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1. Introduction

Almost everything mankind perform, impacts the world around us. As many more people inhabit the world, and use far more of its resources, the environmental concern grows and the resulting effects are making the world less livable. Human are likely to end up in an unlivable world if that trend continues through this century. People in ancient times, had already made their mark on the landscape, before the modern world and human emerged. They used fire to cook, to warm water and themselves, and to clear land of trees and shrubs even before becoming farmers in small settlements. However, these activities have carried out both more intensively and more extensively through the Neolithic, Bronze and Iron Ages to modern times.

All these activities have changed the landscapes around us. Fertile valleys were the first to make room for agriculture, as trees and shrubs were removed and more intensive farming required more irrigation. These changes allowed fertile valleys to carry larger populations that could access the relatively abundant food and water, provided the quantity of water could be maintained and its salinity kept at acceptable levels. People began to live in larger communities and to pursue a range of activities other than being directly involved in agriculture. As time has passed, more people have lost direct daily contact with the natural world around them, so some of the key linkages between how people live and the consequences of lifestyles have been overlooked. Urbanization has separated an increasing number of people from close contact with the natural world. While the humans of 350,000 years ago were building shelters under limestone cliffs to protect themselves from the extreme cold environment, the rise of science in the Industrial Revolution enabled environmental engineers to produce reasonably
comfortable conditions in almost any climate. However the rise of science required high-grade energy and brought the energy and environment related problems to the agenda of the modern world.

The purpose of this study is to investigate the relations between human, architecture, energy, and environment. This study considers the environmental management as the main concept of the architectural theory and evaluates different case studies within the framework of environmental function and performance of buildings.

2. Human and Their Environment

Human beings have always had a mental and physical relationship with their environment. Human beings themselves can be called as microenvironment and the environment around them as the macro environment. The problem has always been to determine and balance the relations between first and the second or the micro and the macro environment. There were times through the history that had extreme environmental conditions. There are still regions on the world where maintaining a direct relationship with the natural environment is almost impossible. Indeed there are only few places in the world that people can survive without developing an interface between themselves and the nature (Fitch & Bobenhausen, 1999). Fitch (1999) in his “The American Building” renames the term “interface” as the third environment.

So what are the interfaces that people need in order to interact with the environment around them? The simplest answer to this question would be “clothing”. However, wearing clothes itself have not always satisfied people, so they also have created spaces such as buildings to live in. To control the environment of these spaces in
order to control the macro environment, have always been much easier. People can create the exact comfort conditions, in their third environment. These comfort conditions for humans depend on the essential requirements of their microenvironment. Several conditions that are listed below determine the metabolic level of relationship between human and their environment (Fitch & Bobenhausen, 1999):

- Thermal
- Atmospheric
- Aqueous
- Luminous
- Sonic
- World of objects
- Spatio-gravitational forces

Adjusting these conditions according to the human needs forms the basic structure of environmental technology and its use in architecture. Environmental technology is one of the tools to create the essential conditions in the third environment. So many issues have affected this tool. The issues that humans were concerned and their solutions through the history have been changing constantly. This whole discussion on controlling the third environment is related to some other discussions that will be presented in the coming sections. Next chapter will discuss the essence of technology and its effect on the environment and the architecture.

3. Human and Technology

The purpose of human being has always been to conquer the physical world in order to establish and extend the power and domain of the human race itself over the universe. Human freedom over nature has depended upon how much he knows about the laws of nature. The pure knowledge of man can be called as “science” whereas the application of
Science is "technology". Often the terms, technology and science, are confused. Science deals with the natural world. Technology is the study of the natural laws, which govern the universe. This is not to say science and technology are unrelated. Science deals with "understanding" while technology deals with "doing".

