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The Ecological Paradigm in Architecture

Comparative Study of Descartes and Ecological Paradigm and Their Influence in Architecture

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Abstract

The goal of this research is to find a theoretical base of the ecological paradigm, and explore the architectural ramification of the paradigm. To understand the paradigm in a historical and philosophical context, the paradigm is comparatively analyzed with the contrasting, Descartes-Newtonian paradigm to reveal the influence of each respective paradigm in various fields of science, such as logic, physics, bio-medical sciences, psychology, social sciences, and architecture. The affect in architectural ream is studied to find out the patterns of how the two contrasting paradigms have been materialized since the era of modern architecture and later. At the end, this paper proposes the possible architectural application methods of ecological design process.

Keywords : Ecological Paradigm, Ecological Architecture, Ecological Design

1. INTRODUCTION

Recently, lots of research have been done regarding the practical application of ecological design in architecture. Most of these research are focusing on the technical and engineering aspect of ecological design, or so called “eco-friendly” design. Conserving energy, working with climate, minimizing the usage of new recource, respectd for site are one of many main characteristics of the eco-friendly design.

However, these practical aspects of architectural application is only a part of bigger ecological picture. It is critical to found a theoretical and philosophical base of ecological paradigm, so that we would not fall into the trap of fragmented and reductionistic logic of Descartes-Cartesian paradigm, or a world view. It is also critical that we acknowledge the practical usage of Descartes-Cartesian way of thinking method but only within the holistic of ecological one.

In this paper, I will compare the Descartes-Cartesian and ecological paradigm throughout the history to reveal how these two ways of thinking, or paradigm, have affected various fields of science, such as logic, physics, bio-medical sciences, psychology, social sciences, and ultimately architecture. Later, I will show you how much the affect of Descartes-Cartesian paradigm have still existed in current architectural design process even when we are dealing with technical aspect of the ecological design. Finally, I will try to propose some feasible methods of ecological design process in architecture.

2. THE CARTESIAN-NEWTONIAN PARADIGM

The world view that laid the basis for modern culture was created in the early stage of the Renaissance. Before this change, the primary world view was holistic, organic, and ecological. People lived their lives in small communities and had holistic and spiritual relationship with nature. Even the goal of science at this time was quite different from that of modern science. Rather than using the means of prediction and control, the main goal was to understand the existential meaning of things and its surrounding environment.

This medieval approach became transformed radically in the sixteenth and the seventeenth centuries. The idea of the holistic, organic, and spiritual universe was replaced by a world-machine metaphor. This metaphor became a major part of the modern way of thinking. This transformation came with the Scientific Revolution involving Galileo and Newton, and a new method of reasoning by Bacon and Descartes.

With his scientific observations of celestial phenomena, Galileo was the first to combine scientific discoveries with mathematical explanations to formulate the laws of nature. These two aspects of Galileo's work, his experimental approach and mathematical description of nature, became the dominant character of science in that time and have remained as such to date. However, the problem of Galileo’s methoddology is that because this methodology was so successful in a quantifiable domain, non-quantifiable properties, such as subjective and mental projection of human beings, were excluded from the domain of science. This trend has become a major hurdle to integrating all human properties as a whole.

In England, Francis Bacon introduced the inductive logic method which is to draw general conclusions from empirical data through experiments. The new reasoning method heavily changed the character and objective of science. From ancient times, the main goal of science had been gaining wisdom and understanding nature in harmony with her. Since Bacon, the goal of science has been gaining knowledge to control and exploit nature. "Nature, in his view, had to be "hounded in her wanderings," "bound into service,” and made a "slave."[1] This kind of attitude represents the prevalence of patriarchal attitudes in science fields.

The shift of world views was completed by Descartes and Newton. Descartes doubted everything he could until reached an indubitable conclusion, the being of himself as a thinker - "*Cogito, ergo sum*." From this he deduced that nothing but thought was the essence of human nature. This deduction led him to the conclusion that mind and matter are separate and totally different entities. This Cartesian division has made us think of ourselves as isolated entities inside material bodies.

Descartes saw the material world as a machine that had no life or spirit. According to him, the natural world was functioning by mechanical laws and everything could be explained in terms of the mechanical movements of their parts. This mechanical image of nature became the dominant model of science since Descartes. Even Descartes applied his mechanical world view to living organisms. Plants, animals, and even human beings belonged to a machine category. The human body became a container activated by a soul connected through the pineal gland in the brain.

