it is wholistic, and realistic, and focuses not on the illusionary or allusionary constructions, but on real-world complexities.

The question, "Is there an ultimate ecological architecture?" has been asked in the beginning of the thesis and has been one of the prime questions of the thesis. The ecological valued environment and the ecosystematic study of the environment concerning architecture with the proposed thinking methods in Chapters 2, 3 and 4 reveal that there can be no ideal architecture of ecology. But ideality is assessed in each unique example with the cooperation of the designer with nature and his sensitivity towards the environment, primarily coping and solving the problematic points, thus finding potentials in problems. Minimizing the material exchanges does not mean mere simplicity, but a functional and aesthetic product will occur when the functions and aesthetization derives from the potentialities of the natural and the cultural context in different scales.

The ecological approach does not simplify architecture but it enriches architecture and its environment because it reflects the dynamism of the environment within itself, creating a new, natural aesthetic.

APPENDIX A

Environmental Impacts of Development*

*Adapted from the *Guiding Principles of Sustainable Design*, U.S. National Park Service document obtained at Internet Site: http://www.nps.gov/dsc/dsgncnstr/dgsd/

Table 1a. Site Access, Development and Pollution

Development Type/ Activity	Noise increased	Air quality deteriorated	Toxics released during construction	Toxic materials spilled or discharged	Pollutants introduced by vehicle transport	Petroleum products spilled	Toxics or sewage discharged by vessels	Odors released	Hot water discharged	Erosion increased
Terrestrial										
- Roads	X	X	X	-	X	X	-	-	-	X
- Trails	X	-	-	-	-	-	-	-	-	X
- Boardwalks	X	-	X	-	-	-	-	-	-	-
Aquatic										
- Docks and piers	-	-	-	-	-	X	X	-	-	-
- Open anchorage	-	-	-	-	-	X	X	-	-	-
Air										
- Airport/ strip	X	X	X	-	X	X	-	-	-	X
- Helicopter pad	X	X	X	-	X	X	-	-	-	X
- Seaplane dock	X	X	-	-	X	X	-	-	-	-
Remote/indirect										
- Remote TV	-	-	-	-	-	-	-	-	-	-

Table 1b. Site Access, Development and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered	Dredging potentially required
Terrestrial									
- Roads	X	X	X	X	X	-	-	-	X
- Trails	X	X	-	X	-	-	-	-	X
- Boardwalks	-	-	-	-	-	-	-	-	-
Aquatic									
-Docks and piers	-	-	-	-	-	-	X	X	-
-Open anchorage	-	-	-	-	-	-	-	-	X
Air									
- Airport/ strip	X	X	X	X	-	-	-	-	X
- Helicopter pad	X	X	-	-	-	-	-	-	X
- Seaplane dock	-	-	-	-	-	-	-	-	-
Remote/indirect									
- Remote TV	-	-	-	-	-	-	-	-	X

Table 1c. Site Access, Development and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife move-ment created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly intro-duced	Diseases introduced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Non-natural foods or habitat intro-duced	Non-target species destroyed
Terrestrial														
- Roads	X	X	X	X	-	X	X	X	X	-	X	X	-	-
- Trails	X	X	X	-	-	-	-	X	-	-	-	-	-	-
- Boardwalks	-	-	X	-	-	-	-	X	-	-	-	-	-	-
Aquatic														
- Docks and piers	-	-	-	-	X	-	-	-	-	-	-	-	-	-
- Open anchorage	X	X	X	X	X	-	-	-	-	-	-	-	-	-
Air														
- Airport/ strip	X	X	X	X	-	X	-	-	-	-	-	-	-	-
- Helicopter pad	X	X	X	-	-	-	-	-	-	-	-	-	-	-
- Seaplane dock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Remote/ indirect														
- Remote TV	X	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2a. Construction and Landscaping and Pollution

Development Type/ Activity	Noise increased	Air quality deteriorated	Toxics released during construction	Toxic materials spilled or discharged	Pollutants introduced by vehicle transport	Petrollium products spilled	Toxics or sewage discharged by vessels	Odors released
Site preparation								
- Excavation	X	X	-	-	X	X	-	-
- Filling	X	X	-	-	X	X	-	-
- Draining	-	-	-	-	-	-	-	-
- Grading	X	X	-	-	X	X	-	-
Foundation								
- Slab	-	-	-	-	-	-	-	-
- Excavated	X	X	-	-	-	-	-	-
- Elevated	-	-	X	-	-	-	-	-
Landscaping								
- Shaping/ planting	X	X	-	-	-	-	-	-
- Ponds	-	-	-	-	-	-	-	-
- Swimming pools	-	-	-	-	-	-	-	-
- Restoration	X	X	-	-	-	-	-	-

