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Environmental simulation in lightweight structure's design as one of sustainability strategies in architecture

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Abstract

Nature is one of the most important sources of inspiration and creativity for the human being in general, the architect and the interior designer in particular. The images of the forms of simulation and imitation of nature are countless, while the process of simulating nature is one of the most important strategies for sustainability in architecture and interior design processes with all its elements, and that through Achieving one of the following axes (formal treatment - functional treatment - technological treatment) or through the merging between them, as these three treatments are the most important products of simulating one of the elements of nature, as it is the result of the interaction of a group of forces with the organism whose behavior is simulated towards one of the external stimuli and influences Until its biological nature returns to balance, as is the case in the adaptation of plants to moisture and drought, for example. Through the research, strategies for simulating the environment will be studied through two basic stages: firstly, conducting biological research on the characteristics and behavior of a particular organism towards a stimulus, and second converting the results into a design that simulates the environment and interacts with it with the same behavior of the organism that has been studied biologically.

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The research aims to study the possibility of simulating nature and its imitation as one of the sustainability strategies through its applications on lightweight installations because of its effective and rapid role in eliminating many problems, the most important of which are the various environmental problems, which will be discussed through the research, where the research works on three axes The first: Sustainability The second: Biomimicry simulation of the following: Lightweight Structure. The merging of the three axes to overcome various environmental problems, and at the end of the study, a set of results related to different treatments and the importance of simulating nature were reached to reach the method by which sustainability can be combined Environmental and technological sustainability in architecture through light construction units, as well as the role of light construction units in solving the presented environmental problems through a design that mimics nature in terms of form and function.

Keywords

Environmental Simulation, Lightweight, Structure's Design, Sustainability Strategies, Architecture.

Introduction

Throughout the ages, nature has been able to attain its ability to surpass human capabilities in many aspects, as it developed over millions of years with the aim of finding, innovating and developing more effective solutions in response to changes, and from here man found that nature is the source of inspiration and simulation since In the early ages, for example, primitive man invented fishing nets after simulating a spider's web.

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The concept of simulation has evolved from mere imitation to an evaluation of the behavior of an environmental object or phenomenon, knowing how it occurs and how it responds to various phenomena, and transforming this data and information into a product that simulates the environment.

The ideaof environmental simulation is not limited to one aspect only, but it extends to all aspects of life such as medicine, engineering and other sciences. From an engineering point of view, the first goal of any design has become the preservation of the environment after its exposure to danger causes bad behavior for humans in dealing with it, as sustainable design is the prevailing global trend for some time as one of the solutions presented to try to save the environment and to preserve its resources and strive to renew it, but what was added is iron It is the combination of sustainable thinking and environmental simulation as one of the sustainability strategies. He found that environmental simulation has several levels and can be summarized in three important levels, which are (the organism level - the organism's behavior level - the ecological level). The idea of environmental simulation in architecture and design is a deeper idea than a mere imitation. It is an idea that requires cooperation between biological scientists and engineers in all their specializations to produce an effective design capable of responding to environmental variables. Through the research, environmental simulations were studied for their levels and how to achieve sustainability through simulation through lightweight facilities.These establishments were chosen to be one of the pure axes because of their advantages, the most important of which are speed of implementation and low costs. Also, one of the most important reasons for studying these facilities is that one of the foundations of their design is simulating the human structure, and therefore it is the most appropriate facility to apply to achieve simulation of the environment under the shadow of sustainability.

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The essence of the idea of simulation is that nature has solved problems that still concern humans and they were unable to find Suitable solutions for them, such as energy problems, for example, but by studying nature and its organisms and systems, we find that they have more than one solution.

Simulation does not convey the apparent behavior or reaction and embody it in architecture, but it is carried out in stages that must be followed gradually until the required results are reached, in short, the natural inputs must be simulated in the design process to reach the desired outputs. An example of this is solar cells simulating the process of photosynthesis in the leaves of intent as a result of the success of solar cells is to follow the simulation process, not only by transferring or by contenting with general information known about nutrition in the dead, but by careful study by biological scientists and botany specialists to reach the result. Required.

Research problem:

The search problem enables the following points:

- Human's bad consumption of the surrounding environment, causing damage to it, and from an architectural point of view, neglecting the role of environmental design and achieving sustainability.
- Lack of interest in simulation from an environmental point of view and lack of interest in being one of the strategies for achieving sustainability in architecture and limiting it to merely transferring or imitating the external form.
- Lack of interest in the biological study stage of simulated organisms.
- Neglecting the importance of achieving the principle of responding to external stimuli in architecture and dealing with it.