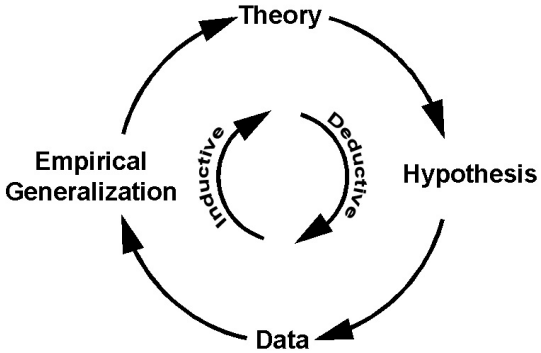

Figure 1. Deductive and Inductive logic cycle.

The man who undertook Descartes' task was Isaac Newton. With his new mathematical method, differential calculus, Newton came out with a mathematical formulation that completed the mechanical world view of his time. His general laws of motion could account for the movement of objects from stones to planets. "In Newton's view, God had created, in the beginning, the material particles, the forces between them, and the fundamental laws of motion. In this way, the whole universe was set in motion and it has continued to run ever since, like a machine, governed by immutable laws."[2] This deterministic character gave birth to a belief that if you know the state of a system, such as, time and location, in all details you could predict the future of the system with absolute certainty.

The Newtonian universe produced the image of absolute space and time - both independent from each other, and indivisible units, atoms. Absolute space was the space of Euclidean geometry - an unchangeable three-dimensional container. Absolute time flows evenly with no respect to external phenomena. "Newton assumed matter to be homogeneous: he explained the difference between one type of matter and another not in terms of atoms of different weight or densities but in terms of more or less dense packing of atoms. The basic building blocks of matter could be of different sizes but consisted of the same 'stuff,' and the total amount of material substance in an object was given by the object's mass."[3]

The drastic change from an organism to a machine in the image of nature greatly affected the way people viewed the natural world. "The Cartesian view of the universe as a mechanical system provided a 'scientific' sanction for the manipulation and exploitation of nature that has become typical of Western culture."[4]

	Proposed methodologies/discoveries	Descartes-Cartesian Characteristics
Galileo Galilei (1564-1642)	Experimental+mathmatical prediction	Only quantifiable domain
Rene descartes (1596-1650)	Deductive logic method Cartesian Division (mind/matter)	Isolated entity with predictible prediction Mechanical world view Determistic world view Absolute Space/Time
Isaac newton (1642-1727)	Differential Calculus General law of motion	
Francis Bacon (1909-1992)	Inductive logic method	

Figure 2. Descartes-Cartesian Characteristics of the Contributers of Scientific Revolution

3. THE HOLISTIC-ECOLOGICAL PARADIGM

Ecological thinking is in heavy debt to the feats of modern physics. The advent of electromagnetics, Einstein's Theory of Relativity, quantum physics, and the newly born Chaos theory are major contributors of this new paradigm.

The discovery of electric and magnetic phenomena by Michael Faraday and James Clerk Maxwell was the first step to undermine the mechanistic world model. "When Faraday produced an electric current in a coil of copper by moving a magnet near it, and thus converted the mechanical work of moving the magnet into electric energy, he brought science and technology to a turning point."[5] Unlike Newton's interpretation of sheer interaction between two masses, this new discovery gave birth to a new concept of space, later called a field. This electromagnetic field became its own reality without mentioning any material bodies. In other words, the interconnective nature of the field undermined the validity of the atomistic view of nature - every entity separated from others and only governed by Godlike mechanical principles.

The real collapse of the Newtonian world view came with the relativity theory and quantum theory. "The notion of absolute space and time, the elementary solid particles, the strictly causal nature of physical phenomena, and the ideal of an objective description of nature, none of this could be extended to the new domains into which physics was now penetrating."[6] In Einstein's special theory of relativity, space and time are not separate entities. Both constitute a four-dimensional continuum, 'space-time'. In this continuum, "different observers will order events differently in time if they move with different velocities relative to the observed events."[7]

"The concepts of space and time are so basic for the description of natural phenomena that their modification entails a modification of the whole framework that we use to describe nature. The most important consequence of this modification is the realization that mass is nothing but a form of energy. Even an object at rest has energy stored in its mass, and the relation between the two is given by the famous equation E=mc2, c being the speed of light."[8]

He went further in his general theory of relativity by including gravity, the mutual force between any materials that has mass. Added to the 'space -time' continuum, gravity has the effect of wrapping the continuum. Euclidean

geometry became thus not a proper model to explain this new interconnected reality. Because any tiny particle has mass in this universe, space and time cannot help affecting by the existence of matter. There is no room for separate entities in this universe.

