IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Sustainable Design and Pollution Prevention by approaching Economy of Resources as the principle of Sustainability in Architecture

1MOBIN ASGHARNEJADTEHRANI

1Ph.D. Scholar

1Jamia Millia Islamia

Abstract

Sustainable design (also called environmental design, environmentally sustainable design, environmentally conscious design, etc.) is the philosophy of designing physical objects, the built environment, and services to comply with the principles of social, economic, and ecological sustainability. Sustainable design is the intention to reduce or completely eliminate negative environmental impacts through thoughtful designs. This concept can be applied across all fields of design such as designing buildings or products.

A sustainable design, regardless of the application, will seek to incorporate environmentally-preferable outcomes such as: Lower energy and water consumption through the entire lifecycle from manufacture to daily use to disposal, Minimize impact on climate change by reducing greenhouse gas emissions or mitigating them through carbon neutralizing activities, Limit resource consumption through waste-free manufacturing, a preference for renewable resources, and an emphasis on recycled materials, Reduce or eliminate waste by minimizing consumption, reusing when possible, and recycling when necessary, Minimize impact on the local ecosystem and look for ways to incorporate bio-mimicry principles where possible, Give preference to non-toxic materials and those that will contribute to the health and wellbeing of humanity, and Emphasize quality and durability over price. This paper concentrates on sustainable designs used in architecture which architects designed and presented to have the solutions of human comfort and save natural energies.

Key Words: Sustainable design, Pollution Prevention, Economy Resources, Sustainability in Architecture.

Introduction

The World Commission on Environment and Development has put forth a definition of "sustainability" as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

— From *Our Common Future*
(London: Oxford University Press, 1987).

This definition of sustainability does not specify the ethical roles of humans for their everlasting existence on the planet. It also fails to embrace the value of all other constituents participating in the global ecosystem. The need for finding long-terms solutions that warrant continuing human existence and well-being is far more compelling than that of finding a proper terminology to describe the human need. In this respect, the debate on the terms "green," "sustainable," or "ecological" architecture is not terribly important.

Architecture is one of the most conspicuous forms of economic activity. It is predicted that the pattern of architectural resource intensity (the ratio of per-capita architectural resource consumption to per-capita income) will generally follow the same patterns. A country's economic development will necessitate more factories, office buildings, and residential buildings. For a household, the growth of incomes will lead to a desire for a larger house with more expensive building materials, furnishings and home appliances; more comfortable thermal conditions in interior spaces; and a larger garden or yard.

During a building's existence, it affects the local and global environments via a series of interconnected human activities and natural processes. At the early stage, site development and construction influence indigenous ecological characteristics. Though temporary, the influx of construction equipment and personnel onto a building site and process of construction itself disrupt the local ecology. The procurement and manufacturing of materials impact the global environment. Once built, building operation inflicts long-lasting impact on the environment. For instance, the energy and water used by its inhabitants produce toxic gases and sewage; the process of extracting, refining, and transporting all the resources used in building operation and maintenance also have numerous effects on the environment.

Architectural professionals have to accept the fact that as a society's economic status improves its demand for architectural resources such as land, buildings or building products, energy, and other resources will increase. This in turn increases the combined impact of architecture on the global ecosystem, which is made up of inorganic elements, living organisms, and humans. The goal of **sustainable design** is to find architectural solutions that guarantee the well-being and coexistence of these three constituent groups.

Principles of Sustainable Design

To educate architects to meet this goal of coexistence, this new science has developed a conceptual framework. The three levels of the framework (Principles, Strategies, and Methods) correspond to the three objectives of architectural environmental education: creating environmental awareness, explaining the building ecosystem, and teaching how to design sustainable buildings. The high propose of this new science built on the pile of three principles of sustainability in architecture. Economy of Resources is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building. Life Cycle Design provides a methodology for analyzing the building process and its impact on the environment. Humane Design focuses on the interactions between humans and the natural world. These principles can provide a broad awareness of the environmental impact, both local and global, of architectural consumption. This research studies just one of three principles of sustainability of architecture (Economy of Resources).

Each of these principles embodies a unique set of strategies. Studying these strategies leads architects to more thorough understanding of architecture's interaction with the greater environment. This allows them to further disaggregate and analyze specific methods architects can apply to reduce the environmental impact of the buildings they design.

