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Simulate the nature environment to achieve thermal comfort in a desert environment

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Abstract

Man has destroyed the natural environment in different ways, and this appeared through the overexploitation of its resources without its ability to regenerate, as well as through the pollutants and wastes that he added to it that caused its destruction and caused an imbalance in its properties. The concern for the environment and its preservation appeared in various fields as an attempt to correct the environmental imbalance and avoid further defects, and for this several environmental trends and methods appeared, and in the architectural field dealing with the environment by drawing inspiration from its original characteristics and simulating its various elements is one of the methods attracting attention to achieve a relationship based on sound principles in the relationship of buildings With the environment, which makes the natural environment a source of inspiration rather than an encroachment on it.

The strategies of simulating the natural environment in various architectural applications helped to generate sustainable forms that have their own characteristics that affect the efficiency of the building and provide comfort to its users. The reliance on mechanical systems to reach an internal environment that is thermally comfortable for humans has led to energy depletion in general, and in particular, the desert environment is the most obvious in that, and with the global trend to rationalize energy consumption and preserve the environment, it was necessary to find quick and effective solutions to the problem of that consumption while obtaining at the same time on the thermal comfort requirements of users.
The research aims to study and analyze the geometry of living organisms in the desert environment and their behavior in order to apply the same principles as an important tool to achieve thermal comfort, so that the different natural systems in that environment and the different materials and processes in them are identified, and then study the possibility of their architectural application. The desert environment is characterized by the presence of many organisms that have the ability to adapt to the environment and deal with it internally and externally, and many of them have unique strategies in adapting and responding to hot climate variables, especially with regard to avoiding heat gain from outside, and their ability to lose heat, and raise their internal temperature. And protect their bodies with good insulation.

Key Words:
Natural lighting - strategies - energy

Introduction:

Nature simulation is the applied science that draws inspiration from nature to find solutions to environmental and climatic problems that affect human comfort by studying designs and natural systems and finding solutions to designs mechanically and structurally, and this is done by imitating plants, animals and living organisms in general or entire ecosystems as a basis for design.

By mimicking nature, we can create products and processes that are sustainable and healthy for local and global ecosystems. These natural inspirations lead to new strategies for achieving specific environmental goals.

Nature is a source rich in ideas, from which we draw inspiration from solutions to design problems, and many architectural forms were adopted inIts formation is to learn and benefit from natural formations and in order to be able to know the potential positive or negative impact of simulating nature as a means to achieve greater sustainability in the built environment, and as a useful strategy in an architectural or civilizational context, it is necessary first to understand and define what simulation of the natural environment is and what it is.The different types of mimicry exist. This is important because a great deal of studies on simulating the natural environment are keenly concerned with the possibilities of mimicry as a means of increasing sustainability outcomes.

There are three main reasons why researchers and designers are interested in biomimetics. First, biomimicry can be seen as a source of innovation in creating new materials and technologies. Most of the research and patents of biological simulation relate to this factor and are not necessarily related to improving the environmental performance of human technology, it is about new approaches to human problems or increasing performance capabilities or the ability to increase profit. Second, there is an increase in interest in the possibilities of mimicking nature as a way to discover more sustainable materials and products, and engineering solutions that are more flexible in terms of meeting human needs. While the idea that biomimicry can radically improve the environmental performance and the built environment. Finally, the third impulse to explore the mimicry of nature comes from a group of researchers who study design on the basis that understanding the living world can contribute to increasing human mental health. The idea of simulating nature or inspiration from nature goes back to the beginning of creation, where the first living being known to man was the crow Learning burial rituals from the mimicry of the raven, while the terminology of simulating the natural environment is relatively new, the actual practice of biomimicry has been going on since ancient times.

Mankind has learned many lessons by observing other creatures and adapting their behaviors to the special needs of mankind. Artists and philosophers have viewed natural beings as an ideal model of harmonious and proportional balance, and also as a classic model of beauty. In all different cultures, humans have learned how to survive from living things. Surrounding it, for example: primitive cultures such as the Eskimo, Amerindian and Bedouins, their simple designs indicate that they are fully aware of the value of the natural environment surrounding them, and they are compatible and adapted to their environment. Many shapes and structures in the architectural elements were inspired by nature, and ancient civilizations such as the Egyptian pharaohs, the Greeks, the Romans, and the Islamic civilization were benefiting from sciences such as mathematics, physics and astronomy by trying to apply them in their designs, for example the simulation of nature appears in the pharaonic columns inspired by the lotus flower In the ancient Egyptian civilization, the shape of the Eskimo house, which was inspired by the house of a polar bear.