In atomic physics, several discoveries unaccountable in terms of classical physics appeared, such as the discovery of the subatomic world and the duality of the subatomic entity. One of the most fascinating discoveries was the fact that "depending on how we look at subatomic units, they appear sometimes as particles, sometimes as waves; and this dual nature is also exhibited by light which can take the form of electromagnetic waves or of particles." [9]

Quantum theory showed the holistic nature of the universe. "It shows that we cannot decompose the world into independently existing smallest units. As we penetrate into matter, nature does not show us any isolated 'basic building blocks', but rather appears as a complicated web of relations between the various parts of the whole. These relations always include the observer in an essential way."[10]

In a different context, the discovery of evolution in biology challenged the illusion of a deterministic Cartesian world. Instead of thinking that every single element is created in the beginning of this universe and run by a system of laws, evolutionary concepts opened the possibility of development from simple forms to complex structures.

However, the evolutionary idea contrasted with the laws of thermodynamics in physics which mean that every phenomenon moves from the orderly state to the disorderly. Thermodynamics was a double- edged sword, since it at once denied the reversible time flow of the Newtonian universe and contrasted with the evolution theory. This problem remained until the advent of "nonlinear revolution." with Chaos and Self-organization Theory.

Self-organization Theory demonstrated that in "far from equilibrium" state, unlike "near equilibrium," a system of matter tends to self-organize itself through positive feedback. Once fed by this constructive loop, this system starts to evolve to a higher level of organization. In other words, the "far from equilibrium" state has a high sensitivity to even a tiny change in the system. This means that on the earth, a typical example of "far from equilibrium" state, every entity is interdependent and interconnected to others and even a tiny transformation has the possibility to change the whole world. Because this leap to another level of system is unpredictable, the deterministic predictions of the Cartesian world view lost its validity.

One of the interesting discoveries in "far from equilibrium" system is a unique structure of the system, fractals. "Fractals have an internal 'microstructure' which exhibits the phenomenon of scaled self-similar layering. Finer and finer magnification of a fractal reveals smaller and smaller versions of the same structure at all levels. Therefore, fractals are infinitely complex. No matter how small a piece you take, it is an equally complex microcosm of the whole. Fractal self-similarity and scaling are particularly important because they repudiate two Newtonian assumptions."[11] One is that reducing and segmenting methods make problems simple, and the other is that we can measure everything objectively with an absolute scale.

The "nonlinear revolution" not only stopped the illusive universality of Cartesian world view but solved the problematic coexistence of Newtonian and new physics in different domains. Because it shows the dynamic and diverse nature of the universe from micro to macrocosms, even Newtonian method can survive in a specific range, the middle range of the ecological world.

All of these developments in science revived the original image of the world, which is holistic, organic, ecological, and spiritual. The Cartesian- Newtonian paradigms caused a dramatic scientific revolution that gave us at once enormous prosperity and problems. The new ecological thinking will change again the way we perceive the world and give us a new alternative to cure the fallacy of the old paradigm.

	Proposing Ecological Characteristics	**Existing Descartes-Cartesian Characteristics**
Electromagnetics	Existance of "Field	Isolated entities
Einstein's Theory of Relativity	Interconnected Space-Time Contiuum	Absolute Space/Time
Quantum Theory	Interconnected object-observer relation	Isolated object-observer relation
Evolutionary Theory	Dynamic evolutional development	Static state
Self-Organization Theory	unpredictable development	Deterministic prediction/development
Fractal	Self-Similarity Scale/infinite complexity	Absolute Scale & Hierarchy

Figure 3. New Ecological characteristics of New Science comparing to existing/replacing Descartes-Cartesian Characteristics

4. THE INFLUENCE OF PARADIGM SHIFT

Though the validity of the old paradigm as a perfect world view had gone before, it has still maintained its influence on the way we perceive the world in many fields. In particular, this influence remains strong in fields related to human thoughts and behavior, such as philosophy, psychology, bio-medicine, economics, and sociology.

4.1 BIOMEDICAL MODEL

"In biology the Cartesian view of living organisms as machines, constructed from separate parts, still provides the dominant conceptual framework. Although Descartes' simple mechanistic biology could not be carried very far and had to be modified considerably during the subsequent three hundred years, the belief that all aspects of living organisms can be understood by reducing them to their smallest constituents, and by studying the mechanisms through which these interact, lies at the very basis of most contemporary biological thinking."[12]

Even though this reductionistic approach has brought an enormous amount of valuable information, it hasn't provided any clue to specific phenomenon such as the cure of cancer to broadly the mystery of life. There have been so many efforts to find a solution to eliminate cancer. Nevertheless, no absolute cure has been found. Because most of the research stands on a reductionistic foundation, they cannot explain properly the interconnective nature of

cancer proliferation. The reductionistic approach isn't able to decipher the mystery of recurrence of cancer after a diseased organ has been removed.

