

# ECOLOGICAL DESIGN

## (Eco-Design)

Architecture, between a design mythology and environmental attitude

Prepared by:  
**Karwan Taib Fatah**

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*“Moral codes adjust themselves to environmental conditions”*

(Will Durant) 1885 - 1981

## Index

<b>Introduction</b>	<b>01</b>
<b>Ecology and Architecture</b>	<b>02</b>
<b>Eco-design's History</b>	<b>03</b>
<b>Ecological design between traditional and modern architecture</b>	<b>04</b>
<b>Eco-design and sustainability</b>	<b>10</b>
<b>Ecological principals</b>	<b>10</b>
<b>Design guidelines &amp; instructions</b>	<b>11</b>
<b>Personal experience</b>	<b>13</b>
<b>Conclusions</b>	<b>14</b>
<b>Sulaimanya city from ecological standpoint (general observation)</b>	<b>15</b>
<b>References</b>	<b>16</b>

## Introduction

Since the last few past decades people are getting more aware about our planet Earth and being more concerned about the risks we are facing due to the global warming and climate changes.

Alongside the other contributors of industries and manufacturers, extraction of natural resources such as building materials will consume energy and consequently causing environmental pollution and contribute to the global warming by releasing the carbon dioxide emission. If we don't do something about this serious matter this millennium probably will be the last one for human beings on this planet.

Buildings are the largest energy consumers, both in the developed and developing countries. According to the United Nations Environment Program, building sector accounts for 30-40 % of global energy use. The consumption of energy by buildings is not only during or for its construction but also during the period when the building is in use; the energy used for heat, cooling, lighting, ventilation.

Every year millions of new buildings are being constructed and new construction materials are being introduced to the building market, subsequently the old used materials will be thrown and ultimately causes pollution to the environment!

Therefore urgent changes are required and regulation measurements need to be taken regarding energy saving, emissions control, production and application of materials.

Using renewable resources, recycling and reuse of building materials is necessary to be considered by the designers.

From buildings design perspective an architectural design method is developed which called Ecological Design or Eco-Design. This is not necessarily requires a complicated and expensive approach to the architectural design.

*“To achieve improved energy efficiency in buildings you often do not need to use advanced and expensive high-tech solutions, but simple solutions such as smart design, flexible energy solutions and provision of appropriate*

*information to the building users,”* says Olivier Luneau, SBCI Chairman and Director for sustainability at Lafarge.

Thus architects and building designers can play a major role in decreasing the amount of carbon footprint released from the building materials, and this by dealing with their projects through an Ecological and sustainable approach. Ecological design is rather a mindset and an ethical responsibility towards the new generations and the bio-system than a design method for approaching sustainability.

## **Ecology and Architecture**

‘Ecology’ is the study of living systems and their relations towards each other in their natural territory and network in a balanced and stable cycle.

Eco-design is a responsible method of design towards nature and Earth, and it is the participation of architecture in to the living system through its understanding and integration of the non-living structure as buildings in to the living system; it’s a human made ecosystem through structures and buildings in a rational and managed way.

**Eco-design** is the approach of designing built environment with special consideration for the impact of the design and the buildings on the planet Earth from an ecological standpoint. It’s about our understanding and perception towards environmental friendly architecture in both design process as well as the structure that results from the design process, use local and sustainable materials, and develop opportunities for improvements within the structure

“An Ecological Building is a structure that is designed to create and sustain mutually beneficial relationships with all of the elements of its local ecology. A building’s local ecology, or environment, is made up of particular physical and biological elements and their interactions.”

Although the green building design or sustainable architecture has many common aspects with Ecological design specially in their care of Earth and people, but the concept is different in sense of: the aim of sustainable architecture is to minimize the negative impact of the building on the environment while the Ecological design goal is to set out a positive increase of beneficial interactions with the environment.