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- Many designers do not refer to light installations, given that the principle of their design is based on the principle of environmental simulation, lack of interest in studying levels and stages of environmental simulation.

Nature simulation:

- **Definition of bio mimicry:**

This term is derived from two words: bio, which means life in the Greek language, and mimicry, which means imitation. There are several definitions to clarify and explain the meaning of simulating nature, including: Conducting tests on nature with all its elements, systems and models so that humans can imitate it in various aspects of life until human problems are solved. Also, the science of simulation of nature is the science that studies the actions present in different ecosystems and methods of responding to external stimuli and interacting with them with the aim of linking a design capable of overcoming various problems. The most accurate process simulation of the environment in architecture is the process of imitating an element or behavior of one of the elements of nature that translates design and manufacture. Simulation generally aims to build imitation models and software for an existing ecosystem, as it represents an imitation of a real system or a physical or biological process. The simulation results in a design that either looks to biology or is influenced by biology influencing design.

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- The evolution of the emergence of the idea of simulating naturalness historical overview:

In 1997 he published a book entitled (Bio mimicry.. Innovation Inspired by Nature) by the scientist Janine Benys, and after the appearance of this book many began to pay attention to the principle of simulation, but this is not the beginning of the idea of simulating nature and using it as a publicity process for it, in the fifties of the last century a new term appeared in engineering classifications when the term bionic appeared and resulted from the merger of Bio+ Electronic at the hands of the scientist Jack E Steele, and this term means simulated engineer, and this term has become given to every engineer who introduces and develops a product based on the idea and principle of natural simulation .

Looking at the works of the artist Leonardo da Vinci in the fifteenth century, he found that he was inspired by his works from nature, as he contemplated them and checked their systems and molecules so that he could simulate them to draw inspiration from his well-known engineering models, for example he was inspired by the plane in his drawings from the fly and thus becomes from Early simulators of nature.

- Nature simulation architecture concept:

The trend of simulating nature appeared in architecture and interior design elements in the late twentieth century and early twentieth century, as a result of environmental and climatic variables that appeared as a result of negative interaction with them, which disturbed their balance, so the solution was to find designs that interact and respond to the variables and stimuli, so architecture transformed To resemble the organism and to achieve the principle of sustainability.

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Where the World Committee for Environment and Development presented the definition of the trend of natural simulation in architecture as obtaining the needs of the presentwithout violating the right of the future generation to provide for its needs, and this **leads to two very important elements:**

1- Legalizing rights: the present generation has the right to obtain its requirements without infringing on the rights of future generations.

2- Preserving the evidence: where the evidence can meet the needs of the present and thefuture.

Therefore, the process of simulating naturalness in architecture requires studying how living organisms can deal and adapt to the surrounding environment, and from here the architects began to transform buildings from just a solid mass to a semi-living organism that interacts and responds to the surrounding environment and to different weather conditions (humidity - rain - drought) Heat - cold – wind).

Where the ability of buildings to stand in front of various phenomena and overcome them, and even produce energy from them, gives the building the ability to survive without disturbing the ecosystem, but buildings have become a positive block that contributes to preserving environmental sustainability.

Stages of simulating nature:

Simulation takes place in all branches of science (engineering - medicine - accounting) by resorting to biological scientists and discussing with them about the function to be achievedby asking the question "What is an ecosystem or an organism whose philosophy depends on the desired behavior?" Simulate it so that it can survive and withstand different environmental variables? ”And biologists determine the answer. No choice has been made between the presented data based on the most appropriate and fittest design.

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In the different engineering branches, the engineer tries through design to adapt all methods of modeling and design to simulate nature in a way that brings the idea closer to the parent model, where the design is not only limited to an external form of the mini, but an integration between the architectural design of the building, interior design, manufacturing methods and the materials used, Therefore, the natural simulation process in architectural trends requires integration and integration between all engineering disciplines (construction - electricity - interior design) to ensure the success of the simulation process.

Principles of dealing with the environment as a source of simulation.

1- Nature as a Model: The mimicry of nature is a science that studies models of nature that did not imitate or inspire these designs and processes to solve human problems.

Natural biomimetic levels:

By examining the biomimetic technologies, it was found that they have three levels:

1- The organism level.

2- Behavior Level.

3- Ecosystem Level

Where the first level (the level of the organism refers to the organism with a sample (plant - animal) and may include part or all of this object, and the second level (the level of behavior) refers to translating an aspect of the behavior of one of the living things into a design, and the third level (Ecosystem level) to simulate ecosystems and integrate common principles and processes that ensure successful work. Each level has five dimensions of simulation.