"An extreme case of integrative activity that has fascinated scientists throughout the ages but has, so far, eluded all explanation is the phenomenon of embryogenesis - the formation and development of the embryo - which involves an orderly series of processes through which cells specialize to form the different tissues and organs of the adult body. The interaction of each cell with its environment is crucial to these processes, and the whole phenomenon is a result of the integral coordinating activity of the entire organism - a process far too complex to lend itself to reductionistic analysis. Thus embryogenesis is considered a highly interesting but quite unrewarding topic for biological research"[13]

A good example of reflecting the limitation of the reductionistic biomedical model is the Human Genome Project in genetics. The goal of the project is to create a map of all of the human genes to unravel the mystery of life. However, even with progress to be close to a final map, nobody has found a definite answer about where life comes from. Instead of making problems simple by going down to smaller units, scientists face systems as complex as in a bigger scale. The literal sum of units is totally different from a whole system.

The holistic medical model has been existed much longer than its counterpart. The holistic model was the main theme of Hippocratic medicine, and has been mainstream in Asia. Both put an emphasis on the interrelation of body, mind, and environment. This interrelation has been rediscovered recently with the placebo effect, psychosomatic phenomenon, homeopathic therapy, and so on.

The basic Chinese concept of the body is of an indivisible system composed of interrelated ingredients that is strikingly close to the new ecological model than to the Cartesian. This similarity is strengthened by the fact that the Chinese perceived the network of relationships as intrinsically dynamic.

A key idea in the holistic view of health is that of balance. In the Chinese model, disease becomes apparent when the body loses balance and *ch'i,* energy or patterns animating cosmos, does not flow properly. This model can diagnosis the causes of any level of disease being out of imbalance, such as, stress, poor nutrition, lack of rest, or being in disharmony with one's friends, family, society, or environment on a larger scale.

The interrelated nature of the new ecological model implies the change of the relationship between healers and patients. Unlike conventional images of doctors who avoid getting involved in patients' lives, the new model emphasizes the importance of taking part in their lives. Through many discoveries of psychosomatic phenomena and the efficiency of homeopathic therapy, not only knowing a patient but a patient's awareness of his or her own state is very important to curing diseases.

The new ecological biomedical model does not mean to dispose of classical medical discoveries that can still be effective in many cases. The new approach suggests a change of attitude to deal with the indivisible human body and its environment. Contrasted with the aggressive and exclusive Cartesian model, the new one reflects the fundamental inclusiveness of an ecosystem, like the cosmos as a whole, which even makes a room for its old-time enemy.

4.2 MODEL OF PSYCHOLOGY

Like other disciplines, psychology is in debt to the ubiquitous Cartesian paradigm. Since Descartes, psychologists have followed the idea of a mind-body division, and this division made them difficult to grasp the nature of subtle interaction between mind and body. Nineteenth century psychologists believed that with an analytical method they could "reduce consciousness to well-defined elements associated with specific nerve currents in the brain."[14]

After the turn of the century, behaviorism and psychoanalysis became the two dominant schools in psychology.

Behaviorism tried to reduce the mental phenomenon into the patterns of behavior governed by the mechanical Newtonian laws. Behaviorists believed that a specific mental activity had a correlation with certain behavior that can be predicted with mechanical laws. Even going further, the correlation between mind- behavior followed the stimulus-response model with the advent of reflexology. The fact that most of the experiments dealt with animals in a secluded space also reflects the atomistic and reductionistic nature of behaviorism.

Psychoanalysis systematized by Sigmund Freud is the other dominant trend in psychology. Unlike behaviorists, Freud discovered the existence of the unconscious in human mind. Later he also structured the human personality with Id, Ego, and Superego.

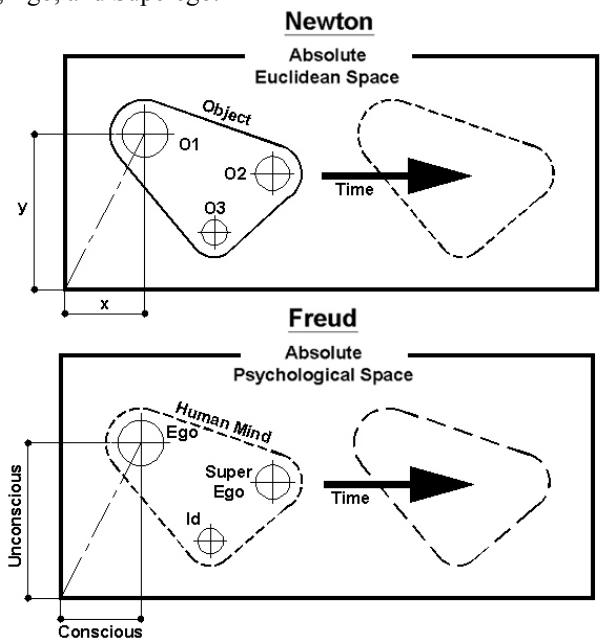

Figure 4. Comparison between Newton space above and Freud space below

Although he reveals the non Newtonian characteristic of human mind, he also remained under the influence of the mechanical world view. Because he wanted to bring up the

