

Utilizing the Biomimicry Principles in the Design of Metal Dynamic Facades

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The Introduction:

The research of the integrated design solutions is the dream of the designer throughout history as he tries, through observing the natural phenomenon and studying the behavior of living beings, to discover the creative structure in nature following up the integrated methodology in the behavior of those livings. Moreover, this is what has been introduced by Biomimicry as being one of the sciences based upon saving creative solutions out of nature.

Biomimicry is considered as one of the modern sciences that study the natural models and simulating them or conclude the solutions for human problems through their designs and biological processes. In addition, this kind of science is concerned with studying and analyzing the living beings and their ideal behavior in nature through Biomimicry metaphors.

Those metaphors results, via designing the metal facilities, in rendering the facilities closer to the familiars forms for human beings in nature on the direct form level. Moreover, those metaphors are confined to the outer cover (The facet) that is compatible with nature surrounding it, whereas the interior part is compatible sometimes with the outer form and sometimes with the requirements of the interior space.

Thus, the design of the metal facade is turning from solid static forms into flexible organic ones consisting of abstract mathematical equations (parameter) based on digital calculations through the computer programs.

With the entry of the digital solutions into architectural applications, the materials and advanced techniques help in redefining the relation between the architecture and the material world, especially in what is related to covers and facades of metal facilities.

Therefore, the metal facades having dynamic characteristics responds effectively to the interior and exterior effects in the environment and this is what is known by the intelligent behavior that helps the metal facades to respond to various environmental effects through providing information via computer systems.

Hence, this study is concerned with utilizing the characteristics of the creative thinking of Biomimicry via inspiring the functions and behavior related to natural structural forms and employing them in designing dynamic metal facades responding effectively to environmental effects and characteristics.

Research Problem:

The problem of the current study can be identified through the following questions:

- 1- To what extent this creative thinking of Biomimicry contributes in designing environmental dynamic metal facades?
- 2- To what extent these dynamic metal facades, designed according to the function or the behavior of Biomimicry, can respond effectively to the environmental effects and characteristics?
- 3- What are the designing procedures and bases of innovation based on Biomimicry?
- 4- What are the mechanisms of evaluating the designing ideas concluded by the creative thinking of Biomimicry and what are the means of evaluating their compatibility with the various environments?

Research Objectives:

This study aims at:

- 1- Discovering the creative role of Biomimicry in designing the dynamic metal facades that respond to environmental effects.
- 2- Acknowledging the methods and procedures of natural inspiration according to Biomimicry and the bases of its designing functioning.
- 3- Identifying the mechanisms and procedures of evaluating the designing ideas concluded by the creative thinking of Biomimicry and the means of evaluating their environmental compatibility.

Research Hypothesis:

The study supposes that the design of metal facades by using the creative thinking of Biomimicry will lead to modernizing dynamic metal facades responding effectively to the environmental effects and characteristics.

Research Methodology:

This study is based on the descriptive methodology that is concerning with describing one phenomena and reaching the causes behind it and the factors controlling it, in addition, it aims at classifying the data and facts, registering, analyzing and concluding the results that lead to the possibility of generalizing the approach studied by it as well as building bases for the facts on which explanatory or revealing hypothesis are built for the phenomena or the approach.

Research Aspects:

Firstly: The concept and Methodology of Biomimicry in the Design.

Secondly: The Role of Biomimicry in designing the facilities and metal facades.

Thirdly: The dynamic metal facades (The Designing Concept and Considerations).

Fourthly: The methodology of the design by the creative thinking in designing environmental dynamic metal facades (Analytical Study).

Research Conclusions:

- 1- Biomimicry is considered as a means for effective generation of metal facades' power through enhancing the ability to limit the power consumption by using the natural models that

perform this role efficiently. This is achieved through applying the biological simulation methodology of Biomimicry upon designing the metal facades by using the Biomimicry elements and supervising its effect on declining power consumption in the buildings and interacting with the environmental effects dynamically. This will be achieved in addition to providing guides for constructing metal facades that work for increasing the efficiency of power consumption in those buildings.

2- The facet is operated as a dynamic system aiming at improving the objectives of the power and the interests of the consumers. The creative designing and thinking contribute in realizing how to employ the gorgeous architectural facades in decreasing the total power consumption in the building.

3- Many natural structural formations have surfaces and those surfaces have the ability to change its physiochemical characteristics in a dynamic form as a response to the changes in the environmental conditions and the impacts resulting from environments characteristics. Thus, the simulation of these structural formations carried by living beings rigorously will lead to creating many dynamic metal facades.

4- Simulating the surfaces of many plants, animals and insects would help in employing surfaces' applications having sticking, anti-fogging and anti-reflecting characteristics that can be used in building up many dynamic metal facades.

References:

- 1- abo al3zm, hany fawzy. (2018). "mfhom altsmym alby2y w athrh 3la tsmym almzlat alm3dnya k a7d nzm al ensha2 al m3dny al 5fyf. mgla al 3mara w al fnon w al3lom al ensanya, no. (11).
- 2- 7mdy, 3byr w shms aldyn, sa7ar.(2014). "al3la8a altfa3lya byn alby2a al6by3yawalmsmm fy do2 astlhamwaghat zgagya mn als5or al6by3ya." international journal of development, El-Zeiny, R. M. A. (2012). Biomimicry as a problem-solving methodology in interior architecture. Procedia-Social and Behavioral Sciences, 50.
- 3- Nachiar, S. S., Satyanarayanan, K. S., & Lakshmipathy, M. (2020). Study on the behavior of tension member based on the concept of bio mimics. Materials Today: Proceedings.
- 4- Gehan. A. N. Radwan, Biomimicry, AN APPROACH, FOR ENERGY EFFICIENT BUILDING SKIN DESIGN, Procedia Environmental Sciences 34 (2016) 178 – 189
- 5- Moheb Sabry Aziz & Amr Y. El sheriff, Biomimicry as an approach for bio-inspired structure with the aid of computation, Alexandria Engineering Journal (2016) 55, 707–714
- 6- Olusegun Aanuoluwapo Oguntona, Biomimicry principles as evaluation criteria of sustainability in the construction industry, Energy Procedia 142 (2017)
- 7- DeLuca, Denise. "The power of the Biomimicry Design Spiral." Biomimicry Inst (2017).
- 8- Marysse, C. (2016). Structural adaptive façades. Department of Structural Engineering, Faculty of Engineering and Architecture, University of Gent, Gent.
- 9- Jalil, Wijdan Deyaa Abdul. (2016). The application of biomimicry in kinetic façades. Journal of Engineering, University of Baghdad. 22(10).
- 10- Poirazis, Harris. (2004). "Double skin façades for office buildings." Holland: Lund Institute of Technology. (Page. 13).