Besides the impact of the design on the surrounding, Eco-Design emphasizes the life cycle of the materials and asking specific questions such as:

- Where these elements will go?
- How could be implemented in such way to maximize its benefit to the natural system?

The focus of Eco-Design is not only on each element separately but rather on the way they are placed together as a whole. There is a fundamental difference between Eco-Design and approaching sustainability through engineering solutions to decrease the building's negative impacts on the environment.

A branch has developed From Eco-Design that called Permaculture; this last seeks for minimizing waste, human labor and energy input by building systems, in the same time it's aiming to maximize the benefits between the elements through the design, in order to achieve an optimum level of collaboration and integrating itself with nature.

## Eco-design's History

The concept of Eco-design in its contemporary context starts from the 1920s, when architect and designer created designs for structures, cars and other objects that encouraged a wise use of resources. His most famous creation, the geodesic dome (see fig-01), remains an excellent example of lightweight, efficient construction. Fuller was concerned about sustainability and about human survival under the existing socio-economic system, yet remained optimistic about humanity's future.

Today, innovators take the concept of ecodesign to a whole new level, creating lighting, appliances, furniture and even clothing that don't drain the Earth's resources.



• (fig-01)

(fig-01) the Geodesic Dome

is a particular type of structure shaped like a part of a sphere or a ball designed by the American engineer called Richard Buckminster Fuller in the 1940's

(Richard Buckminster "Bucky" Fuller (July 12, 1895 – July 1, 1983)[1] was an American systems theorist, architect, engineer, author, designer, inventor, and futurist.

Fuller published more than 30 books)

## Ecological design between traditional and modern architecture

When we analyze the modern concept of Eco-design or green architecture we are mainly dealing with two main phenomena;

- 1 - Traditional building styles with low technical influence
- 2- Application of Modern and high performance technology to achieve the optimum ecological results.

In both cases (traditional or modern building styles) the ecological products are “flexible, reliable, durable, adaptable, modular, dematerialized and reusable”. Additionally these products providing economical reasonability and social compatibility.

Although in many cases, the modern architecture appears as the manifestation of sculptural expression of certain ideas or science and new developed building products rather than representing the continuity of living system in its complex process.

Below are some practical examples for both phenomena:

### 1- Traditional building styles

In this part we analyze the traditional Kurdish building materials from an Ecological viewpoint.

If we look closely to the traditional Kurdish building style it's by nature an Eco-driven building style; the buildings are entirely made from locally available materials and mainly taken directly from the nature such as clay or mud-bricks, straw, wood, bamboo, stones. (see fig-02 - 03)



• (fig-02)



• (fig-03)

(fig-02)

A traditional building in Suleimanya made out of locally made materials

(fig-03)

One of the old streets in Suleimanya; the buildings are well integrated in the natural landscape as well as the relationship between individual buildings are in harmony

The thick mud-brick walls with wooden structure roof and clay layer on top providing relatively high insulation properties. Almost all materials used in the old traditional buildings are easy to dispose and be returned to the nature; better still it could be recycled in most cases.

The production of its elements require minimum amount of energy and fuel with relatively low carbon dioxide and pollutions.

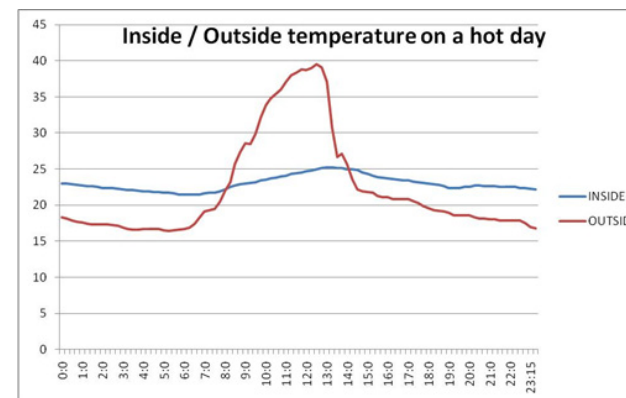
Making mud-bricks are technically easy and doesn't need any energy to make except for sunshine and the materials are all locally available and directly taken from nature. In most of the traditional Kurdish villages the walls are made from mud-bricks and roofs from wooden beams, bamboo and a thick layer of mud on top. (Mud bricks are made by mixing clay earth with water and sometimes straw which helps stop the bricks cracking, then placing the mixture into moulds to dry in the sun. Mud bricks are joined with a mortar, made from a similar clay-water mix as the bricks themselves.