psychoanalysis to the level of hard science, his way of interpreting his discoveries was in the realm of the Cartesian-Newtonian paradigm. "As Newton established absolute Euclidean space as the frame of reference in which material objects are extended and located, so Freud established psychological space as a frame of reference for the structures of the mental "apparatus." The psychological structures on which Freud based his theory of human personality - Id, Ego, and Superego - are seen as some kind of internal "objects," located and extended in psychological space."[15] As in Newtonian dynamics, these internal objects conflict with each other in psychological space through the pair of forces, such as "derives" and "defenses." "As in Newtonian physics so also in the psychoanalysis, the mechanistic view of reality implies rigorous determinism. Every psychological event has a definite cause and gives rise to a definite effect, and the whole psychological state of an individual is uniquely determined by "initial conditions" in early childhood."[16]

The turning point of classical psychology might come with Carl Gustav Jung. Moving away from the mechanical model of Freudian psychoanalysis, he developed many ideas that are considerably similar to those of the new sciences. Unlike his teacher, Freud, who saw the unconscious as a separate entity, Jung thought the unconscious was the source of consciousness. Even further, he classified the realms of the unconsciousness: a personal unconsciousness and a collective unconsciousness shared by all humankind. The idea of the collective unconscious denotes a link between the individual and humanity as a whole, or, between the individual and the entire cosmos. The existence of this link suggests that the psychological problems of an individual cannot be solved without touching through emotional, social, and cultural environment of an individual. Recently, psychotherapists are becoming aware of the correlation between the breakdown of social relations and mental distress. Accordingly, psychotherapies are gradually shifting from individual level to group and family ones.

Also, like a new biomedical model, the new psychology sees the human as an integrated whole mind/body system. Although, psychotherapists and psychologists usually deal with mental phenomena, they can understand them only within the context of the whole integrated system.

The interconnected relation between an individual psyche and its environments requires the change of the relationship between a therapist and a patient. The successful results of the psychotherapy require that the therapist not take control of all the processes but facilitates a process in which the client becomes the main performer.

4.3 MODELS OF SOCIAL SCIENCES

Social sciences include economics, political science, sociology, social anthropology, and history. These fields could not be an exception from the success of the Newtonian model. In other words, the reductionistic and deterministic approach became the fundamental method in these sciences. As their names imply, the fact that each field deals with a part of the whole social phenomena reflects the fragmentary and compartmental characteristics of social sciences. For example, economics deals with the economy that is only an aspect of a whole ecological and social fabric. These features came out of the Newtonian assumption that the reduction of subject matters into a certain level would make them be independent and separate from outside experimental disturbances.

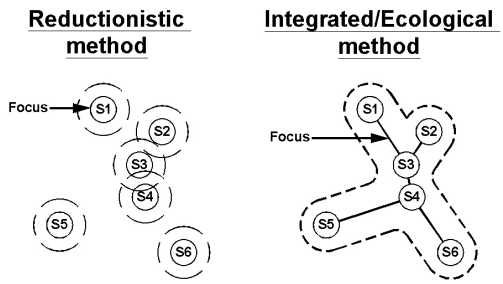

Figure 5. Comparison between reductionistic study method and integrated/Ecological one. S1~S6 represent each social sciences.

Another aspect of social phenomena is the dynamic evolutionary nature that is beyond the domain of social sciences. This dynamic nature of society is quite different from those subjects covered by natural sciences. Though, the Newtonian model has lost its crown as a general unifier in micro and macrocosms, it remains still valid within a middle range. In this range, because of the limit of human perception, all phenomena look quite stable and steady. Even the reason the evolutionary transformation has been under the influence of the mechanic model is that this change requires a huge amount of time and it seems to be static within the scope of human perception. However, the evolution of social patterns proceeds at a much faster pace, and the deterministic principles cannot be appropriate means to cover this ever moving dynamic system.