Technology is a human activity. It is a distinct cultural activity in which man forms and transforms natural reality for practical ends with the aid of tools and procedures. In his "A Question Concerning Technology" Heidegger (1976) states that "the manufacture and utilization of equipment, tools, and machines, the manufactured and used things themselves, and the needs and ends that they serve, all belong to what technology is". He combines the idea of four causes in philosophy with the essence of technology. Those four causes are:

- **The material**: the matter out of which, for example a silver chalice is made
- **The form**: the shape into which the material enters
- **The end**: the sacrificial rite in relation to which the chalice required is determined as to its form and matter
- **The effect**: actual chalice, in this instance, the silversmith.

According to Heidegger these four causes are the ways, all belonging at once each other, of being responsible for something else. Instead of causality as simply perpetrating technology as a means to an end, Heidegger (1976) views the four causes as four "ways of occasioning" which play in unison to bring about presencing; they "let what is not yet present arrive into presencing" (Heidegger, 1976). Heidegger (1976) approaches the problem of technology with the purpose of finding its essence. The method is that of reducing technology to its fundamental being, so that all problems and aspects thereof
may be understood. Explication of this reduction of technology involves a series of definitions corresponding to the steps by which he strips technology down to its essence.

- **Instrumentality**: technology is an instrument to achieve human ends, specifically those of building up or arranging.
- **Causality**: instruments are designed to for the purpose of causing an end.
- **Enframing**: gathering together which challenges man and puts him in position to reveal the real in the mode of ordering.
- **Revealing**: something is brought forth only when it passes from concealment into unconcealment; when it is revealed.
- **Poiesis**: about poetics, bringing into appearance and concrete imagery, arising of something from out of itself, bringing forth.

Modern science and modern technology have been willingly and systematically applied to every facet of the human life. Heidegger states that “modern technology is something incomparably different from all earlier technologies because it is based on modern physics as an exact science. He concludes that “modern science represents nature as a calculable coherence of forces.” Nature at any case seems to have the most crucial significance when dealing with technology. McCleary (1983) in his “An Interpretation of Technology” clearly defines the relations between technology, human and nature. He explains, “Man’s fundamental activity is one of productive interchange with nature”. This productive interchange that we may call as “technology” is defined as the discourse between societies and their natural environments in the production of the built environment.
According to McCleary (1983) construction of a new nature, which is interposed between societies and original nature, is called “supernature”. Supernature is definitely a product of technology. A higher level of supernatural existence is super supernature, which is the concern of high technology. McCleary (1983) divides the levels of technology which is an interconnection between the original nature and human, in three:

- High technology
- Middle technology
- Low technology

The product of super-supernature is the concern of high technology. Low technology on the other hand being the concern of those who wish to return to that earlier relation that existed between societies and their natural environments and it is this relation that is favored by a technologically underdeveloped region. McCleary (1983) claims that current practice of our professions is in the bondage of a middle level technology to the exclusion of both high and low technologies.

Heidegger (1976) maintains that the questioning technology more, the mystery of its revealing shows itself. Because “yet the more questioningly we ponder the essence of technology, the more mysterious the essence of art becomes. The closer we come to the danger the more brightly do the ways into the saving power begin to shine and the more questioning we become. For questioning is the piety of thought” (Heidegger, 1976). Finally, Heidegger wants to emphasize whether the kind of revealing of ‘Being’ that shows itself in the fine arts can rescue man from danger of enframing, which is the essence of technology. So man has to rethink the meaning of the modern science and technology.
4. Human and Building

The relation of human with the buildings is related to the essence of architecture. It is essential at this point to remember the purpose of architecture. Fitch (1999) defines the ultimate task of architecture as “to act in favor of human beings”. He states that the purpose of architecture is to maximize our capacities by permitting us to focus our limited energies upon those tasks and activities that are essence of the human experience.

To be able to understand the relation between the buildings and the occupying people we should also remember the essential needs of humans so that we would be able to understand the expected fundamental requirements about the buildings and the third environment they create. The relation of human with the environment can be reviewed in two different levels, which are perceptual and metabolic. The conditions that determine the metabolic level of relation are already given in the previous section in this paper. The perceptual level on the other hand, comes into play only after the metabolic level requirements are met (Fitch, 1999).