#### The main disadvantages of mud-brick buildings are:

- In the rainy seasons they need to be protected from driving rain.
- Need for constant maintenance.
- The walls need to be notably thick in order to sustain the loads and obtaining a reasonable insulation value.
- Limitations for constructing vertical and high raised buildings.
- Limited resistance to earthquakes and natural catastrophes.

The walls and ceiling in traditional Kurdish building style is a good example of the classical **thermal mass** as well. The wall mostly acts to hold back heat transfer from the exterior to the interior during the day, the material property and its thickness preventing thermal energy from reaching to inside (see fig-04).

When temperatures fall at night, the walls re-radiate the thermal energy back into the night sky. Therefore it is important for such walls to be massive to prevent heat transfer into the interior.



• (fig-04)

(fig-04)

Diagram showing the thermal mass of the wall; the fluctuation of temperature in day time with the difference between indoor and outdoor.



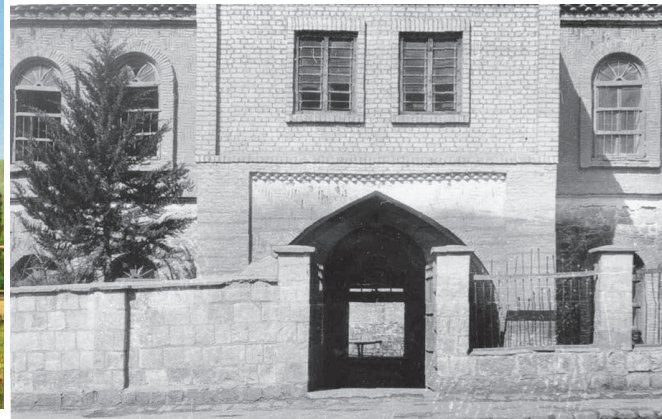
## Passive solar and high thermal mass

Besides the material use, the traditional buildings are associated with **passive solar design**; a design technique is utilized to take advantage of the local climate and consider the sun's position in the sky to help heat and cool the building in all different seasons. For instance, in many of the old houses in Suleimanya we see that the houses has two opposite sides with a central internal yard connecting both sides, the usage of each one of the sides are depending on the season and the time of the day; the sun position is playing an important role in this regard.

Furthermore, we notice that the integration of the buildings in the nature is visually optimal. But unfortunately these types of buildings are coming to an end soon and massively concrete buildings are coming in place! (see fig- 05 -08).



• (fig-05)



• (fig-06)



• (fig-07)



• (fig-08)

(fig-05)

An image of Suleimanya (near the Public Park and Maulawi Street) in the 1970s, the greenery and space are impressively present

(fig-06)

One of the old buildings in Suleimanya whereby the traditional building's craftsman are clearly expressed in its details

(fig-07)

A current view of Mawlawi Street in Suleimanya; the absence of greenery and domination of non ecological elements are remarkable

(fig-08)

A building on Mawlawi Street built in the 1980s; diversion from the original building styles and natural environment



This is not only a tragedy because of the ecological and environmental values of those buildings but also day by day our cities are losing its prestigious legacy and its rich identity which has been built throughout years.