Table 2b. Construction and Landscaping and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered
Site preparation								
- Excavation	X	X	X	X	X	-	-	-
- Filling	X	X	X	X	X	-	-	-
- Draining	-	-	-	-	X	X	-	-
- Grading	X	X	X	-	X	X	-	-
Foundation								
- Slab	-	-	X	-	X	-	-	-
- Excavated	-	-	X	X	X	-	-	-
- Elevated	-	-	-	-	-	-	-	-
Landscaping								
- Shaping/ planting	X	X	X	-	-	-	-	-
- Ponds	-	-	-	X	X	-	-	-
- Swimming pools	-	-	-	X	X	X	-	-
- Restoration	-	-	-	-	-	-	-	-

Table 2c. Construction and Landscaping and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife move-ment created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly intro-duced	Diseases intro-duced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Non-natural foods or habitat intro-duced	Nontarget species destroyed
Site preparation														
- Excavation	X	X	X	X	-	-	-	-	-	-	-	-	-	-
- Filling	X	X	X	X	-	-	-	-	X	-	-	-	-	-
- Draining	X	X	X	X	-	X	-	-	-	-	X	X	-	-
- Grading	X	X	X	X	-	-	-	-	-	-	-	-	-	-
Foundation														
- Slab	-	X	-	X	-	-	-	-	-	-	-	-	-	-
- Excavated	-	X	-	X	-	-	-	-	-	-	-	-	-	-
- Elevated	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Landscaping														
- Shaping/ planting	X	X	X	-	X	X	-	X	X	X	X	X	X	-
- Ponds	-	X	-	X	-	-	-	-	-	-	-	-	-	-
- Swimming pools	-	X	-	X	-	-	-	-	-	-	-	-	-	-
- Restoration	X	X	-	-	-	-	-	-	-	-	-	-	-	-

Table 3a. Energy and Pollution

Development Type/ Activity	Noise increased	Air quality deteriorated	Toxics released during construction	Toxic materials spilled or discharged	Pollutants introduced by vehicle transport	Petrollium products spilled	Toxics or sewage dis-charged by vessels	Odors released
Supply Source								
- wood-local	-	X	-	-	-	-	-	-
- Fossil- imported	-	X	-	X	X	X	-	-
- Biogas- local	-	-	-	-	-	-	-	X
- Propane- imported	-	X	-	-	X	-	-	-
- Solar	-	-	-	-	-	-	-	-
- Windmill- local	-	-	X	-	-	-	-	-
- Hydroelectric (with dam and storage)	-	-	X	-	-	-	-	-
- Hydroelectric (small- scale, water wheel or ram)	-	-	-	-	-	-	-	-
- Hydrothermal	-	-	X	-	-	-	-	-
- Electric- imported	-	-	X	-	-	-	-	-
- Electric- local	X	X	X	-	X	X	-	X
- Natural Gas- imported	-	-	X	X	-	-	-	-
Transmission of								
Powerlines								
- Above ground	-	-	X	-	-	-	-	-
- Buried	-	-	X	-	-	-	-	-
Pipes								
- Above ground	-	-	X	X	-	-	-	-
- Pipes	-	-	X	X	-	-	-	-
- Vehicle- bulk (also requires road access)	X	X	-	X	X	X	-	-
- Boat- bulk (also requires docks, piers)	X	X	-	-	-	X	X	-

Table 3b. Energy and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered
Supply Source								
- wood-local	-	-	-	-	-	-	-	-
- Fossil- imported	-	-	-	-	-	-	-	-
- Biogas- local	-	-	-	-	-	-	-	-
- Propane- imported	-	-	-	-	-	-	-	-
- Solar	-	-	-	-	-	-	-	-
- Windmill- local	-	-	-	-	-	-	-	-
- Hydroelectric (with dam and storage)	-	-	X	X	X	-	-	-
- Hydroelectric (small- scale, water wheel or ram)	-	-	X	-	-	-	-	-
- Hydrothermal	-	-	X	X	-	X	-	-
- Electric- imported	-	-	X	-	-	-	-	-
- Electric- local	-	-	X	-	-	-	-	-
- Natural Gas- imported	-	-	X	-	-	-	-	-
Transmission of								
Powerlines								
- Above ground	-	-	X	-	-	-	-	-
- Buried	-	-	X	-	-	-	-	-
Pipes								
- Above ground	-	-	X	-	-	-	-	-
- Pipes	-	-	X	-	-	-	-	-
- Vehicle- bulk (also requires road access)	-	-	-	-	-	-	-	-
- Boat- bulk (requires docks, piers)	-	-	-	-	-	-	-	-