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The simulation process may take place for one of the levels or by combining them, it is possible to find a design that simulates a living organism in its behavior and shape, in this case the first level (simulating the organism) and the second level (simulating the behavior) is combined.

- Organism Level:

-The types and factions of living organisms have evolved over millions of years when species were created and became extinct and others appeared, and some of them were able to survive and overcome the changes that occurred as these organisms have survival mechanisms that have withstood and adapted to the continuous changes over time. Therefore, researchers have an enormous set of examples that can be relied upon to solve the problems faced by society and that living organisms have already been exposed to and have been able to overcome and solve them in energy and material effective ways.

The solutions presented by these organisms are beneficial to humans, especially with regard to access to changes in resources, climate changes and other matters that result from the negative impact of current human activities on many ecosystems in the world.

An example of this is a simulation of the Namibian desert beetle, as it lives in desert areas without much rain. It has the ability to capture moisture from the rapidly moving fog as water droplets collect on his rough body, and by tilting his body in the direction of the wind, the water reaches his mouth. Thus, he has the ability to withstand the scarcity of water. Where this beetle can be simulated in countries with a rare desert nature and whose inhabitants are exposed to drought problems as in the Somali famines, evidenced by one of the examples that the Namibian desert beetle was simulated in terms of how it deals with water, as this was applied in the Las Palmas Theater in the Canary Islands.

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Simulating a single organism without simulating the way it participates in the primary context of the ecosystem in it and contributing to its survival produces design results that remain somewhat traditional or even below average in terms of environmental impact, and since simulating organisms tends to have a specific characteristic instead From a complete system, the environmental simulation here boils down to a technology that is added to the building instead of being a complete system with several corners - but this is not a fixed rule at this level.
- Amazing sustainable results can be reached if the designer relies on the review of biologists, from which he can obtain techniques Innovative and powerful.

- **Behavior Level:**

Many organisms face the same environmental conditions as humans and need to solve similar problems. These organisms tend to work within the limits of the carrying capacity of an environment in a certain place and within the limits of energy and materials available at a certain value. These limits and pressures are the catalysts that create an ecological adaptive capacity for living organisms to become adaptive organisms that evolve according to the surrounding conditions, and with that, their behavior and create patterns that are well adapted to the surrounding environment. There are many examples of living things that change their behavior in order to be able to survive by establishing a relationship of mutual benefit with the surrounding organisms and with the environment, since at this level the organism does not maintain its survival and define it but the survival of those around it.

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At this level, the organism itself is not the source of the simulation, its behavior. An example is the CH2 building in Australia, which was designed to simulate the behavior of termites in building their hold in a manner that ensures the stability of the internal temperature. In this port, the water is reused after cleaning it in a manner similar to the behavior of termites in dealing with water.

Magnetic field, northern Australia is a very hot place during the day and cold at night. So researchers believe that termites have harnessed their confrontation in one way or another to use the Earth's magnetic force as a strategy to preserve the climate of their homes. Ants are well built for their dwelling, providing all rooms with an adequate level of humidity and a good indoor temperature.

The behavior of termites has been simulated in the way the temperature is maintained internally in building the CH2 building in Australia by using a pointed façade that controls the amount of heat entering the building during the day and stores an amount of energy to provide warmth at night where the building can provide energy in an effort to make this The area is inter-balanced by 2020. Also, the strategy of building this building is based on cooperation between internal spaces as a simulation of the behavior of hope in cooperation in building his home.

Simulating this level requires making decisions about whether or not what is being imitated is appropriate in the human context. For example, simulating termites in their behaviors in full may be inappropriate for humans, but their behaviors are taken to simulate what is appropriate in achieving a thermally comfortable building, which increases the level of building sustainability and gives a regenerative ability to the built environment, and to fully simulate the behavior of these organisms must be all The conditions are identical and this is impossible to achieve without simulating the entire system.

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Ecosystem Level:

Ecosystem simulations are an integral part of simulating nature. The term mimic environment has been used to describe the simulation of ecosystems in the design. This level is the most sustainable system. On the ground, however, there is no project that relies in all its corners onthis type of ecological simulation at the functional level. There are many suggested examples, such as the Lloyd Crossing Project. The project uses estimates of how the ecosystem on the site works before its development and is called this stage (Pre-development measures) to determine the objectives of the environmental performance of the project over a long period oftime. One of the advantages of design in this level of simulation is that it can be used in conjunction with other levels (organism level, behavior level).

