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# APPLICATION OF BIONIC ARCHITECTURE IN BUILDINGFACADES OF MODERNMATERIALS

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**Abstract:** The purpose of this research is to recognize the concept of Bionic architecture and its application in pursuit of sustainable architecture compatible with nature as well as the production of absorbentlight materials in the facade of the building. The present research is based on the purpose of the applied research type. Applied research is a type of research that is conducted in accordance with the needs and activities of the communities and humanity and is based on the nature and method of the type of descriptive-analytic blend. Related Information are collected based on the library resources, articles, and site books and then analyzed. The research results show that although the bionic architecture seems to cost more, the long-term cost will be offset by saving energy, avoiding maintenance, and long and useful life. Research findings also show that the LSF structure, which is a very lightweight and earthquake resistant structure, can be used in the bionic architecture.

**Keywords:** Bio architecture, Facades, Material, Smart, Energy

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## 1-introduction

Humanity always has long been inspired by nature in its construction.Throughout the history of evolution, if the path of human movement is distanced from the behavior of nature, it causes the phenomena to appear as natural damage or special dilemmas.The human's pursuit of nature is seen in the works of engineering and the art of architecture, which has created beautiful and diverse works. The bionic architecture is the inspiration for nature in the design of the building.Bionics means biodiversity or the use of fictitious organs of nature. What is nowadays a special

feature of engineering projects is that experts from different angles of architecture and engineering are trying to move onthis way.But what is needed in designing buildings in the third millennium is the subject of coordination and interaction between architecture and technology in this regard (yeganeh. et al. 2018).This paper tries to investigate the originality of the project from a structural and architectural point of view and in line with the natural behavior and life-style needs of technology based on this centuryand suggests that in the third millennium, the path of training and designing of buildings should be shaped by the creation of a team consisting of an architect, structural designer, designer of electrical and mechanical installations with a view to utilizing nature and the principle of minimum energy consumption and green architecture with each other so that the design is created optimally (Fayez, 1396).In recent years, many happiness fell to the ecology of the planet caused people to reconsider in many industries.In the area of architecture, the study of the type of materials and how to construct structures and their design led architects to inspire nature in various forms to definitions such as Bionic architecture of sustainable architecture and energy uptake.

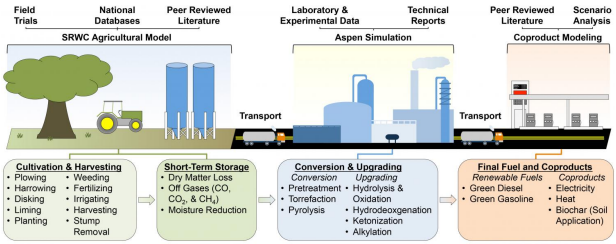


**Fig1: Natural ecosystems are characterized mainly by locally adopted and integrated processes**

In the meantime, exploring the design of structures based on the Bionic architecture and inspiration from nature in the past also brings the way to their future. Our traditional architecture, in the same beautyhasa very good performance and strength, and it shows well in ancient times, with the least facilities and the best design, they have made the climate more desirable in the desert climate and use a variety of materials (clay and brick) to make the best stand.The past architect also lived in nature, and, besides utilizing nature, always paid attention to the fact that he did not harm to nature but he learned most of the lessons from natural design techniques (salighe, 2016).Considering the technology and cost of consuming materials and the use of the latest

technology achievements in the construction industry was the first statement in this style of architecture of the Bionics, followed by structural systems and new building materials entered into the realm of architecture which featured the technology.Bionics' term consists of combining the two words of biology to mean biology and technique, which means an art. This word was first used by Jack Steel at a conference called "Vital Models, a Key to New Technologies" in the 1960s. Bionic science examines the structures and patterns in nature and their use in solving human problems. This science does not seek to copy or imitate nature only, but aims at the proper patterning of knowledge derived from nature. (Golabchi, 2014).