Environmental technology deals with controlling and adjusting the third environment in a metabolic level. There are four stages of optimizing metabolic fit between building and its environment (Fitch, 1999).

- Mechanical systems
- Enclosing membranes
- Building’s exterior surfaces
- Site

Figure 1 illustrates these four different steps and their effects on the concept of environmental technology in buildings.
Fig. 1 Four stages of optimizing thermal fit between building and its environment. Instead of employing transparent walling membranes and then relying upon complex mechanical systems to compensate for high rates of energy transfer across interface, the design process should begin at other end of the design option spectrum. (1) Mechanical systems. (2) Enclosing membranes. (3) Building’s exterior surfaces. (4) Site (Fitch, 1999)

Banham (1969) in his “Architecture of the Well-Tempered Environment” discusses the environmental management in three different modes:

- Conservative mode
- Selective mode
- Regenerative mode

Thick walls of a house in a hot climate holds solar heat during the day, slows down the rate at which the interior becomes hot, and then, after sunset the radiation of that heat into the house helps to temper the sudden chill of evening. This whole technique can be termed as “Conservative” mode of environmental management. “Selective” mode, on the
other hand, employs structure not just to retain desirable environmental conditions, but also to admit desirable conditions from outside. However traditional construction has always had to mix these two modes, even without recognizing their existence, just as it has always had to incorporate the “Regenerative” mode of applied power without fully acknowledging its presence (Banham 1969).

The Eskimo displayed a good example for the conservative mode of environmental management by designing the igloo (Fig. 2). In shape and material the igloo represents high-level environmental responsibility. The rounded shape of an igloo offers maximum resistance and minimum exposed surface to wind while enclosing the most volume with the least material. With no mechanical aids and no source beyond a small blubber stove, internal air temperatures are held at tolerable levels.

*Figure 2* Historical design for the Eskimo igloo, Baffin Island, Canada. (Fitch, 1999)
Another pre-industrial age example for the conservative mode of environmental management is the mud masonry Indian House (Fig. 3). The high heat capacity of mud masonry, well suited to the great fluctuations of the desert, is cannily exploited in primitive housing. Because the air, though dry, is very hot, ventilation is not desirable. Native Americans build freestanding brush-covered arbors for daytime shade, using houses for storage and cold weather sleeping. rooftops are used for summer sleeping.

Figure 3 Mud masonry Indian House, American Southwest. (Fitch, 1999)

Larkin Administration Building by Frank Lloyd Wright is the first entirely air-conditioned building on record (Fig. 4). It is built in 1904 and demolished in 1950 and was one of the early masterpieces of pioneer, modern architecture (Banham, 1969). Wright in the Larkin Building design, serves as a bridge between the history of modern architecture as commonly written, the progress of structure and external form, and a
history of modern architecture understood as the progress of creating environments.

Larkin Building is one of the good examples, which employ both selective and regenerative modes of environmental management. The mechanical and architectural aspect of the whole environmental concept is illustrated in Figure 5.

Figure 4 Larkin Administration Building, Buffalo, NY, 1906 by F. L. Wright (Banham, 1969)

Figure 5 Larkin Administration Building, environmental management system (Banham, 1969)

1- Fresh air intake
2- Tempered air distribution
3- Foul air and exhaust
4- Utilities duct
5- Tempered air outlet grilles under edge of balconies.
Almost six decades after the completion of the Larkin Building, Richard Laboratories by Louis Kahn is built in Philadelphia (Fig. 6). Louis Kahn’s apparent provisions for environmental services give an immediately striking profile to both plans and elevations of this building, and have been equally immediately understood and admired. Kahn’s opinion concerning the mechanical services and their effects on the architectural form and theory had dominated the basic design ideas of Richard Laboratories. He states that (Banham, 1969):

“I do not like ducts, I do not like pipes. I hate them really thoroughly, but because I hate them so thoroughly, I feel that they have to be given their place. If I just hated them and took no care, I think they would invade the building and completely destroy it.”