The Greek philosopher and scientist Aristotle (183-122 BC) placed nature at the center of his scientific studies. In his book HistoriaAnimalium he describes many animal phenomena. Nature was something to be observed, represented and respected. And Leonardo da Vinci was the first biomimetic designer. Da Vinci, the first researcher in biomechanical engineering, attempted to simulate nature in 2841 AD by simulating a bird's ability to fly, as he made observations on gliding from studying birds and the way they balance themselves with their wings and tails. Leonardo's drawings provided a fundamental link to early observations. In proving that everything in nature is interconnected, and that the clear and interconnected rules of nature can be applied through geometry.

Then many thinkers followed it in the nineteenth century when they made a leap in simulating nature, turning it from being a mere idea of "observation" to application.

The Wright's brothers developed their first prototype aircraft in 2484, and it was considered the first successful attempt.

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Leonardo da Vinci's drawings of the flying apparatus are considered one of the earliest biological designs in the third century. Landscape designer Joseph Paxton in London in 1881 CE built the "Crystal Palace" for the great exhibition of 999,000 feet. Its design used iron crossbars to support approximately 199,999 pieces of glass over a wide-open area, inspired by the interlinked water lily leaf that helps the plant support the great weight in the water.

Mathew Baker in 1989 got the idea of designing a ship's hull from the head and tail of a mackerel to improve maneuverability and reduce friction.

In 1969, German biophysicist Otto Schmitt first used the term Biomimetics in a research paper he presented at the International Biophysics Conference in Boston. To express the study inspired by living things, Schmidt invented an electrical circuit that was modeled on the neural impulse systems of the marine animal Squid in 1913 when he was a doctoral student. The word Biomimetics, introduced by Schmidt, was borrowed five years later in Webster's29 dictionary and was defined as the study of the composition, structure, or function of biologically produced materials, materials such as enzymes or silk, biological mechanisms, and processes such as protein synthesis or photosynthesis, especially for the purposes of manufacturing products. Similar by artificial mechanisms that mimic the natural mechanisms.

Biomimicry, additional molecular mechanics, mathematical sciences, and engineering studies became known in architecture in the late 1960s. Similar architectural studies can be seen in the work of Buckminster and was inspired by the Rays, which are one of the primary organisms that produce complex metal skeletons. “The symbiotic relationship between structural and material competencies.” Fullers designed the geodesic dome building. Biomimicry evolved with its continued incorporation into the field of architecture into two additional definitions.

First: Bio-utilization: The term bio-utilization refers to the appropriate use of nature as material in design.

Second :Biomorphism: The term biomorphism refers to simulating the formal characteristics of nature. Blending nature with the building is an example of a biological use, such as having trees, shrubs, flowers ... etc around the building to promote passive ventilation strategies. A shape that can make outdoor temperatures cooler by planting trees, plants and shrubs and even incorporating water in close proximity to The perimeter of the building. This cold air can then be absorbed into the building by opening the windows, reducing the need for mechanical cooling systems. Morphology can be found more recently at the Milwaukee Museum of Art.

This building was designed by architect Santiago Calatravas, whose idea was inspired by the flying movement of a bird. Calatrava crosses its other graceful bridges around the world with the characteristics of structural constructs. There are interactions that occur between mimicry of nature, biological use, and biogenesis. But a distinction can be made between them considering that the biological use and the biological morphology are both mere simulations of the aesthetic qualities of nature, as biological simulation is a simulation of the functional characteristics of biological forms, processes and systems. More specifically, the simulation of nature engages the functional aspects of nature that a specific natural adaptation provides, rather than its aesthetics.

If the design interacts with the functionality provided by a particular natural adaptation. If not, then it is not called a simulation

The term biomimicry appeared in 1982 CE and was popularized by the biologist and author

Janine Benyus, who defined the simulation of nature in her book as "a new science that studies the models of nature and then imitates or takes inspiration from these designs and processes to solve human problems." She suggested looking to nature as a "model, scale and milestone" and asserted that sustainability is the goal of simulating nature. Being encouraged is currently on.

The field of mimicry of nature through two institutions; Biomimicry Guild and Simulation Institute

The Biomimicry Institute Syndicate is the only innovation company in the world that uses deep knowledge of biological adaptations to help designers, engineers, architects and business leaders solve design and engineering challenges in a sustainable way. The institute encourages learning from natural forms, processes, and ecosystems and then simulating them to create more sustainable human technologies and designs. Research papers in the field of biological simulation and their relationship to bioengineering, chemical engineering, physical engineering and architecture are increasing, which helps to understand and simulate nature in more meaningful ways. Biomimicry is nowadays defined as "the imitation of the functional basis of biological shapes, processes and systems to produce sustainable solutions". Therefore, mimicry of nature is the proposed guiding principle to be a paradigm shift for creative, problem-based learning necessary to orient towards sustainability.