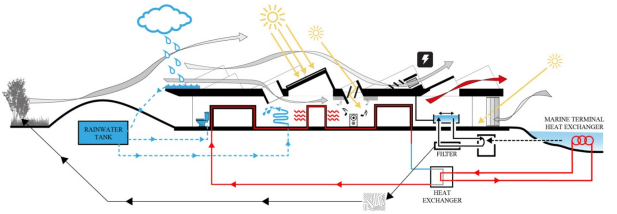


**Fig2: Sustainable Buildings based on Bio Architecture**

2. Theoretical foundations and research background

Inspiration from nature is not a new idea. Over the past fifty years, many biotechnologies, such as flying mechanisms based on flying birds and insects, hardened ceramics based on pearls, rubber and hard composites based on fiber orientation in wood, etc., represent the inspiration from nature and bionic. In the first decade of the 21st century, the amount of Bionic research has been developed. Climate change, reducing fossil fuels and increasing energy consumption are one of the biggest problems today.The building sector consumes more than a third of the total energy and is the largest source of greenhouse gas emissions in most countries. Most of the energy used in the building is used for heating, cooling, ventilation, lighting, and so on. A small percentage of energy is used to produce building materials and destruction of about 10 to 20 percent. Renewable energy sources should be used to prevent the global climate change and the destruction of non-renewable resources. The purpose of this research is to recognize the concept of Bionic architecture and its application in pursuit of sustainable architecture compatible with nature as well as the production of light absorbing materials.

2-1.Bionic in architecture

The goal of architects is to get into the Bionic world of architectural innovation. Architects are

investigating in common areas of architecture and biology to identify appropriate patterns and discover innovative ideas and transfer biological properties to architecture. Bionic architecture can be divided into six major groups:

1. Role and pattern: The nature inspired roles are usually used in decorations; in some cases, they also have a functional role.

2. Structures: The inspiration for the structure of the organisms and its application in architecture is possible by understanding the structures and mechanisms of the form of living organisms. To translate natural structures into architecture, we need to have a deep understanding of the structure and how to transfer the load in them.

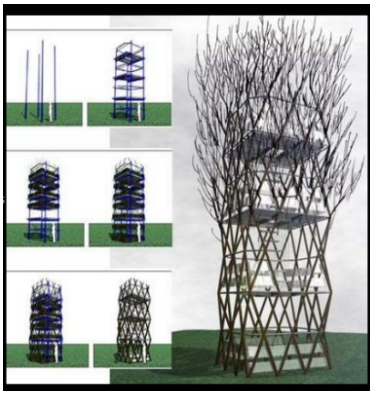

**Fig3: structures inspired form bio morphs**

3. Materials: Characteristics of living organisms can be transported to artificial human handmade materials.

4 Form: Form is one of the most important criteria in architectural design. In Bionic architecture, the mere transfer of natural forms to architecture is not significant. Therefore, the relationship between form, function, structure, and material is very important. Form's use includes four subset forms of animal, human, plant, and still life.

5. Function: Natural organisms have evolved over hundreds of thousands of years and have evolved in terms of complexity, variety, and adaptability. Humans can transform certain functions that come from natural organisms, according to their needs, and apply them in architecture.

6- Process: Inspiration for processes in nature that leads to the formation of phenomena is much more attractive than functional and modeling. (Golabchi 2014).

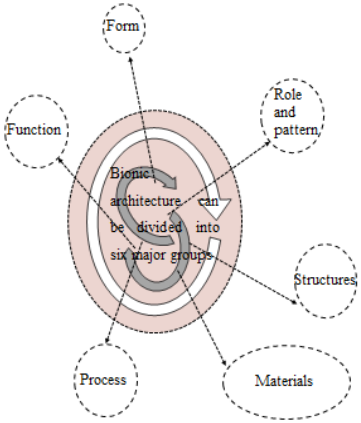


**Fig3: Bionic architecture Dimensions**

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2-2. Solar cells

Energy demand in the modern society and the desire for renewable and environmentally friendly energy are constantly increasing with minimal dependence on fossil fuels. Many scientists believe that the sun as a renewable energy source can be a good solution to this energy demand crisis. Therefore, solar cells can be a good solution for using solar energy. In nature, sunlight is absorbed by the leaves, and when it moves in its branches, it is converted to the required chemical force by contact with chlorophyll and carbon and water. Plants do the photosynthesis by absorbing sunlight(yeganeh, Bamanian, 2012).

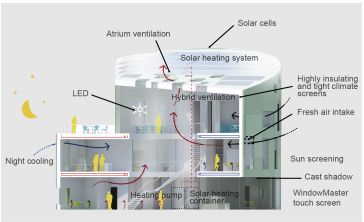



**Fig4: solar cell application in buildings**

2-3-Application of types of materials in architecture

The materials described below are materials and materials that have special and practical potential in the field of architecture and construction. This list is based on the characteristics, structure, and characteristics of these materials:

1. Recycled Materials: These materials are mainly made of second-hand materials and clean waste. Used for the preparation of recycled materials, valuable parts of second-hand materials are used, however, the resulting product is usually of lower quality than the original material. Nowadays, the use of recycled materials has been very much considered with regard to the principles of sustainable architecture.