	Descartes-Cartesian	**Ecological**
Bio-medical	Modern mio-medical model Genon Project - **Reductionistic analysis & prediction** **Healer/Patient**	Hippocratic/Chinese medicine Embryogenesis- **unpredictable development** Placebo Effect- **psychosomatic phenomenon** Homepathic therapy – **Interconnected mind-body** **Healer-patient**
Psychology	Behaviorism Psychoanalysis by Sigmund freud(1856-1939) –**Deterministic prediction**	Collective unconscious mind by Karl Gustav Jung (1875 ~ 1961)- **Interconnected**
Social Sciences	Reductionistic division "**Value-free**" social model	Environmental auditing - "**Value-ridden**" social model

Figure 6. Comparison between Descartes-Cartesian and Ecological characteristic in different scientific fields.

The fundamental difference of social phenomena from natural sciences is that social domains are composed of a number of value systems. Because of the qualitative nature of values, the mechanical model sifts these out and only deals with the quantifiable restrictive range of phenomena. This "value-free" social model affects where people put a value on and vice versa.

5. THE INFLUENCE OF THE PARADIGM SHIFT IN ARCHITECTURE

As a field dealing with human phenomena, architecture has been molded by the way people live and perceive the world. Because the paradigm shifts have changed life styles as well as world views, these shifts naturally have led architecture to new directions on how to accommodate new way of life.

5.1 THE CARTESIAN MODEL IN ARCHITECTURE

The influence of Cartesian model is manifested in different types in architecture. One is a tendency to search for mechanical principles or metaphors. Another is imminent Cartesian attitudes - reductionism, determinism, and self-referential character - which have changed the way architects see their own works.

5.1.1 APPLICATION OF MECHANICAL PRINCIPLES

As the triumph of the Newtonian mechanics reached its peak with the Industrial Revolution, an optimistic atmosphere prevailed that the Newtonian method could solve any problems. Many architects believed that they could separate their architectural "subject" from "outside" environments, like the cultural context, and apply the scientific methods to the architectural environment.

In Bauhaus, not cultural meaning, use and function became a guide, and forms were to be created out of the program and the industrial methods of production. Although this school encouraged students to synthesize allied disciplines and to take part in collective designing process, the basic goal was to apply a system of mechanical principles to architecture. In Russia, Vkhutemas, a school of architecture, stood in the same context of Bauhaus. With a motto of "the measure of architecture is architecture"[17], the experimentation of forms was carried out to find general principles.

5.1.2 UNIVERSALIZATION AND MACHINE METAPHOR

The standardization and mass production after the Industrial Revolution were main features of a machine metaphor. Walter Gropius, one of the founders of Bauhaus, wrote: “Standardization is not an impediment to the development of civilization, but on the contrary, one of its immediate prerequisites. A standard may be defined as that simplified practical exemplar of anything in general use which embodies a fusion of the best of its anterior forms - a fusion preceded by the elimination of the personal content of their designers and all otherwise non-generic or nonessential features. Such an impersonal standard is called a 'norm,' a word derived from a carpenter's square. The fear that individuality will be crushed out by the growing 'tyranny' of standardization is the sort of myth which cannot sustain the briefest examination. In all great epochs of history the existence of standards - that is the conscious adoption of type-forms - has been the criterion of a polite, well-ordered society; for it is a commonplace that repetition of the same things for the same purposes exercises a settling and civilizing influence on men's minds."[18] In his remark, we can find the atomistic and exclusive nature of standardization which assumes the generalization of individual personalities.

The trend of a machine metaphor in architectural field is also well shown in Le Corbusier's book, "Towards a New Architecture." He wrote: "Industry on the grand scale must occupy itself with building and establish the elements of the house on a mass-production basis. We must create the mass-production spirit: the spirit of constructing mass-production houses, the spirit of living in mass-production houses, the spirit of conceiving mass-production houses. If we eliminate from our hearts and minds all dead concepts in regard to the house, and look at the question from a critical and objective point of view, we shall arrive at the 'House-Machine', the mass-production house, healthy and beautiful in the same way that the working tools and instruments which accompany our existence are beautiful."[19] In his comment, a term 'House-Machine' directly reveals the influence of the metaphor.

International Style was another trend, based on the idea of the universal application of mass-producing buildings, just like standardized machines. Instead of taking into account local conditions, this style demanded the application of a prototype living unit to all around the world. New materials, steel and glass, replacing indigenous materials, functioned as a means to sterilize the cultural context as well as to accommodate new technology.

5.1.3 THE CHANGE OF DESIGN PHILOSOPHY

The success of the reductionistic and atomistic approach in science provided a sanction for self-referential approaches that seek to make architecture itself the focus of architecture. As this self-referential characteristic made architects neglect environmental factors including users and focus on a specific aspect of architecture, it became hard to deal with comprehensive human environments. It failed to produce user- responsive designs.