This is one of the most important buildings that the environmental management ideas have so much affected the whole appearance of the building itself. The selective and regenerative modes of environmental management in this building have many similarities with Wright’s Larkin Building. Figure 7 demonstrates the environmental control systems of Richard’s Laboratories.

*Figure 6* Richard Memorial Laboratories, Philedelphia, PA, 1961 by Louis Kahn (Banham, 1969)

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In the late 80’s while the application of computer technology into buildings was the main theme of the architectural practice, Norman Foster Associates have designed an innovative building in Hong Kong that is dominated by several environmental management ideas. In 1986, Hong Kong and Shangai Banking Corporation Headquarters is built in Hong Kong by Norman Associates (Fig. 8a). Flexible layout and systems such as raised floor system provide space for services distribution, and helps to cope with the future change and growth (Fig. 8b). Computer technology is also used in the building in order to control the sun scoops that are used to track the sun location, together with mirrors positioned both outside and on top of the building atrium to diffuse sunlight to different floors through atrium and down to the plaza floor (Figure 9) (Dobney, 1997).
The concept of energy efficiency in Hong Kong Bank resulted in the sunshades on the external facades to avoid direct sunlight into the building and to reduce the heat gain. Seawater is also used instead of fresh water for toilet flushing and as coolant for the air conditioning system to save energy (Dobney, 1997).

Figure 8 Hong Kong and Shanghai Banking Headquarters, Hong Kong (Dobney, 1997)

Figure 9 Hong Kong and Shanghai Banking Corporation Headquarters, Atrium (Dobney, 1997)
In 1997, Norman Associates built another innovative design for Commerzbank in Frankfurt, Germany (Figure 10). Commerzbank Headquarters is termed as the “world’s first ecological tower” and the “world’s tallest building” (Fischer & Grüneis 1997). This building is also important since Foster combined the environmental technologies with the ecological principles and carried this approach to his architectural concepts and theories.

Commerzbank Headquarters’ plan form is triangular, compromising three ‘petals’, the office floors and a ‘stem’ formed by a full height central atrium. Four-story gardens are set at different levels on each of the three sides of the tower, forming a spiral of gardens around the building. These gardens become the visual and social focus for village-like clusters of offices. Ventilation is another important issue in this building where mechanical ventilation and air extraction is proposed only on days with extreme conditions and the outer offices are ventilated directly from the outside, naturally. The offices on the atrium side draw air from outside indirectly through ventilation flaps in the 46 feet high glass walls of the garden facades. Just like the Hong Kong Bank, Commerzbank also has a complicated computer technology that controls; the quantity of air pumped in or out, cut of supply to unoccupied spaces, external sun shading, the opening angle of windows, and the release or lock of controls and regulators. Cooling on hot days is achieved by a static, water filled cooling system and the cold water needed for cooling is produced by environmentally friendly absorption type refrigerating machines. High heat insulation quality on the facades and glazing also has a positive influence on the energy balance of the building. Fluorescent tubes with daylight-dependent regulation light the offices and movement detectors automatically switch continuous lighting in the corridors and offices (Fischer & Grüneis, 1997).
Similar to what Banham proposed in 1969, Baker and Steemers (2000) categorized the modes of environmental management in contemporary architecture. They state that there are two modes of environmental management. Selective mode, employs the designs that work with a combination of form and fabric operating in a calculated relationship with mechanical systems such as Hong Kong Bank or Commerzbank Headquarters however, external and internal climates are separated with a sealed enclosure and mechanical services are applied as the main providers of the internal environment in the exclusive mode of environmental management.

*Figure 10* Commerzbank Headquarters, Frankfurt, Germany (Fischer & Grüneis, 1997).
The environmental management concepts, techniques and their influence on architecture and the architectural theory have always been changing since human created their third environment. Table 1 summarizes all these different approaches in the context of major issues and the building themes in the world of architecture, since 1960’s.

