SUSTAINABILITY AS A FIFTH DIMENSION IN ARCHITECTURAL SPACE DESIGN

Submitted By

Weaam Mahmoud El-Sayed Zaghloul

B.Sc. of Architectural Engineering, Faculty of Engineering, Ain University, 2008

Master in Architectural Engineering, Faculty of Engineering, Cairo University, 2012

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Sciences

Department of Environmental Engineering Sciences
Institute of Environmental Studies and Research
Ain Shams University

2018

APPROVAL SHEET

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بسم الله الرحمن الرحيم

"و قل رب زدني علماً "

صدق الله العظيم

To my Mom, Dad, Husband and Sister and family for all your Support and Unconditional love

i. Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy degree in Environmental Architectural Engineering, Institute of Environmental Studies and Research, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or qualification at any other scientific entity.

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Weaam Mahmoud

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iv. Abstract

This dissertation aims at formulating a contemporary definition for architectural space design based on bridging the gap between space understanding and sustainability philosophy. The reason is that the current definitions dealing with architectural space meaning and understanding show a lot of contradictions and criticism among each other. This goes back to the effect of super modernity which resulted in both the call for sustainability as well as the problem in understanding architecture space. The research studies space conception on the philosophical level as it was basic and generic. On the scientific levels, there were attempts for individual scientists such as; Ibn Alhaytham, Newton, Leibniz and Berkeley. In field of architecture, space was introduced for the first time as an enclosed area inside a certain place. Physically it was defined as a three dimensional entity (volume). In Renaissance period, time was regarded in architectural space design through flowing spaces concept. In 18th century new theories evolved such as; the Volumetric theory of Semper; and the Aesthetic theory of Kant. In the 20th Siegfried Giedion offered the modern definition of architectural space known as Space-Time architecture. Later on; new space theories evolved such as The Place Theory of Martin Heidegger; and many others rejected place as an alternative such as Space of Junk, Space of Flow and many others.

On the other hand, the middle of the 20th century witnessed the emergence of Sustainability movement. The research showed that many sustainable oriented approaches in architectural practice were a result of this movement; green design is the strongest among all. Rating systems evolved to evaluate the architectural products in light of sustainability.

Challenges become more difficult as the current definition for architectural space as a four-dimensional entity (x,y,z & t) is incomplete. And a new space definition is required to encompass sustainability within. This research work offers a comparative analysis for the space discourse on the level of conception, functionality, morphology, and sustainability; in order to coin a new definition for architectural space in light of sustainability which is Space-Time-Place, as a restorative step for sustainable design understanding in terms of architectural space design.

KEYWORDS
The meaning of space - Sustainable space - Space-time and sustainability.

v. Summery

This research work studies different interpretations for the meaning of space in terms of sustainability. The research is divided into three parts. The first two parts represent a critical analysis and studies for the two major elements of the research which are space (conception and design) and sustainability (philosophy and design) in the field of architecture; while the third part is the critical analysis to link both.

The First Part is a study for the architecture space conception, its roots, philosophy and principles. Also it classifies Space design requirements into two categories which are: Functional requirements, and Morphological Requirements.

Chapter One studies the different interpretations for space conception through history. It starts with the general understanding to the operational definition of the term. This is through the in depth study of the concept of architectural space over various historical periods such as; Prehistoric period, Ancient Egyptian Civilization, Mesopotamia Civilization, Ancient China Civilization, Greece Civilization, Roman Civilization, Early Christian and Byzantine Architecture, Gothic Architecture, Islamic Architecture, Renaissance Architecture, and Age of Enlightenment Architecture. Then the research studied different theories evolved to discuss architectural space conception such as Volumetric and Aesthetic theories. Then the research moves a step forward to study the modern space theories and its criticism faced by place theories. From this study it was clear that there is a deficiency in the current definition of architectural space especially after the remarkable development that took place in the field of Sustainability.

Chapter Two and Three offered a comprehensive understanding for the basic requirements affecting the architectural space design such as; **Functional Requirements** which are classified into three major groups (e.g. Programmatic, Allocation; and Operation, utility, and maintenance requirements). And **Morphological requirements** which are classified into two major groups (e.g. Quantitative, and Qualitative requirements).