2. Biodegradable materials: The constituents of this material are degraded by microscopic animals in the soil after their life and buried underground. Therefore, they do not pose a threat to environmental pollution.

3. Biomaterials: Includes plastics and other materials made from renewable sources. a research that is currently being considered on these materials is the use of a specific bacterium that consumes 2CO gas and is able to disassemble these plastics.

4 Intact Materials: Materials that do not affect the physical and chemical influences on them. An example of this kind of material is steel alloy.

5 Intelligent Materials: These materials, which are the main argument of the paper, are materials and products that are variability and able to change their intrinsic or intrinsic properties in response to physical and chemical effects in a reversible manner.

6 Hybrid or Linked Materials: These materials are made up of at least two different combinations. Like the combination of natural and artificial compounds.

7. Materials with Fossil Layer Structure: These are a kind of

aggregate with gradual joined layers. This material is the result of a continuous change in the properties of materials. An example of this kind of is crude oil that created from putting of multiple layers over many years.

8 Nanomaterials (nanoscale materials) are materials made of nanoscale materials (one billionths) and have a lot of points in common with smart materials. Materials with a nanoscale structure are used as the final coatings for the manufacture of products. For example, anti-corrosive coatings, air purifiers, surface cleaners, and bioactive coatings are used. (Turani 1387).

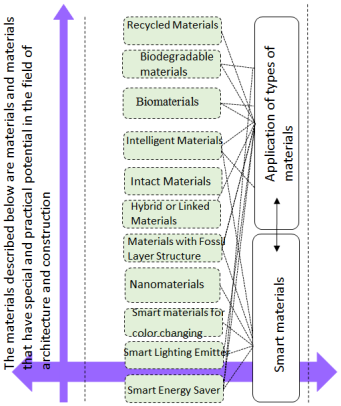
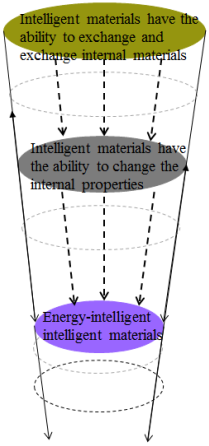



**Fig5: Types of smart materials**

2-4-Smart materials

Smart materials are a new term for materials and products that have the ability to understand and process environmental events and show a good reaction to it. In other words, these materials are capable of being varied and able to change their shape, form, color, and energy in a reversible manner in response to the physical or chemical effects of the environment. If we categorize materials into non-intelligent, semi-intelligent, and intelligent materials, the first group, ie, non-intelligent materials, does not have a specific attribute; semi-intelligent materials can only change their shape and form for a single time or a short time, in response to environmental influences, but in intelligent materials, these changes will be repeatable and reversible. Smart materials are also known as "flexible" and "adaptable" materials, due to their specific characteristics in adjusting to environmental conditions.(Ritter, 2007).




**Smart materials Classification**

**Fig6: Smart materials in modern architecture**

**The following chemical and physical influence variables are the stimuli that intelligent agents respond to themselves:**

1. UV light: ultraviolet section and visible electromagnetic radiation

2. Temperature: Temperature changes that create a physical system like the human body

3. Pressure: The pressure difference created in a region

4. Electric field: The field generated around an electric charge

5. Magnetic field: The field created around a magnet or a moving electric charge

6. Chemical environment: The presence of a chemical element or chemical composition, such as water.

2-5-1. Smart materials Classification

1. Intelligent materials have the ability to change the internal properties: Includes intelligent material transformer, Color changing

Smart materials, Change linker materials

2. Energy-intelligent intelligent materials: Includes smart materials of light emitter, intelligent materials of power supplies, intelligent materials of energy saver

3. Intelligent materials have the ability to exchange and exchange internal materials

2-5-2-Smart materials for color changing

These materials are capable of reversing their color or visual properties in response to one or more external triggers. Due to their motivating factors, these materials are of various types, but some of them are highly regarded in architectural applications including photochemical, thermochromics, and electrochemical materials. These materials exhibit a change in color when exposed to visible UV light, infrared light, or electromagnetic radiation. The application of electrochemical materials is also in the architecture of electro-optical glasses. Electro-optical materials, exposed to sunlight, change their visibility, transparency(Atkins, 2004).