Economy of Resources

By economizing resources, the architect reduces the use of nonrenewable resources in the construction and operation of buildings. There is a continuous flow of resources, natural and manufactured, in and out of a building. This flow begins with the production of building materials and continues throughout the building's life span to create an environment for sustaining human well-being and activities. After a building's useful life, it should turn into components for other buildings.

When examining a building, consider two streams of resource flow. Upstream, resources flow into the building as input to the building ecosystem. Downstream, resources flow out of the building as output from the building ecosystem. In a long run, any resources entered into a building ecosystem will eventually come out from it. This is the law of resource flow conservation. For a given resource, its forms before entry to a building and after exit will be different. This transformation from input to output is caused by the many mechanical processes or human interventions rendered to the resources during their use in buildings. The input elements for the building ecosystem are diverse, with various forms, volumes, and environmental implications. The three strategies for the economy of resources principle are energy conservation, water conservation, and material conservation. Each focuses on a particular resource necessary for building construction and operation.

Energy Conservation

After construction, a building requires a constant flow of energy input during its operation. The environmental impacts of energy consumption by buildings occur primarily away from the building site, through mining or harvesting energy sources and generating power. The energy consumed by a building in the process of heating, cooling, lighting, and equipment operation cannot be recovered.
The type, location, and magnitude of environmental impacts of energy consumptions in buildings differ depending on the type of energy delivered. Coal-fired electric power plants emit polluting gases such as SO_2, CO_2, CO, and NO_x into the atmosphere. Nuclear power plants produce radioactive wastes, for which there is currently no permanent management solution. Hydropower plants each require a dam and a reservoir which can hold a large body of water; construction of dams results in discontinuance of river ecosystems and the loss of habitats for animals and plants.

Water Conservation

A building requires a large quantity of water for the purposes of drinking, cooking, washing and cleaning, flushing toilets, irrigating plants, etc. All of this water requires treatments and delivery, which consume energy. The water that exits the building as sewage must also be treated.

Material Conservation

A range of building materials are brought onto building sites. The influx of building materials occurs primarily during the construction stage. The waste generated by the construction and installation process is significant. After construction, a low-level flow of materials continues in for maintenance, replacement, and renovation activities. Consumer goods flow into the building to support human activities. All of these materials are eventually output, either to be recycled or dumped in a landfill.

Methods for Achieving Sustainable Design

The ultimate goal and challenge of sustainable design is to find win-win solutions that provide quantitative, qualitative, physical, and psychological benefits to building users. There are many possibilities for achieving this seemingly difficult goal. The three principles of sustainable design- economy of resources, life cycle design, and humane design provide a broad awareness of the environment issues associated with architecture. The strategies within each principle focus on more specific topics. These strategies are intended to foster an understanding of how a building interacts with the internal, local, and global environments. This section discusses methods for applying sustainable design to architecture.

Economy of Resources

Conserving energy, water, and materials can yield specific design methods that will improve the sustainability of architecture. These methods can be classified as two types.

1) Input-reduction methods reduce the flow of nonrenewable resources input to buildings. A building's resource demands are directly related its efficiency in utilizing resources.

2) Output-management methods reduce environmental pollution by requiring a low level of waste and proper waste management.

Energy Conservation

Energy conservation is an input-reduction method. The main goal is to reduce consumption of fossil fuels. Buildings consume energy not only in their operation, for heating, lighting and cooling, but also in their construction. The materials used in architecture must be harvested, processed, and transported to the building site. Construction itself often requires large amounts of energy for processes ranging from moving earth to welding.

Energy-Conscious Urban Planning

Cities and neighborhoods that are energy-conscious are not planned around the automobile, but around public transportation and pedestrian walkways. These cities have zoning laws favorable to mixed-use developments, allowing people to live near their workplaces. Urban sprawl is avoided by encouraging redevelopment of existing sites and the adaptive reuse of old buildings. Climatic conditions determine orientation and clustering. For example, a very cold or very hot and dry climate might require buildings sharing walls to reduce exposed surface area; a hot, humid climate would require widely spaced structures to maximize natural ventilation.

Energy-Conscious Site Planning

Such planning allows the designer to maximize the use of natural resources on the site. In temperate climates, open southern exposure will encourage passive solar heating; deciduous trees provide shade in summer and solar heat gain in winter. Evergreens planted on the north of a building will protect it from winter winds, improving its energy efficiency. Buildings can be located relative to water onsite to provide natural cooling in summer.