It is also possible to integrate existing sustainable building methods that are not of a special biological nature such as ecosystems or vital aids, where human and non-human systems are combined to achieve the mutual benefit of both.
Whereas wastewater treatment is simulated in ecosystems and is integrated with plants. The Australian system simulates soil-based decomposition to treat gray and black water and again integrates actual worms and soil microbes into the process. There is also an added advantage of an ecosystem-based biological simulation design approach. This applies to a range of time and spatial scales, and can serve as a primary or A goal for what constitutes a sustainable or even renewable design for a specific location as evidenced by the Lloyd Crossing project. Butthe most important feature of such an approach to biomimetic design may be potentially positive impacts on overall environmental performance. Through this level, buildings are transformed into a system that behaves like an ecosystem, which increases sustainability and environmental performance.

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The related understanding of the ecology leads to the design of a built environment with the ability to participate in the natural environment. It also requires increased collaboration between disciplines that rarely work together, such as architecture, biological and ecology. Such an approach challenges traditional thinking in architectural design, particularly the typical boundaries of a construction site, and the length of time within which a design might function. In short, the design at this level depends on creating an integrated environment as a simulation of an existing system that has proven successful from an environmental point of view.

Results:

1- Environmental simulation is not just an imitation of a form of nature, but the idea of environmental simulation is deeper than a mere imitation.

2- Learning from nature in designs is the only way to ensure the preservation of the environment after causing harm resulting from human bad behavior.

3- Biologists and specialists in studying living organisms must join hands with engineers to reach architectural designs that simulate the environment in a sophisticated way andto ensure the success of the design.

4- Environmental simulation has three basic levels that can be designed on the basis of one of them or by combining them.

5- The most complex level of environmental simulation is the third level related to the simulation of the ecosystem, but it is the most sustainable level.

6- Lightweight installations have an effective role in preserving the environment, especially those that use environmental simulation in their design.

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7- All human beings must know the properties of their evidence in order to be able to provide solutions to the problems that nature was able to solve before. Environmental simulations may be done by studying the tiniest component of an object, and the decisive factor in design power is its ability to solve a problem.

8- Light construction units have an important role in creating an effective environment that has the ability to get rid of a large percentage of the surrounding environmental pollution by creating a sustainable unit.

Recommendations:

1- Delve into the study of the nature of living organisms and learn about their coexistenceand adaptation behavior.

2- Interest in teaching environmental simulation sciences in the study of all disciplines, to bring everyone closer to the characteristics of living organisms and to identify the extent of their ability to solve problems.

3- Paying attention to designs related to lightweight facilities and studying their role in solving many environmental problems.

4- The combination of formal and functional simulation must be achieved more precisely.

5- Simulation should not be limited to designing an attractive shape only.

6- Studying recent trends in design and raw materials manufacturing technology, which in turn are reflected in interior design, and access to advanced implementation techniques for raw materials, reformulating and employing them to suit design needs.

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References

1- http://www.arsco.org/article-detail-704-11-0

2- Simulating nature ... Nature inspires our innovation - Eureka Scientific Journal - Article submitted by: Muhammad Atallah - Faculty of Engineering - Department of Mechanics - March 2013 - Link: https://eurekamagazine.wordpress.com/2013/03/28/%D9%85%D8%AD%D8%A7%D9%83 %D8%A7%D8%A9%D8%A7%D9%84%D8 % B7% D8% A8% D9% 8A% D8% B9% D8% A996D80A700D9% 84% D8% B706D8% A8% D9% 8A% D8% B9% D8% A996D8% AA% D9% 84% D9% 87% D9 % 859D8% A7% D8% A8% D8% AA% D9%83% D8% A7% D8% B1% D9% 86 /

3- https://tasmeemblog.wordpress.com/2015/11/25/biomimicry/

4- Simulating nature ... Nature inspires our innovation - Eureka Scientific Journal - Article submitted by: Muhammad Atallah - Faculty of Engineering - Department of Mechanics - March 2013 - Link: https: //eurekamnagazine.wordpress .com

5- http://beetlecreative.com/blog_type/biomimicry-of-orchids/

6- Arab Gate - Expo Milan, China Pavilion - Link: http://www.arch-news.net

7- https:////i0.wp.com/www.eleven-magazine.com/wp content / uploads / 2017/01 / Untitled5.jpg? Resize = 1000% 2C671 & ssl = 1