It is crucial that the local authorities encourage designers to concentrate on the great value of our traditional building styles especially in the old districts of the Kurdish cities and trying to adapt the modern techniques to enhance the functionality, durability and upgrading its standards to meet the modern life's needs and expectations. In addition to the scientific and environmental knowledge the local knowledge has a sufficient value for the designer, to integrate buildings in a specific landscape, and using local resources and taking inspirations from local building styles; the architect works with the local climate to optimize the design and make the best use of the local climate to reduce the use of fuels and energy.

Even globally until about 200 years ago humans where not polluting the environment; if we look at the architecture that created before 19th century, we could observe the fact that people were building their buildings from ecological and recyclable materials.

## **2- Modern application of Ecological design**

Although there are many modern buildings conceptualized and designed through an ecological approach yet quantitatively non-ecological buildings are significantly larger and out of proportion. However we name some projects as examples for ecologically designed projects such as the Elephant and Castle Eco Tower in London that designed by Ken Yeang (see fig-09) , in this project he worked with vertical landscaping and combined the horizontal and vertical vegetation this is a similar approach to the Eco-friendly building with Vertical Garden by architect Gaetano Pesce (see fig-10). According to Ken Yeang Ecodesign is not about proscribing one material or system in favor of another from a technical viewpoint, but rather about the overall awareness of how our human communities and built environment become an integral part of life on the planet.

The Castle House which designed by Hamilton architects is another example for eco-driven design (see fig-11); this eco-residential tower is partially energy self-sufficient by utilizing wind turbines on the top of the tower on 147 m high from the ground level, the Castle House will have 310 apartments and Located at Elephant and Castle South London same district as the building of Ken Yeang.



• (fig-09)



• (fig-10)

(fig-09)

Elephant and Castle Eco Tower (London) designed by Ken Yeang, he is a Chinese Architect and writer, he is considered as a 'guru' in ecological design

(fig-10)

Vertical Garden design in Osaka-Japan by architect Gaetano Pesce

(fig-11)

The Castle House which designed by Hamilton architects



• (fig-11)



If we look closely at the forms of above mentioned projects we realize that Eco-design could affect the buildings appearance and give them shape.

On a much bigger scale, the MASDAR city in Abu-Dhabi; this will become the world's first carbon neutral city and a sustainable model for green urbanization in the future and remarkable project on the worlds map.

MASDAR city will produce zero carbon dioxide emissions, no waste, and run on renewable energy; a modern city with nine times less energy usage per person in compare to a developed country like the United States.

This utopian city is intended to bear 40,000 residents and 50,000 visitors, will be car free, but not necessarily crowded with bikes and pedestrians. A Personal Rapid Transit system in form of small pods on rails will provide the mobility in form of private metro car. Goods will be transported in a similar way.



• (fig-13)



• (fig-12)

(fig-12)

The headquarters of the International Renewable Energy Agency (IRENA), to be located in Masdar City. It will be the first building in history to produce more energy than it consumes

(fig-13)

View from air of Central Plaza in Masdar City

## Eco-design and sustainability

The goal of Eco-design is sustainability, which simply means that these products are built, used and discarded in a way that doesn't cause a significant threat to the environment. Although this is not a simple task in a world addicted to cheap, disposable and constant change!

Sustainability is approaching built environment through application of three concepts: cyclic, solar, and safe:

- “Cyclic” refers to the production of goods made from materials that are either compostable or recyclable.
- “Solar” refers to the products are made using renewable sources of energy.
- “Safe” manufacturing process and by-products released into the environment should be or nontoxic.

The main difference between engineering approach towards green design and ecological design is that the first will start with the end and aim to achieve a predefined goal while the second approach start with the existing environment, try to create a harmony and be integrated with the natural existence of the ecological system.

## Ecological principals

Eco-design is not only concerned about the built environment during the design process but also during the manufacturing process, transportations, recycling and reintegration at later stages.