Passive Heating and Cooling

Solar radiation incident on building surfaces is the most significant energy input to buildings. It provides heat, light, and ultraviolet radiation necessary for photosynthesis. Historically, architects have devised building forms that provide shading in summer and retain heat in winter. This basic requirement is often overlooked in modern building design. Passive solar architecture offers design schemes to control the flow of solar radiation using building structure, so that it may be utilized at a more desirable time of day. Shading in summer, by plants or overhangs, prevents summer heat gain and the accompanying costs of air-conditioning. The wind, or the flow of air, provides two major benefits: cooling and hygienic effects. Prevailing winds have long been a major factor in urban design. For instance, proposals for Roman city layouts were primarily based on the direction of prevailing winds.

Insulation

High-performance windows and wall insulation prevent both heat gain and loss. Reducing such heat transfer reduces the building's heating and cooling loads and thus its energy consumption. Reduced heating and cooling loads require smaller HVAC equipment, and the initial investment need for the equipment will be smaller. Aside from these tangible benefits, high-performance windows and wall insulation create more comfortable thermal environments. Due to the insulating properties of the materials, the surface temperatures of windows and walls will be higher in the winter and lower in the summer. The installation of smaller HVAC equipment reduces mechanical noise and increases sonic quality of the indoor space.

Alternate Sources of Energy

Solar, wind, water, and geothermal energy systems are all commercially available to reduce or eliminate the need for external energy sources. Electrical and heating requirements can be met by these systems, or combination of systems, in all climates.

Day lighting

Building and window design that utilizes natural light will lead to conserving electrical lighting energy, shaving peak electric loads, and reducing cooling energy consumptions. At the same time, day lighting increases the luminous quality of indoor environments, enhancing the psychological wellbeing and productivity of indoor occupants. These qualitative benefits of day lighting can be far more significant than its energy-savings potential.

Energy-Efficient Equipment & Appliances

After construction costs, a building's greatest expense is the cost of operation. Operation costs can even exceed construction costs over a building's lifetime. Careful selection of high efficiency heating, cooling, and ventilation systems becomes critical. The initial price of this equipment may be higher than that of less efficient equipment, but this will be offset by future savings. Appliances, from refrigerators to computers, not only consume energy, they also give off heat as a result of the inefficient use of electricity. More efficient appliances reduce the costs of electricity and air-conditioning. The U. S. Environmental Protection Agency has developed the "Energy Star" program to assist consumers in identifying energy efficient electronic equipment.

Choose Materials with Low Embodied Energy

Building materials vary with respect to how much energy is needed to produce them. The embodied energy of a material attempts to measure the energy that goes into the entire life cycle of building material. For instance, aluminum has a very high embodied energy because of the large amount of electricity that must be used to manufacture it from mined bauxite ore; recycled aluminum requires far less energy to refabricate. By choosing materials with low embodied energy, the overall environmental impact of a building is reduced. Using local materials over imported materials of the same type will save transportation energy.

Water Conservation

Methods for water conservation may reduce input, output, or both. This is because, conventionally, the water that is supplied to a building and the water that leaves the building as sewage is all treated by municipal water treatment plants. Therefore, a reduction in use also produces a reduction in waste.

Reuse Water Onsite

Water consumed in buildings can be classified as two types: gray water and sewage. Gray water is produced by activities such as hand washing. While it is not of drinking-water quality, it does not need to be treated as nearly as intensively as sewage. In fact, it can be recycled within a building, perhaps to irrigate ornamental plants or flush toilets. Well-planned plumbing systems facilitate such reuse. In most parts of the world, rainwater falling on buildings has not been considered a useful resource. Buildings are typically designed to keep the rain from the occupants, and the idea of utilizing rain water falling on building surfaces has not been widely explored. Building envelopes, particularly roofs, can become rainwater collecting devices, in combination with cisterns to hold collected water. This water can be used for irrigation or toilet-flushing.

Reduce Consumption

Water supply systems and fixtures can be selected to reduce consumption and waste. Low-flow faucets and small toilet tanks are now required by code in many areas of the country. Vacuum-assisted and bio-composting toilets further reduce water consumption. Bio-composting toilets, available on both residential and commercial scales, treat sewage on site, eliminating the need for energy-intensive municipal treatment. Indigenous landscaping - using plants native to the local ecosystem - will also reduce water consumption. These plants will have adapted to the local rainfall levels, eliminating the need for additional watering. Where watering is needed, the sprinkler heads should be carefully placed and adjusted to avoid watering the sidewalk and street.