Table 3c. Energy and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife movement created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly introduced	Diseases introduced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Nonnatural foods or habitat introduced	Nontarget species destroyed
Supply Source														
- wood-local	X	X	X	-	-	-	-	-	-	-	-	-	-	-
- Fossil- imported	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Biogas- local	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Propane- imported	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Solar	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Windmill- local	X	-	-	-	-	-	-	-	-	-	-	-	-	-
- Hydroelectric (with dam and storage)	X	X	X	X	-	X	-	-	-	-	-	X	-	-
- Hydroelectric (small- scale, water wheel or ram)	X	-	X	-	-	-	-	-	-	-	-	-	-	-
- Hydrothermal	X	-	X	-	-	-	-	-	-	-	-	-	-	-
- Electric- imported	X	X	X	-	-	-	X	X	X	-	X	-	-	-
- Electric- local	X	-	X	-	-	-	-	-	-	-	-	-	-	-
- Natural Gas- imported	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Transmission of														
Powerlines														
- Above ground	X	X	X	-	-	-	X	X	X	-	X	-	-	-
- Buried	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Pipes														
- Above ground	X	-	X	-	-	X	-	-	-	-	-	-	-	-
- Pipes	X	-	X	-	-	-	-	-	-	-	-	-	-	-
- Vehicle- bulk (also requires road access)	-	-	-	-	-	-	X	-	X	-	-	-	-	-
- Boat- bulk (also requires docks, piers)	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Table 4a. Water and Pollution

Development Type/ Activity	Noise increased	Air quality deteriorated	Toxics released during construction	Toxic materials spilled or discharged	Pollutants introduced by vehicle transport	Petrollium products spilled	Toxics or sewage discharged by vessels	Odors released	Hot water discharged
Supply									
- Wells	-	-	-	-	-	-	-	-	-
- Cisterns	-	-	X	-	-	-	-	-	-
- Impoundments	-	-	-	-	-	-	-	-	-
- Diversions	-	-	-	-	-	-	-	-	-
- Desalinization	-	-	X	-	-	-	-	-	X
- Recycling	-	-	X	-	-	-	-	-	-
- *Importing (also requires road access)*	X	X	-	X	X	X	-	-	-
Distribution									
- Above ground pipes	-	-	X	-	-	-	-	-	-
- Buried pipes	-	-	X	-	-	-	-	-	-
- Vehicle transport (also requires road access)	X	X	-	-	X	X	-	-	-

Table 4b. Water and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered	Dredging potentially required
Supply									
- Wells	-	-	-	-	-	X	X	-	-
- Cisterns	-	-	-	-	-	-	-	-	-
- Impoundments	-	-	X	X	X	-	-	-	-
- Diversions	-	-	-	-	X	-	-	-	-
- Desalinization	-	-	-	-	-	-	-	-	-
- Recycling	-	-	X	-	-	-	-	-	-
- Importing (also requires road access)	-	-	-	-	-	-	-	-	-
Distribution									
- Above ground pipes	-	-	X	-	-	-	-	-	-
- Buried pipes	-	-	X	-	-	-	-	-	-
- Vehicle transport (also requires road access)	-	-	-	-	-	-	-	-	-

Table 4c. Water and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife movement created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly introduced	Diseases introduced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Nonnatural foods or habitat introduced	Nontarget species destroyed	Animal rights issues raised
Supply															
- Wells	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Cisterns	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Impoundments	X	X	X	X	-	X	-	-	-	-	-	X	-	-	-
- Diversions	X	X	X	-	-	-	-	-	-	-	-	X	-	-	-
- Desalinization	X	X	X	-	X	-	-	-	-	-	-	X	X	-	-
- Recycling	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-
- Importing (also requires road access)	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-
Distribution															
- Above ground pipes	X	-	X	-	-	X	-	-	-	-	-	-	-	-	-
- Buried pipes	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-
- Vehicle transport (also requires road access)	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-

Table 5a/6a/7a.Waste Disposal/Storage/Communication/Walls and Fences and Pollution