2-5-3-Smart Lighting Emitter

These materials are compounds and preparations that stimulate molecules inside them with the effects of energies such as brightness or electric field and produce the light. This phenomenon is in fact a temporary state for molecules that occurs due to the effect of higher energy, at which time a portion of the energy absorbed by the molecules is emitted in the form of visible electromagnetic radiation without exiting heat. They refer to this phenomenon as "Be bright "(the same).

2-4-3- Smart Energy Saver

These materials are capable of storing both visible and hidden energy, for example in the form of light, heat, hydrogen, or electricity. It should be noted that these materials have the ability to be reversible. Therefore, these materials are capable of storing energy in a variety of ways. But in the meantime, intelligent heat storage (heat)

materials have been more prominent. These materials have an intrinsic property that enables them to store energy in the form of heat or cold (reversed heat). (Addington& Schodek 2005)

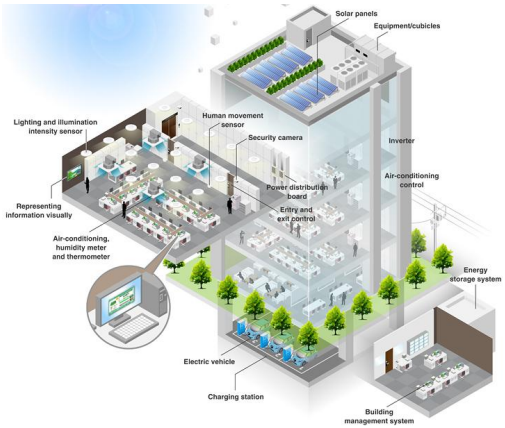



**Fig10:materials are capable of storing both visible and hidden energy**

2-5-Structural LSF

A lightweight steel structure, which is briefly described as the SSF structure, is one of the new construction systems used to run buildings with limited floors, usually up to 5 floors, and are approved by civil engineers in countries Developed and modern.This structure is made of rolled steel sheets to provide building stability, gypsum boards and boards as an inner covering and external wall pieces as a facade. This system has the ability to combine with other structural systems. Using this system reduces the weight of the structure by up to 50 percent, and this is the highest score against the earthquake.This system, which is very similar to the methods of building wooden buildings, is based on the use of components to name Stud, and Track and Runners, and are composed of a combination of cold rolled galvanized steel profiles and in the main structure of the building is set up. The sections used in this system are U, C, and Z, which are usually connected to each other with cold connections.In most cases, this system runs with a light roof and provided in the case of other types of roofs. The beams and struts of this type of light roofs are like" Stud "and the walls of the" tracks". The final roof is usually sloped using metal truss made of rolled cold rolled profiles. Other parts of the building are executed using cold rolled profiles and can be applied to the wall with a variety of views such as rock, bricks, PVC facades, wooden or aluminum,

paint, tiles, ceramics, etc. Inside, as with the usual walls, it is possible to paint, wallpaper and ... on the plaster panels.

The interior space is also filled with sound and thermal insulation. The thin-walled steel sections are galvanized steel sheets that are shaped using cold rolling and Roll Formingtechniques. The thickness of the base metal (thickness of the metal, excluding protective coatings) ranges from 455 to 0 mm to 3 mm, according to the regulations for steel rolled steel sections. The production and cutting of these sections in the factory makes it possible to produce smooth and uniform sections of high volume and speed. The placement of these steel sections at distances close to each other creates bearing walls that have a good resistance to the lateral loads due to wind and earthquakes (Yeganeh, Kamalizadeh, 2018).

**3 - Research Method**

The method of research is to explain and interpret the direction of movement in order to achieve the facts related to the subject of research (Hafez Nia, 2006: 19).) The present research is based on the purpose of the applied research type. Applied research is a type of research that is conducted in accordance with the needs and activities of the communities and humanity and is based on the nature and method of the type of descriptive-analytic blend. Information related to references to library resources, articles, and site books are collected and then analyzed.

**4. Research findings**

As you know, traditional Iranian architecture has been affected by the element of light, water, nature, wind and soil. But the Bionic architecture is not just limited to the use of natural elements in architecture, but must also discover the laws within the natural components of the body structure of organisms to the molecular makeup of viruses in order to create living spaces for human beings. Regarding the cost of this type of architecture, we can say that today, the projects that are called "Bionic Architecture" in the world or arein the design stage, cost more than the similar projects. But if we assume that the bionic architecture, the maximum performance at least cost, is determined in that case, although this architecture seems to cost more, but in the long run, this cost with energy saving, no maintenance and life Useful and long-term compensation. The cost to architects is to spend time familiarizing themselves with the rules and laws that exist in nature, which, after understanding these laws, will be able to create the right architecture for human.