The designer need to be aware about the following key aspects of ecosystems:

- The ecological process that depends of the local climate and the network within the environment.
- The living cycle of organisms in term of energy – waste – energy continuity.
- Solar energy and its transformation as the drive of the ecological cycle.
- Dynamic balance of the ecological system.
- Oxygen production and removal of CO<sub>2</sub>.

- Water supply and recycling it.
- Waste recycle and pollution control.
- Production process of the raw materials used in the design and their impact on the environment.
- Climate and atmospheric control.

### **Design guidelines & instructions**

Progressively the living standards are getting higher especially among the modern and civilized societies, in order the new designs meet the expectations, this will make the designers tasks more complex, demands extra efforts and awareness of their creations as well as its environmental consequences.

The designer will have a difficult mission in balancing between the required comforts levels, energy use with its environmental impacts. Therefore ecological design brief is needed alongside with the design and financial brief.

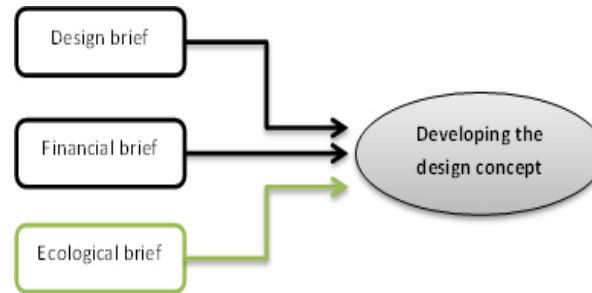
During the design process the following aspects need to be taken in consideration:

- 1- Considering the buildings as the third layer of human body; after the natural skin and clothing as the first and second protection layers, this is an ecological interpretation to the building's function in relation to the direct users.
- 2- Ensuring that a minimum amount of nonrenewable source of energy is used in the structural process.
- 3- The four key strategy points for designers for use of materials are:
  - Reduce (energy)
  - Reuse
  - Recycle
  - Reintegrate.



4- The Eco-design approach for projects requires from beginning to start with three key briefs:

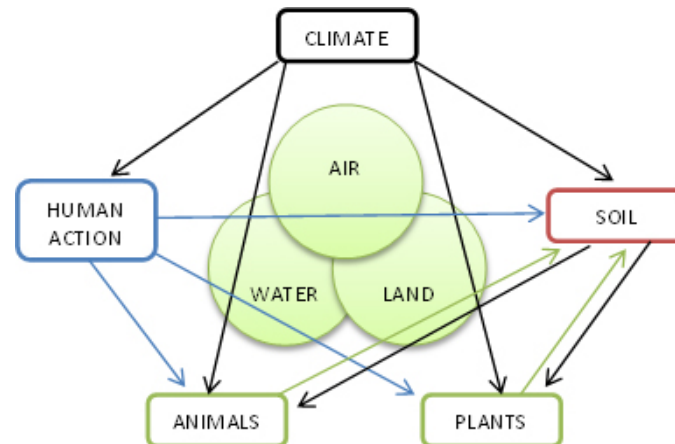
- Design brief
- Financial brief
- Eco-design brief



• (fig-14)

5- integration of the building in to the ecological environment through a Systemic integration; means the integration of the built environment with the ecosystems and biosphere (air, water and land) and the circulation process of the systems energy and inputs.

6- It's crucial for the designer to evaluate the ecological zone where the building comes because every environment has different properties and therefore need to be analyze the relationship and interaction of the building with its surrounding.



• (fig-15)

7- Applying vegetation is relatively a practical and easy way to balance the biotic and abiotic components of the design; there are various methods of integrating greenery in the building, vertically as well as horizontally.

(fig-14)

Design briefs required for developing ecological design concept

(fig-15)

Diagram showing the interaction of the ecological system

## Personal experience: designing a building with Ecological approach

For a residential project in Suleimanya, in front of Azady park (see fig-16), I've made a proposal with some basics of ecological approach to the design by:

- Dedicating significant area for greenery in the heart of the building as well as vertical vegetation on the facades; on one hand to integrate the building to the park located at opposite side besides providing the residence a semi indoor garden where they can socialize, and on the other hand to partially balance the carbon oxidase caused by the building.
- Solar cell plates planned to be planted on the roof to provide green-power to the common areas.
- Using local made clay bricks for the walls which has relevantly high thermal insulation value besides all external walls are designed to be cavity walls.