The Second Part is concerned with the study of sustainability. It studies its different roots, backgrounds and its movement. Then the

research moves to identify its principles for sustainable practice. This is through the next two chapters as follow:

Chapter Four studies Sustainability as a generic movement and Sustainable design as an action of sustainability in field of architecture. This is through the in depth study of their history, movement, pillars of sustainability, and problems facing its understanding. In addition to; the meaning of sustainability in architecture whether it's influencing paradigms or strategic principles.

Chapter Five studies sustainable oriented design approaches especially Green Design as it is the strongest among all. Also it discusses the roots of different rating systems which are common and based on six major strategic principles which are:

- Optimize site potential.
- Optimize energy use.
- Optimize building space and materials.
- Optimize operational and maintenance practice.
- Protect and conserve water.
- Enhance indoor environmental quality.

The Third part is the critical analysis to link both; space (conception and design) and sustainability (philosophy and design) in the field of architecture. Then it offers a case study that explains the discussion offered through this analysis.

Chapter Six offered a Re-imaging of architectural space definitions in terms of sustainability. This is through a comparative analysis for the space discourse on the level of conception, functionality, morphology, and sustainability. Then moved to explain the problem facing architecture space design in terms of sustainability offering a new paradigm of thinking which is **Sustainable Indoor Design (SID).** This is through the integration between the comprehensive model of sustainable design represented in its four major quadrants (e.g. Indoor space qualitative design, Outdoor space qualitative design, Indoor qualitative design, and Outdoor qualitative design); and the Bill Reed's Trajectory of Ecological Design model to provide the **Model of Regenerative Sustainable Space Design**. This model shows that space design definition has to move from the classic definition of space design which is Space-time to **Space-Time-**

Place. The new conception of architectural space design add position to the old definition which means that space should be understood as (x,y,z)t instead of x,y,z and t.

vi. Introduction and over view

Space is a term that has multiple meanings. Usually physical space refers to a three-dimensional boundless extent where objects and state of matter coexist with certain qualitative relations to each other (Jammer, 2012). In modern physics it is defined as Space-Time; a four dimensional configuration. The importance of understanding space-time is that it can define the universal form for objects existence and coordination in terms of space as (x,y,z) and time as (Δt) (Craig Callender, 2001).

There have been many interpretations to the term through different domains of science, philosophy and architecture. These interpretations can be defined into two perspectives. The **first Trial** is related to the understanding of the general space of our universe. The first trials were by philosophers like **Plato** who defined space as what he called the Third ; an everlasting nondestructive entity that provide things existence (Lars Qvortrup, 2011). **Socrates** who defined space "Khôra" as an interval between the being and nonbeing just as the idea of matrix (Michael Cage, 2018)(Michael Cage, 2018). **Aristotle** moved a step forward where he defined place "Topos" instead of space as an entity that is similar to the container or as two bodies one of them contains the other (Jammer, 2012).

The second trials was based on scientific interpretations like in case of **Ibn Alhaytham** who argued the Geometrical conception of space as an imagined void that can be perceived through distance between elements that acts like mathematical lines of no width but length only (Rossella Lupacchini, 2014). In the 17th century he was followed by three important interpretations. **Sir. Isaac Newton** who offered the idea of **Absolute space** as an absolute entity and nature with no regard to any subjective matter within, **Gottfried Wilhelm Leibniz** who offered the idea of **Relative Space** as a relative relation between objects recognized by their distance and magnitude (George D. Shollenberger, 2014), and **George Berkeley** who argued that space recognition is based on sight, not for materialistic objects. It is the impact of light and color on human sight perception were he called it as the **Philosophy of Visibility of Spatial Depth** (George Berkeley, 2018). **The second perspective** is more specific and related to architecture, space conception started with the pre-historic era as a place for sheltering and dowelling. Then it was developed through civilizations like ancient Egyptians, Greece and Roman civilizations based on big concepts .Religion was the most important among all. Space as an effective element of

architecture was greatly regarded in **Gothic** followed by the **Renaissance** Period; this period offered the concept of **flowing spaces** that are based on making the space be seen as a continuous infinite space through the use of depth and light (Giedion, 2009) .
The discovery of linear perspective by **Filippo Brunelleschi** played great role in that (Lupacchini and Angelini, 2014)(Kemp, 2006); Space was interpreted as Space and Time where scale refers to human measures; while depth refers to time (Murray, 1969). Attempts to interpret the nature of space emerged in terms of two schools with two major theories in the space definition discourse:

- **The Aesthetic theory of space** related to **Immanuel Kant** who tried to reduce the tension between the Newton's absolute space and Leibniz's relative space. He believed that space and time depends upon the *"Subjective Constitution of the mind"* (Rawes, 2008, P.4).

- **The Volumetric Theory of space** offered by **Gottfried Semper** who proposed that the Enclosing Space is the first impulse of architecture. Many scientists and philosophers offered enhancement for this theory; for example **Georg Wilhelm, Friedrich Hegel** pointed to the idea of enclosure. **Karl Gottlieb, Wilhelm Bötticher** proposed that the enclosing space is a primary element to spatial enclosure. This theory remained a source of inspiration for many architects as **Adolf Loos**, **Berlage** and **Peter Beherns** who presented the Enclosed Space as an ultimate essence of architecture(Adrian Forty, 2004).

The 20th Century witnessed a second shift in architectural space interpretation by many schools of modern movement. Technology served in maximizing window bays size; this offered possibilities to think of the enclosure as a relation between the inside space and the outside place(Adrian Forty, 2004) (Banham, 1967 P.99-101). Some of these significant are The work of **Walter Gropius**, **le Corbusier** and **Frank Lloyd Wright** (Gail Satler, 2000) (Dzwier zynska, 2017) (Wesdijk, 2012).

In 1940 **Sigfried Giedion** formalized modern space concept in the architectural discourse through his remarkable book *"Space, Time, and Architecture"*(Giedion, 2009). He offered three different space conceptions in architecture; **the first** is interplay of volumes where the interior was

neglected; it is shown clearly in Egypt, Sumer, and Greece architecture. **The second conception** started in the middle period of Roman who paid more attention to the interior space. **The third conception** combined between the first and second space conceptions; which resulted in refusing to deal with architectural work as only a sculpture *"piece of art"*, but instead emphasizing on the relation between the In/Out side space as a totally new approach to be known as **Transparency in Architecture**. His book was followed by **Bruno Zevi** book *"Architecture as a space"* who assured that space is the protagonist of the architecture and urban design (Zevi, 1993). Later on theories to criticize the modern theory of space evolved; it tried to lessen the space importance, and consider it the most tyrannical element at architecture and urban design level(Adrian Forty, 2004).

- **The Place Theory of Martin Heidegger**: He believed that there is no space if there is no place to fit, which means that **Space is of Place**. **Gaston Bachelard** enhanced this idea through two spatial dialectics; the first one is the Vertical/Horizontal dialectic a relation between verticality (the power of the dynamic forms) and the two horizontal planes sky and earth. The second was the In/Out Side dialectic a relation between enclosed space and the exposed one this dialectic opened the gate for interpreting the physical world as a mental constitution of mind, i.e."*A Mental World*" (Dovey, 1999).
- **New Space Theories by Marc Augé ''Non-Places'':** He rejected place as an alternative of space. It offered "Non Places " as a result of ***"Super Modernity"*** where Non Places are those spaces of transit and temporal occupation founded within public buildings like airports, hotels, super markets...etc; such spaces are produced by the power of capitalism (Auge, 1997).
- **Space of Flow by Dovey**: He rejected the space historical rooted spatial organization. His argument was based on the role of technology as new tool for a new spatial politics(Castells, 2010).
- "**Junk Space**"**by Rem Koolhaas:** The space that is shaped by technology or the excess use of non-places like in shopping malls, entertainment venues...etc. (Jameson, 2003).
- **Space Trilogy**" or "**Differential Space**" **by Henri Lefebvre**: He declared in his theory Production of Space (POS) the refusal of "Abstract Space Concept" because it is separated from the lived practice of space or from the local and physical properties of