As always new activity is in line with a new generation then it is expected to today's generation templates Iranian architecture be to better know and provide new approaches in architecture with the rules of traditional architecture in such a way that the roots of culture and history combine with in a new

frame to create contemporary Iranian architecture. In fact, the Bionic architecture is trying to enrich the building. Therefore, LSF structures can be used in the bionic architectural view of the building, which is both very costly and cost-effective.In fact, the Bionic architecture is a movement that has begun since the early 21st century in the world and is used to design and construct buildings whose original laws have come from nature. According to the case studies presented at the international airports with the Baoon and the Bionic Lava Tower, inspiration from the bionic architecture in this way is costly and costly in the buildings of the building. Another advantage of this structure, lightweight, and resistant to earthquakes and therefore can be used in architectural bionics and inspired by the views of butterfly and honeycomb-like case studies presented in this article use from glass in whole of the facade of building which is also a sunlight absorber that reduces energy consumption and a is a new design in the bionic architecture of the facade of the building in terms of its geometric shape. But in these structures, safety and fire are also to be considered.

## 5. Conclusion

In this paper, we first outlined the concepts of the bionic architecture in the building, and provided a few examples of this. Findings from this research show that projects that are called "Bionic Architecture" in the world or are in design phase require more costs than similar projects. But if we assume that the bionic architecture is mean the maximum performance at least cost, is determined in that case, although this architecture seems to cost more, but in the long run, this cost is compensated with energy saving, no maintenance and life Useful and long-term. The results of this research indicate that the LSF structure, a very lightweight and earthquake resistant structure, can be used in the bionic architecture. In the design of the bionic architectural design of the building inspired by nature and geometric shapes such as butterfly and honeycomb in five-story buildings, this design and the glass facade of the building can be used.It is hoped that by presenting this research, a new step in the bionic architecture in the building's view can be taken, which both reduces both energy consumption and cost-efficiency. Therefore, this scheme can save time and money.

**References**

1-Asma Fayez, Mohammad Reza NazsanMohammadi, SomayehOmidvari, 1396, Bionics Materials Study, A Way to Achieve Sustainable Architecture, 2nd International Conference on Civil Engineering, Architecture and Crisis Management - 2017

2-Qarooni, Fatemeh, Omranipour, Ali, Yazdi, Mohammad, 1392, Architectural Design with Bionic Approach, Case Study of Architectural Shells Inspired by Abalon Oysters, Architectural Design with Bionic Approach No. Page 140-1

3. salighe, Zahra, 2016, Bionic Architecture A way to optimize energy use (Examining examples of Bionic architecture in the traditional architecture of Kashan, Conference Paper: The first national conference on architecture and energy with the approach of modern building systems.

4-Dr. MahmoodGolabchi, MortezaKhorsandNiko, 2016, Boynick Architecture, First Edition, Tehran University Press

5-Atkins, Ronald L. and Partners,(2004). "Advanced Energetic Materials",The National Academics Press,Washington, DC.

6-Addington, D. Michelle; Schodek, Daniel L. (2005). "Smart Materials and Technologies for the Architecture and Design Professions", Architectural Press/Elsevier: Oxford. - Allen, P. and Todd,

7-Ritter, Axel, (2007). "Smart Materialsin Architecture, Interior Architecture and Design", Birkhauser, Switzerland.- Schwartz, Mel M. (2002). "Smart

PooyaLotfabadi, HalilZaferAlibaba, ArefArfaei ,(2016) . Sustainability; as a combination of parametric patterns and bionic strategies . Renewable and Sustainable Energy Reviews . 57 ( 2016).1337-1346

8- Yeganeh, Mansour, Bayegi, Fatemeh, Sargazi, Azadeh.2018. Evaluation of environmental quality components on satisfaction, delight and behavior intentions of customers (case study: Gorgan restaurants. Am. J. Res. 5-6

10- Yeganeh, Mansour, Bemanian Mohamdreza.2012. Architecture as an Organism, International Conference on Industrial Engineering and Operations Management.

11- yeganeh, Mansour. Kamalizadeh, Mansoureh. 2018. Territorial behaviors and integration between buildings and city in urban public spaces of Iran? s metropolises, Frontiers of Architectural Research 7 (4), 588-599