Armed with the idea that "scientific" models could modify the human race, the Modern Movement went along with the great ideologies, such as Rationalism, Fascism, Nazism, and Soviet Socialism. These ideologies were all self-referential in some degree and lost contact with real life. This trend led to one misguided myths in design: the manipulation of physical forms into beautiful compositions will inevitably give an advantage to those who experience it. Le Corbusier wrote: "The architect, by his arrangement of forms, realizes an order which is a pure creation of his spirit; by forms and shapes he affects our senses to an acute degree and provokes plastic emotions: by the relationships which he creates he wakes profound echoes in us, he gives us the measure of an order which we feel to be in accordance with that of our world, he determines the various movements of our heart and of our understanding; it is then that we experience the sense of beauty."[20]

Post-modernism in architecture set out by Robert Venturi was in opposition to the simplified, self-referential, and 'universal' space in modern architecture. In his book, "Complexity and Contradiction in Architecture," he emphasized the importance of symbolism in architecture. However, he did not actually swerve away from the principles of modern architecture. Even he acknowledged

the symbolic value of popular taste, he used these codes not for their own value, but only as material for the architect's formal compositions. The arbitrary character of his symbolism is well illustrated in one of his works, the Guild House, a home for the elderly in Philadelphia. He placed an oversized, non-functioning, gold color TV antenna on top of the building to symbolize the elderly sheltered there. Venturi said: "The television antenna . . . expresses a kind of monumentality . . . with its anodized gold surface, can be interpreted in two ways: abstractly, as a sculpture in the manner of Lippold, and as a symbol for the aged, who spend so much time looking at TV."[21] Even the concept of post-modernism recognized user's taste and symbols but in the architectural design process architecture as a self-referential formal object remains main concern in architectural field.

This trend led to a peak in so called 'Deconstuctivism.' Peter Eisenman said: "My first concern in looking at the nature of architecture involved an attempt to change the nature of the sign of the substance - from referring to man to architecture itself."[22] Also, he wrote: "What is being proposed is an expansion beyond the limitations presented by the classical model to the realization of architecture as an independent discourse, free from external values."[23] The Deconstuctivism movement became crown the illusion of Cartesian separation.

5.2 THE ECOLOGICAL MODEL IN ARCHITECTURE

The ecological model has existed throughout the history of architecture. Before the advent of the Industrial Revolution and the Cartesian paradigm, people had a holistic, spiritual relationship with nature and this was reflected through nature-friendly architectural environments. Unlike the exclusive Cartesian model, because of the inclusive nature of ecological model, many different types of models represent the ecological idea in part or overlap each other. These can be divided into two groups; a performace-based ecological model and a process-based one. The former has a goal of creating environments that are to function as a part of an ecosystem. The latter covers a wide range of ecological ideas permeating through a design and thinking process. A common character of these two groups is that they are following a part or whole features of an ecosystem. A difference between a biological metaphor in Cartesian model and an ecological one is that the former deals with the form and the latter the process.

5.2.1 PERFORMANCE-BASED ECOLOGICAL MODEL

This model is to literally apply biological characteristics to architectural environments, such as metabolic, evolutionary, or biological feature. New Alchemy, founded in 1971, is the typical case of this trend. It suggests a small micro-ecosystem in architectural environments by combing biotechnology and architecture. The New Alchemy listed nine principles to accomplish this goal: "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 on renewable energy sources.", "Design should be sustainable through the integration of living systems.", "Design should be co-evolutionary with the natural world.", "Building and design should help heal the planet.", and "Design should follow a sacred ecology."[24] However, in spite of their technological accomplishment, there is still a trace of the Cartesian model by neglecting other factors, such as cultural, behavioral, and perceptual natures of architectural works.

5.2.2 PROCESS-BASED ECOLOGICAL MODEL

The inclusiveness of the ecological metaphor requires fundamentally different design process from the Cartesian one. From new scientific discoveries, it became apparent that a whole ecosystem including human being is composed of dynamic interconnective patterns integrating all phenomena. To accommodate the new image of the human being, a design process in architecture needs an alternative solution. The point is that how architects can integrate all diverse factors including users in an ecological manner.

There are three distinct trends to incorporate human context in a design process: collaborative design, contextual design, and intangible design.

Collaborative design is a means through which designer and users alike participate in the design process as equal partners, shaping not only the outcome but the aims of designing.

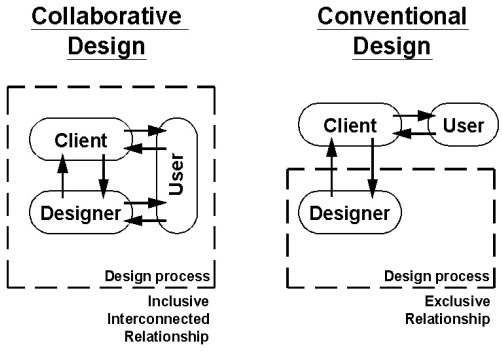

Figure 7. Comparison between Collaborative design process and conventional.