1. The role of simulating the natural environment in architecture:

Biomimicry is the imitation of an organism or the behavior of an organism or an entire ecosystem, in terms of its forms, materials, construction methods, processes or functions. It is a source of innovation, especially in creating a more sustainable architecture. Looking at plants or animals that are highly adaptive or that survive in harsh climates or through climate change may give ideas about how buildings should function or how they should function.

Simulating organisms or ecosystems involves translating into solutions appropriate to the human context. This translation process often results in designs that do not immediately resemble the organism or ecosystem that inspired it, but rather employ the same functional concepts.

The attractiveness of natural mimicry in architecture increases the link between function and form. But mimicry of nature does not copy shapes from nature; It involves ideas, solutions, or inspirations from nature in architectural challenges.

So the architect needs a biologist to lead him to obtain biological information, because living things solve problems with environmental challenges. Nature will lead people to expand their capabilities and opportunities to solve and improve their ability to design sustainable buildings, recyclable materials and build better environments if they continue to learn from nature. Nature simulation is used as a design strategy tool in architecture in two classes, one looking for biology that aims to describe human needs and the other being biological effect design that nature seeks to find a function in an organism. Built environment designers must draw inspiration from nature not only for innovations in materials and construction methods but also in space design and building functionality for sustainable future environments.

2. Basic elements of simulating the natural environment:

Biomimicry depends on three interrelated elements, each of the three elements is the origins or values of biological simulation that seeks to understand the theory, method and application of the genius of nature. The elements are ethics - reconnection - simulation, and when the three elements are combined together, the inspired design becomes a simulated design of the environment. Natural.

What distinguishes biological simulation is simulation of ethics, simulation of reconnection and simulation of basic values with the aim of creating conditions conducive to life. Form the basic elements of simulating the natural environment

Ethics:

Ethical practice is an important element that must be adhered to when studying biology and leveraging it in preparing life

Best for a human being.

Reconnecting The interconnectedness between man and nature increases through the discovery of life's genius, patterns and principles, and the use of human intelligence by beginning to listen to nature.

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Simulation:

Simulation is the realization of humans' vision suitable for sustainability on Earth. Simulating nature as a model, teacher and scale, not by copying but by learning and application. It is the synthesis of principles, patterns, strategies, and function found in nature to know design. Innovations inspired by nature. Nature is not just design; It connects, calculates, connects, and programming .. Simulation occurs when we solve human problems through vital inspiration, and ultimately reduce our negative impacts on the Earth.

- **Natural Simulation Approaches:**

The simulated design of the natural environment relies heavily on biological knowledge, as biologists are considered to be the basis of the simulation design process of the environment, however the role of the designer remains central when it comes to extracting biological strategies in the most applicable design principles for solving human problems, which It does not aim to create an exact replica of a natural form, biological process, or ecosystem only, but rather is to extract design principles from biology and use those principles as a stimulus to thinking.

It also offers new and inspiring solutions.

The researchers have concluded two main approaches in the process of simulating the design of the natural environment in different terms. MaibrittZari noted that the first approach is "design with reference to biology," which means identifying a human need or design problem and looking for ways in which organisms or other ecosystems are solved.

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Both Gamage and Hyde defined it as the "direct approach" as the design simulates the strategies of an organism, a behavioral pattern, or an inherently system with the help of a similar translation system. It is also called "design that looks to biology" and "solution-based approach" which defines a specific characteristic, behavior or function in an organism or an ecosystem, translating that into human designs, and is referred to as "design biology" and "" The curriculum is top-down. The second approach is also referred to by MaibrittZari as the "effect of biology in design." This means simulating nature where a specific characteristic, behavior, or function of an organism or an ecosystem is identified and then translated into the context of human design.

It is also referred to as "biology influencing the design of biological simulation" and "bottom-up approach" and "indirect approach". Design by reference to biology. A human need or design problem is identified, then an attempt is made to find solutions to this problem through research and perception. To solutions of other organisms or ecosystems to a similar problem.By observing organisms and ecosystems, or accessing previous biological research and information. The designer in this case will be able to come up with potential biological solutions without in-depth scientific understanding or collaboration with the biologist or ecologist. But in this case the design will be at a level of limited scientific understanding. It is easy for the designer to simulate shapes and some simple mechanical aspects of living organisms or an ecosystem, but it is difficult to simulate complex processes and chemical processes without biological scientific cooperation.