8- https://asknature.org/strategy/surface-allows-self

9- Algorithms In Nature & Architecture (Biomimitic Architecture) - by: Shiva Khoshtinat - University of Florence January 2015 - online link: https://www.researchgate.net/publication/293178740

10- http://www.cladglobal.com/architecture_design_features?codeid=29664&source=related

ISSN: 2785-9673 VOLUME 3, ISSUE 2, 2020, 26 – 43. www.egyptfuture.org/ojs/

11- https://asknature.org/idea/fog-catching-materials/#.WsVUnS5ubIU

12- https://www.archdaily.com/395131/ch2-melbourne-city-council-house-2designinc

13- https://www.asla.org/awards/2005/05winners/022.html

14- https://www.asla.org/awards/2005/05winners/022.html

15- Sustainable Architecture and Building Design (SABD) www.rrch.hku.hk/research /BEER/sustain.htm by Sam C M Hui.

16- Vale Brenda and Robert (2000). The New Autonomous House. London: Thames &Hudson Ltd.

17- The role of contemporary interior architecture for light construction units in solving social and intra problems - Thesis

18 - Master - unpublished - submitted by: Ma Rana Hisham Muhammad - under the supervision of: Prof. Dina Mandour - Dr / Mai Abdel Hamid Abdel Malik - Faculty of Fine Arts, Alexandria University, Department of Decoration - 2016 18- https://inhabitat.com/this-prefab-cabin-is-designed-to-take-you-off-grid-inthe-scottish- highlands/

19- Greenhouse Solutions with Sustainable Energy, by: Mark Desndorf - Page86, 2007.

20- http://www.scidev.net/global

21- http://www.eesi.org/publications/Fact%20Sheets/EC_Fact_ Sheets/EE_Buildings.

22- https://jehadalkhandq.blogspot.com.eg/2014/12/GreenArchitectureSustainability Environment.html

23- Dr. / Mai Abdel-Hamid Abdel-Malik - Interior Architecture for Extended and Additive Spaces - Master Thesis - University of Alexandria 24 - Faculty of Fine Arts, Department of Decoration, Specialization of Interior Architecture - 2006

24- Schlaich, Jörg and Mike Schlaich. "LIGHTWEIGHT STRUCTURES." Widespan Roof Structures (2000): 178

ISSN: 2785-9673 VOLUME 3, ISSUE 2, 2020, 26 – 43. www.egyptfuture.org/ojs/

25- The role of contemporary interior architecture for light construction units in solving social and intra problems - an unpublished master's thesis - submitted by: Eng. Rana Hisham Muhammad - under the supervision of: Prof. Dina Mandour - Dr / Mai Abdel Hamid Abdel Malik - College Fine Arts, Alexandria University, Department of Decoration - 2016

26- https://asknature.org/idea/stick-s-lightweight-structuralsystem/#.Wse6FS5ubIU

27- www.asknature.org

28- New Containers Architecture, by Jure Kotink 2013 page

29- http://mytutorial.srtcube.com/5r-concept-for-wastemanagement/environment-science/693-453#7487

30- http://www.arch-news.net/2013-11-01-22-50-53/2013-12-19-09-4047/item/33240-ova-studio#.U3pEydKSZIE

31- www.ovastudio.com/portfolio/hive-inn-hotel/

32- Algorithms In Nature & Architecture (Biomimitic Architecture) - by: Shiva Khoshtinat - University of Florence January 2015 - online link: https://www.researchgate.net/publication/293178740

33- http://www.syr-res.com/article/5365.html

34- http://www.abeerseikaly.com/weavinghome.php

35- https://www.archdaily.com/424911/hygroskin-meteorosensitive-pavilionachim-menges-architect-in-collaboration-with-oliver-david-krieg-andsteffen-reichert

36- https://asknature.org/idea/algal-turf-scrubber/#.Wsni7y5ubIU

ISSN: 2785-9673 VOLUME 3, ISSUE 2, 2020, 26 – 43. www.egyptfuture.org/ojs/

37- http://www.squareddesignlab.com/projects/eco-pod

38- Hoda Gad Al Rab Abdo Madkour, A Study Of Interactive Learning Spaces Within Educational Facilities, International Journal of Architectural Engineering and Urban Research, Vol. 3, No. 1, 2020, pp. 12-17.

39- Ashraf Hussein Ibrahim, Dina Fikry Gamal, Heba Ibrahim Muhammad, Essential Design Standards For Contemporary School Courtyard As Necessity To Advance The Arts And Technical Schools In Egypt, International Journal of Architectural Engineering and Urban Research, Vol. 3, No. 1, 2020, pp. 18-25.

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