Development Type/ Activity	**Noise increased**	**Air quality deteriorated**	**Toxics released *during* construction**	**Toxic materials *spilled or* discharged**	**Pollutants introduced by vehicle transport**	**Petrollium *products* spilled**	**Toxics or sewage discharged by vessels**	**Odors released**
Waste Disposal/Storage								
Human/ organic (secondary, onsite)	-	-	X	X	-	-	-	X
Solid/ Trash (landfill, offsite)	X	X	-	-	X	X	-	X
Communication								
Radio/ microwave transmission tower	-	-	X	-	-	-	-	-
Satellite	-	-	-	-	-	-	-	-
Telephone	-	-	-	-	-	-	-	-
- Lines above ground	-	-	X	-	-	-	-	-
- Lines buried	-	-	X	-	-	-	-	-
Walls and Fences								
Stone wall	-	-	-	-	-	-	-	-
Cement/ Brick wall	-	-	X	-	-	-	-	-
Wooden fence	-	-	X	-	-	-	-	-
Wire fence	-	-	-	-	-	-	-	-
Open trench	-	-	-	-	-	-	-	-

Table 5a/6a/7a.Waste Disposal/Storage/Communication/Walls and Fences and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered
Waste Disposal/Storage								
Human/ organic (secondary, onsite)	-	-	X	-	X	X	-	-
Solid/ Trash (landfill, offsite)	-	-	-	-	-	-	-	-
Communication								
Radio/ microwave transmission tower	-	-	-	-	-	-	-	-
Satellite	-	-	-	-	-	-	-	-
Telephone	-	-	-	-	-	-	-	-
- Lines above ground	-	-	X	-	-	-	-	-
- Lines buried	-	-	X	-	-	-	-	-
Walls and Fences								
Stone wall	-	-	X	-	X	-	-	-
Cement/ Brick wall	-	-	X	-	X	-	-	-
Wooden fence	-	-	-	-	-	-	-	-
Wire fence	-	-	-	-	-	-	-	-
Open trench	-	-	X	X	X	-	-	-

Table 5a/6a/7a.Waste Disposal/Storage/Communication/Walls and Fences and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife movement created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly introduced	Diseases introduced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Nonnatural foods or habitat introduced	Nontarget species destroyed
Waste Disposal/Storage														
Human/ organic (secondary, onsite)	X	-	X	-	-	-	-	-	-	X	-	X	X	-
Solid/ Trash (landfill, offsite)	-	-	-	-	-	-	X	-	X	-	-	-	-	-
Communication														
Radio/ microwave transmission tower	X	-	-	-	-	-	X	-	-	-	-	-	-	-
Satellite	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephone	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Lines above ground	X	X	X	-	-	-	X	X	X	-	X	-	-	-
- Lines buried	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Walls and Fences														
Stone wall	-	X	-	X	-	X	-	-	-	-	X	-	-	-
Cement/ Brick wall	-	X	-	X	-	X	-	-	-	-	X	-	-	-
Wooden fence	-	-	-	X	-	X	-	-	-	-	X	-	-	-
Wire fence	-	-	-	X	-	X	X	-	-	-	X	-	-	-
Open trench	-	X	X	X	-	X	-	-	-	-	-	-	-	-

Table 8a. Operations and Maitenance and Pollution

Development Type/ Activity	Noise increased	Air quality deteriorated	Toxics released during construction	Toxic materials spilled or discharged	Pollutants introduced by vehicle transport	Petrollium products spilled	Toxics or sewage discharged by vessels	Odors released
Machinery/ vehicles	X	X	-	-	X	X	X	-
Routine recycling	-	-	-	-	-	-	-	-
Fire Management								
- Fire breaks	-	-	-	-	-	-	-	-
- Controlled burns	-	-	-	-	-	-	-	-
Wildlife Management								
- Introduce predators	-	-	-	-	-	-	-	-
- Trap/ poison species	-	-	-	X	-	-	-	-
- Trails	-	-	-	-	-	-	-	-
- Shoot species	-	-	-	-	-	-	-	-
- Sterilization	-	-	-	-	-	-	-	-
- Natural controls	-	-	-	-	-	-	-	-
Vegetation Management								
- Poisoning	-	-	-	X	-	-	-	-
- Cut/ clear	-	-	-	-	-	-	-	-
- Natural Controls	-	-	-	-	-	-	-	-
Activities								
- Hiking	X	-	-	-	-	-	-	-
- Boating	X	-	-	-	-	X	X	-
- Camping	X	X	X	-	X	X	-	-
- Snorkel/ SCUBA	X	-	-	-	-	X	X	-
- Horseback riding	X	-	-	-	-	-	-	X
- Nature study	X	-	-	-	-	-	-	-