Natural Simulation Approaches:

1. **Direct Curriculum**
2. **Indirect curriculum**

- Define the problem
- Reframe the problem
- Search for solutions
- Biological
- Determine the biological solution

- Extraction of life principles
- Application of life principles
- Knowledge of the biological solution
- Determine the biological solution
- Extraction of life principles
- Reframe the solution
- Search for a problem
- Define the problem
- Application of life principles

For example, Mick Pearce's Eastgate Building is the architectural example most used to mimic nature. Eastgate is designed to have a thermally comfortable indoor environment with minimal mechanical cooling, thus reducing greenhouse gas emissions. Pearce based his design in part on using the thermal power to regulate the temperature observed in termites in South Africa such as Mick Pearce's Eastgate Building, which mimics a termite mound.

The indirect approach The effect of biology on design is to identify specific characteristics or behaviors in an organism or an ecosystem and then use them as guidelines for developing industrial or architectural designs. When biological knowledge affects human design, the collaborative design process initially depends on people who have knowledge. With related biological or ecological research and not on specific human design problems. An example of biology influencing a design approach in simulating nature is the scientific analysis of the lotus flower Nelumbonucifera that appears clean from swamp water.

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This led to the development of Lutsan paint manufactured by Sto AG, which enables buildings to self-cleaning form while it can be said that reducing the need to clean buildings may reduce water consumption, reduce the need to use toxic chemicals for cleaning, and can protect building façades from damage. Due to the accumulation of surface pollutants, the use of lotus paint can lead to more sustainable results in the built environment. This example illustrates the need to focus on the sustainability behind mimicking nature to increase the chances of achieving results in a more sustainable way. Example: Self-cleaning lotus and getting inspired in building paints.

Nature simulation levels:-

Studies show that mimicking any living thing, for example, is a simulation of a certain aspect of that organism. This aspect may be the shape of an organism or the way in which the organism performs a function. The simulated aspect is referred to as the “biological simulation level.” GanineBenyus classifies the levels of simulation of nature into three levels that can be applied when addressing the problem of designing a form, process, and ecosystem.

By analyzing the organism or ecosystem, form, and process, a solution can be achieved through nature. For this application, it is important to determine which aspect of biology can mimic the nature simulation planes of Janine Beneos Pedersen Zari criticized the classification of Janine Binius; Whereas, “form” and “process” are aspects of an organism or ecosystem that can be emulated. However, an "ecosystem" is the entire collection of living things and their relationships, so these three terms seem an illogical way of describing biological simulations. It classified the levels by studying existing biological simulation techniques into three levels of simulation, namely organism, behavior and ecosystem.

A plant or animal may include simulating a part of an organism or an entire organism. The second level indicates to simulate.

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Behavior, and it may include translating how the organism works. The third level is the simulation of entire ecosystems and the principles that allow them to function successfully. Within each of these levels there are five possible dimensions of imitation. A simulated design might be for example in terms of form, from what the material is made of, how that structure is made, how the process works, or what the function can do.

Results:

1. The transfer of natural concepts to engineering can be done through the "direct approach" that is based mainly on previous studies to find possible natural models, for example biological or concepts, which are then used to develop a specific technical solution, or the "indirect approach" begins. With a specific technical problem, and research studies are carried out to find possible solutions in nature to a similar problem.

Three levels of biomimicry, which can be defined as "living organism", "behavior" and "ecosystem", can be applied to the design problem, and within each of these levels the design may mimic nature in terms of form, materials, construction, process and function

Recommendations:

1. Continuing to study and explore the field of biological simulation and learn from natural environment strategies as there is a large variety of local desert plants and animals in hot climates that provide sources of inspiration for solving many design problems.
2. Engineers and architects should deal with buildings as part of a living system and use the environment to set goals for design solutions through trial and error. Buildings contribute to the environment and respond to ecosystems and social systems, rather than being static buildings that do not respond to the environment and work against the ecosystem.

3. Establishing an educational curriculum in the field of architecture and design that links biology and design, to raise awareness of the possibilities of simulating nature and transferring knowledge between designers and biologists. Which could lead to new majors in biological sciences and engineering.
4. The architect should be able to incorporate concepts from nature in the design rather than simply copying and imitating living things. The goal is to improve the ecosystem, economics, aesthetics, psychological comfort, and all that the age requires of using lighter structures, clean and inexpensive environmental materials, and energy conservation. As if he was creating a new architectural language based on the concepts of the natural environment.

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