Materials Conservation

The production and consumption of building materials has diverse implications on the local and global environments. Extraction, processing, manufacturing, and transporting building materials all cause ecological damage to some extent. There are input and output reduction methods for materials conservation. As with water, some of these methods overlap.

Adapt Existing Buildings to New Uses

One of the most straightforward and effective methods for material conservation is to make use of the resources that already exist in the form of buildings. Most buildings outlive the purpose for which they were designed. Many, if not all, of these buildings can be converted to new uses at a lower cost than brand-new construction.

Incorporate Reclaimed or Recycled Materials

Buildings that have to be demolished should become the resources for new buildings. Many building materials, such as wood, steel, and glass, are easily recycled into new materials. Some, like brick or windows, can be used whole in the new structure. Furnishing, particularly office partition systems, are also easily moved from one location to another.

Use Materials That Can Be Recycled

During the process of designing the building and selecting the building materials, look for ways to use materials that can themselves be recycled. This preserves the energy embodied in their manufacture.

Size Buildings and Systems Properly

A building that is oversized for its designed purpose, or has oversized systems, will excessively consume materials. When a building is too large or small for the number of people it must contain, its heating, cooling, and ventilation systems, typically sized by square footage, will be inadequate or inefficient.
This method relates directly to the programming and design phases of the architectural process. The client's present and future space needs must be carefully studied to ensure that the resulting building and systems are sized correctly. Architects are encouraged to design around standardized building material sizes as much as possible. In the U. S., this standard is based on a 4'x8' sheet of plywood. Excess trimming of materials to fit non-modular spaces generates more waste.

Reuse Non-Conventional Products as Building Materials

Building materials from unconventional sources, such as recycled tires, pop bottles, and agricultural waste, are readily available. These products reduce the need for new landfills and have a lower embodied energy that the conventional materials they are designed to replace.

Consumer Goods

All consumer goods eventually lose their original usefulness. The "useful life" quantifies the time of conversion from the useful stage to the loss of original usefulness stage. For instance, a daily newspaper is useful only for one day, a phone book is useful for one year, and a dictionary might be useful for 10 years. The shorter the useful life of consumer goods, the greater the volume of useless goods will result. Consequently, more architectural considerations will be required for the recycling of short-life consumer goods. The conventional term for consumer goods that have lost their original usefulness is waste. But waste is or can be a resource for another use. Therefore, in lieu of waste, it is better to use the term "recyclable materials." One way buildings can encourage recycling is to incorporate facilities such as on-site sorting bins.

Conclusion

Even in contemporary century with the help of new design methods, new construction material and a lot of technological devices, the present buildings are very expensive and uncomfortable to live in and according to the energies sources which today we use, we will have some problems in near future. So, it is not bad to have a look at the way of design and the natural systems which our ancestors used. Of course, it is hard to go back to the ways our ancestors used to live with, but surely to study and learn from the ways they used and the sustainable design they introduced and presented, can be necessary and useful as we can vividly see some logic and reason in their way. Sustainable design in traditional architecture are cheap, simple and logical and by using the natural resources of energies such as wind, water and sunshine can provide the comfortable situation of life for human.

References

[1] Nicol J.F, Roaf, S. Adaptive thermal comfort and passive architecture, in Santamouris, M. (ed)Advances in Passive Cooling, London: Earthscan; 2007.

[2] Roaf S. Wind Catchers, Living With the Desert, (ed: Beazley, E.), England: Air & Philips press; 1982.

[3] Ghobadian V. Climatic Analysis of the Traditional Iranian Buildings, Tehran: Tehran University Publications; 1998, p. 8-10

[4] Bahadori M.N. "An Improved Design of Wind Towers for Natural Ventilation and Passive Cooling", Solar Energy; vol. 35, No.2; 1985

[5] Meir I, Roaf S. Between Scylla and Charibdis: In search of the sustainable design paradigm between Vernacular and Hi-Tech, Procs. PLEA Conference, Santiago, Chile; 2003.

[6] Tavassoli, M. Architecture of hot arid climate, Tehran: Tehran University Publication; 1974.

[7] Fathy, H. Natural Energy and Vernacular Architecture, Chicago: The university of Chicago Press; 1986.

[8] Uphan P.A. Persian Architecture, Tehran: Soroush Press; 1976.

[9] Ghrishman R. Iran, from the earliest time to the Islamic conquest, New York: Penguin Books; 1987.