Table 8b. Operations and Maitenance and Pollution and Physical Process

Development Type/ Activity	Erosion increased	Sedimentation/ siltation increased	Soil disturbed or compacted	Soil removed and disposed of	Surface water flow disrupted	Groundwater supply reduced	Groundwater supply depleted	Long-shore dirt/ beach dynamics altered
Machinery/ vehicles	-	-	-	-	-	-	-	-
Routine recycling	-	-	-	-	-	-	-	-
Fire Management								
- Fire breaks	X	X	X	-	X	-	-	-
- Controlled burns	-	-	-	-	-	-	-	-
Wildlife Management								
- Introduce predators	-	-	-	-	-	-	-	-
- Trap/ poison species	-	-	-	-	-	-	-	-
- Trails	-	-	-	-	-	-	-	-
- Shoot species	-	-	-	-	-	-	-	-
- Sterilization	-	-	-	-	-	-	-	-
- Natural controls	-	-	-	-	-	-	-	-
Vegetation Management								
- Poisoning	-	-	-	-	-	-	-	-
- Cut/ clear	X	X	-	-	-	-	-	-
- Natural Controls	-	-	-	-	-	-	-	-
Activities								
- Hiking	X	-	-	-	-	X	-	-
- Boating	-	-	-	-	-	-	-	-
- Camping	-	-	-	-	-	-	-	-
- *Snorkel/ SCUBA*	-	-	-	-	-	-	-	-
- Horseback riding	X	-	-	-	-	-	-	-
- Nature study	-	-	-	-	-	-	-	-

Table 8c. Operations and Maitenance and Biological Systems

Development Type/ Activity	Vegetation altered	Vegetation destroyed	Habitat altered	Habitat destroyed or fragmented	Coral reefs disturbed or destroyed	Barriers to wildlife movement created	Collisions or road kill on wildlife increased	Corridors for exotic species invasion created	Exotic/ alien species directly introduced	Diseases introduced	Life cycles of wildlife disrupted	Nutrient flow/ food chains altered	Nonnatural foods or habitat introduced	Nontarget species destroyed
Machinery/ vehicles	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Routine recycling	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fire Management														
- Fire breaks	-	X	X	X	-	X	-	X	X	-	X	-	-	-
- Controlled burns	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Wildlife Management														
- Introduce predators	-	-	-	-	-	-	-	-	X	X	X	-	-	-
- Trap/ poison species	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Trails	-	-	-	-	-	-	-	-	-	-	-	-	-	X
- Shoot species	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Sterilization	-	-	-	-	-	-	-	-	-	-	X	-	-	-
- Natural controls	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetation Management														
- Poisoning	X	X	X	X	-	-	-	-	-	-	-	-	-	X
- Cut/ clear	X	X	X	X	-	-	-	-	-	-	-	-	-	-
- Natural Controls	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Visitor Activities (may require access roads, trails, docks, structures)														
- Hiking	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Boating	-	-	-	-	X	-	X	-	-	-	-	-	-	-

APPENDIX B

UIA/AIA World Congress of Architects

Chicago, 18-21 June 1993

In recognition that:

A sustainable society restores, preserves, and enhances nature and culture for the benefit of all life, present and future; a diverse and healthy environment is intrinsically valuable and essential to a healthy society; today's society is seriously degrading the environment and is not sustainable.

We are ecologically interdependent with the whole natural environment; we are socially, culturally, and economically interdependent with all of humanity; sustainability, in the context of this interdependence, requires partnership, equity, and balance among all parties.

Buildings and the built environment play a major role in the human impact on the natural environment and on the quality of life; sustainable design integrates consideration of resource and energy efficiency, healthy buildings and materials, ecologically and socially sensitive land-use, and an aesthetic sensitivity that inspires, affirms, and ennobles; sustainable design can significantly reduce adverse human impacts on the natural environment while simultaneously improving quality of life and economic well being.

We commit ourselves, as members of the world's architectural and building-design professions, individually and through our professional organizations, to:

Place environmental and social sustainability at the core of our practices and professional responsibilities

Develop and continually improve practices, procedures, products, curricula, services, and standards that will enable the implementation of sustainable design

Educate our fellow professionals, the building industry, clients, students, and the general public about the critical importance and substantial opportunities of sustainable design

Establish policies, regulations, and practices in government and business that ensure sustainable design becomes normal practice

Bring all existing and future elements of the built environment - in their design, production, use, and eventual reuse - up to sustainable design standards.

Olufemi Majekodunini

President

International Union of Architects

Susan A. Maxman

President

American Institute of Architects

APPENDIX C

Hannover Principles:

1. Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse, and sustainable condition.

2. Recognize Interdependence. The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.

3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry, and trade in terms of existing and evolving connections between spiritual and material consciousness.

4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist.

5. Create safe objects to long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.

6. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems in which there is no waste.

7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.

8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.

9. Seek constant improvements by sharing knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers, and users to link long-term sustainable considerations with ethical responsibility, and reestablish the integral relationship between natural processes and human activity.

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