Due to the financial issues and limitations of floor numbers by Sulaimanya municipality the plan didn't go ahead and less green building will come to the existence in place.



(fig-16)

I've developed the design-concept for this building in October 2011

the integration of landscaping in the body of the building, planning for solar cell panels on the roof and using locally made clay bricks for the walls giving certain ecological property to this design.

• (fig-16)

## Conclusions

Humans account for 0.25% of the bio mass on the earth but in parallel humans are responsible for 99% of the Earth's pollution which caused by only 8% from their built environment.

Besides the building sector accounts for 30-40 % of global energy use, indeed these are frightening facts!

- We need to build up a better relationship between our built environment and the natural environment.
- Architects, designers and engineers are in a position to act and have an influential role in that respect. Ecological design approach could be a convenient tool towards a sustainable built environment.
- Local authorities could give more attention to the environmental factors and encourage developers, architects and designers to develop and design environment friendly buildings and products in our region. While we are not living in an industrialized country but the pollution is noticeable even we could feel it with our senses, our contribution in carbon dioxide is relatively high due to the high quantitative cars, generators and energy consumption.
- Our contemporary cities look like designed for car drivers and barely for pedestrians; therefore creating walk friendly paths is urgently required with natural shades of greenery to encourage people to walk. Furthermore, appropriate public transportation facilities are close to nonexistence in the Iraqi Kurdish cities.
- In contrast to the traditional buildings in Kurdistan, most of the new buildings has low value of thermal insulation and consequently demand higher energy consumption to make the indoor areas livable.
- Integrating more greenery to the open areas and also in to the buildings: vertically, horizontally with attention to the type of plants, their life span, distance from source and its positive contribution to the local environment.
- By looking to a city like Suleimanya from top we could see enormous non-ecological masses and flat unused surfaces such as building's rooftops; that could be utilized for energy solar cells as well as roof gardens.
- Using materials from the local ecological system is not only beneficial ecologically but also strengthen the character and collective identity of that area. Amman (Jordan) is a good example for that.

## **Sulaimanya city from ecological standpoint (general observation)**

Based on this research I do point some of the ecological concerns related to architecture and urbanism.

- 1- Concrete and abiotic components are in a constant increase on daily basis which make the local ecological system even more unbalanced.
- 2- Limited greenery in relation to the population and in relation to the energy consumption and production of dioxide carbon by cars, factories...
- 3- Week energy, water and sewer management within the buildings as well as on city scale.
- 4- Due to the rapid growth of the populations the city getting crowded, more cars on roads and limited reliable public transportations. as said before if we look it from a distance it seems as the whole city is designed for car drivers and not pedestrians; most of the pathways are inconvenient for safe walk.

## **Suggestions**

In order to help enhancing the ecological status and eliminating environmental disasters for the future generations some measurements could be taken including but not limited to:

- 1- utilizing the unused concrete roofs and open spaces for greenery and solar cell panels wherever suitable.
- 2- Bringing more landscape into the city and planting trees for shade, air quality and creating multi use streets with convenient pathways for pedestrians to reduce the use of cars .
- 3- recycling sewer water through sewer treatment plants.
- 4- Recycling wastes by putting recycling plants in place and educating people in this regard to segregate and categorize the wastes.
- 5- Launching building codes and makes the use of thermal Insulation, orientation, passive and active solar energy consideration mandatory in the design briefs.
- 6- Rainwater could return to the ground this by applying permeable paving in streets specially in high density populated areas, this is beneficial for the native landscaping which requires less irrigation.

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