Table 1 Historical Quest for Building Reality

<table>
<thead>
<tr>
<th>Decade</th>
<th>Issues</th>
<th>Building theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s</td>
<td>Sense of coolness, heating, ventilation, insulation, shading</td>
<td>Air-conditioning systems</td>
</tr>
<tr>
<td>1970s</td>
<td>Energy crisis</td>
<td>Energy-efficient buildings</td>
</tr>
<tr>
<td>1980s</td>
<td>Application of computer technology in buildings</td>
<td>Intelligent buildings</td>
</tr>
<tr>
<td>1990s</td>
<td>Concern about the sick building syndrome and environmental impacts</td>
<td>Healthy buildings</td>
</tr>
<tr>
<td>Twenty first century</td>
<td>Global effort for sustainable development</td>
<td>Environmentally sensitive buildings</td>
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</tbody>
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5. Towards Sustainable Architecture

Architecture has proven itself, over time, to be susceptible to the winds of fashion. From the Modern Movement to the Post-Modern Movement, from Rationalism to Deconstructivism, architects often find themselves rushing towards the next new trend, as the tastes and needs of their clients change to adopt the newest, latest and greatest; whatever that may happen to be. Today, the big word swarming around the architectural profession is "sustainable architecture".
Sustainable architecture, as a concept, is still new to have different experts describing it differently. But its roots stem back to the pollution crises of the 60’s and the energy crises of the 70’s. In fact energy efficient buildings was an expected result of the evolution of the environmental technology in the building industry. A more detailed explanation of this evolution was already given in Table 1.

When people realized that creating the ideal comfort conditions in their third artificial environment with the help of high environmental technologies, is not the only issue but to provide the high grade energy for this process is another difficult one, a number of design professionals began looking for less energy-intensive ways to build. A lot of different strategies developed such as reusing existing structures in new ways, as opposed to demolishing them, landscaping with drought-tolerant, indigenous plants, life cycle costing, recycling building materials, etc. These approaches, taken independently, were good ideas that worked in some circumstances for some clients. Sustainability takes all these diverse approaches and combines them together with a unifying theme:

- Buildings are systems that require materials and energy to build and maintain.
- The resources that supply the materials and energy are finite.
- Design decisions should incorporate lower-impact resources where possible, to reduce energy use, minimize environmental damage, and create humane environments for working and living.

Some of the underlying philosophies are murkier, wrapped up in new-age thinking that sometimes confuses design issues with morality. Nonetheless, with rocketing gas prices, energy conundrums, and ongoing concerns about water conservation, especially in developing countries, sustainability offers responses that can make sense at the bottom line, not just at the court of current fashion.
6. Conclusion

The recent history of architecture has seen the development of a new and more sophisticated synthesis and collaboration between leading architectural and engineering practices. The numerous developments in the technology of building have greatly expanded the scope of environmental design. However modern design strategies have evolved into an increasing reliance on man-made systems. The efforts to create the ideal interior environments accelerated the on going evolution of the building technology and that resulted in the construction of many overly complicated and oversized environmental control systems. Architect as a result begins to lose the control of the building and as a consequence develops a form and then hands it to the engineer. This lack of communication and coordination between disciplines causes the production of buildings that lack sense of having architectural form being environmentally sensitive. However contemporary practice exhibits a greater diversity of approach than ever before and the basis of this diversity rests on the relationship between the environmental function of form and fabric of a building and its mechanical service systems.

This study aimed to exhibit the relations between environment, energy and human and combine these relations under the shelter of an architectural theory that is deeply concerned of its first, second and third environments. All the case studies that are reviewed through this study illustrate the effects of environmental technology on architecture. However, there are still some questions has to be answered in more detail:

- What characteristics of people are important in shaping the environment?
- How and to what extend does the environment affect people?
- What are the mechanisms that link people to the environment?
7. References