Contextual design is about designing not an object themselves but about contexts - dynamic situations and patterns. The term contextual design here is quite different from the term used by some postmodern architects in their attempt to fit their work into its surroundings. "Contextual design is done as a catalyst to user experience, usually aesthetic experiences.

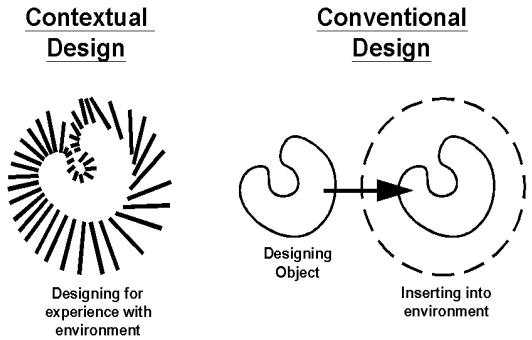

Figure 8. Comparison between Contextual design process and conventional.

Intangible design is design in space and time of experience itself."[25] With intangible design, users' experience becomes the main core of the design process. Objects may be used to facilitate desired experience in intangible design, but they have a secondary meaning to experience itself. Intangible design is proper to the emerging postindustrial design, such as software interface design. With the advent of computer technology, it becomes more effective to incorporate these new design processes into architectural tasks.

6. CONCLUSION

Throughout the history, there were many design methodologies to deal with human phenomena. Because these methodologies have reflected the image of human being in its each era, newly discovered dynamic and interconnective nature of ecological system requires new methodology.

Modern architecture was the laboratory of diverse design approaches. However, because most of them dealt with a part of whole system, they used to make situations worse. Even though, some of them could theoretically solve problems, their fragmentary character prevented them from accomplishing their original goal.

As mentioned in previous chapters, Modern architecture is based upon the belief that our world could be understood and predicted with the logo-centric view of Descartes-Cartesian paradigm. The famous architecture school at the early 20 century, Bauhaus and Vkhutemas advocated the systematic usage of reductionistic method in architectural design process, where research on functions without any social or cultural values could generate universal law of architectural design principles. This generalizing trend of architectural principle is also based upon “type-form”, which advocates the need of standardization and mass production. This is truly well-reflected in Le Corbusier’s “Machine-House” metaphor.

Another aspect of Modern architectural movement is its self-referential logic, which is the by-product of reductionistic and exclusive characteristics of Descartes-Cartesian paradigm. Because of this charater, Modern architecture was eagerly used for the destructive idealogies at the time.

Post-modernism tried to fix these problems of modern architecture by introducing contextual aspects of architectural elements. This movement advocates associated historic and social values of architectural style and elements. However, this movement could not solve the self-referential drawbacks of architectural design process as those elements are only used within the framework of the same self-referential design process.

It is clear that though architecture has evolved throughout, the traditional method of architectural design process prevents the interconnected/inclusive nature of truly ecological design. As suggested, Collaborative Design, Contextual Design, and Intangible Design introduce new ways of design process based upon the ecological paradigm.

However, as we could see similarity to the validity of Newton’s general law of motion in the specific scop of our world, Descaretes-Cartesian paradigm-based architectural design process could find its valid usage in the framwork of ecological paradigm-based design process, but not vice-versa.

NOTES

1. Capra, Fritjof. The Turning Point, p.56.
2. The Tao of Physics, p.56.
3. The Turning Point, p.65.
4. Ibid. p.61.
5. , The Tao of Physics, p.59.
6. Ibid., p.62.
7. Ibid., p.62.
8. Ibid., p.63.
9. Ibid., p.67.
10. Ibid., p.68.
11. Sally J. Goerner. Chaos and the Evolving Ecological Universe, p.41.
12. Capra, Fritjof, The Turning Point, p.102.
13. Ibid., p.104.
14. Ibid., p.170.
15. Ibid., p.182.
16. Ibid., p.183.
17. Kostof, Spiro. A History of Architecture, p.703.
18. Le Corbusier. Towards A New Architecture, p.13
19. Mitchell, C. Thomas. Redefining Designing, p.6.
20. Le Corbusier. Towards A New Architecture, p.7.
21. Venturi, Robert. Complexity and Contradiction, p.116
22. Mitchell, C. Thomas. Redefining Designing, p.21
23. Ibid., p.22.
24. Todd, John. Bioshelter, Ocean Arks, City Farming, p.79
25. Mitchell, C. Thomas. Redefining Designing, p.68.

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