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Nature as a Fundamental base for an Architectural Design, How we set basic base to Design Architectural Envelope Inspired by Sustainable Features of Leaf

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Abstract

Proceeding from the idea that nature is morphing to adapt with its environment, transformability in nature is a strategy For Adaption. Architecture is able to breathe and grow as plants. The field of this specialization is called breathing and living architecture. Designing an external envelope for the building, which is able to breathe through the organization of domestic environmental quality factors of architectural space (temperature and humidity) is very important especially when it is working to organize the necessary lighting for space according to function and requirements of the occupants, and in the same time concludes the construction of the amount of carbon dioxide. Today the concept of "breathing building" should be implemented as a design strategy to achieve more adaptively and responsively against extreme climate changes, through the invention and providing architectural elements which also are hightech sensitive to these climate changes, and able through this sensitivity to design an internal space appropriate with the activity and comfortable for the occupant.

Keywords: Adaptive envelopes, Architectural design, Bionic architecture, Domestic environmental quality, Inspiration from Nature.

Introduction

Generally, in Syria especially in Damascus most buildings of all functions and sorts are suffering in short comings in performance, especially at the environmental level due to the absence of specific current guidance with policies towards designing buildings to be friendly environment and contributing by some ways to improve their environmental performance and working hardly to protect the surrounding environment from the construction sector, which has become and contributed significantly in energy consumption and put up carbon dioxide (CO_2). The presence of technology will stop carbon emissions by half in both existing and new buildings[1]. The introduction of this problem calls for architects to work on the development and improvement as much as possible, and then work seriously when it needed to find and invent mechanisms to improve the performance of these buildings toward environment as well as occupants. The absence of internal thermal comfort factor because of poor design in most buildings put the responsible authorities at high costs. For example (increasing energy, low productivity and other consumption), in the time, it can be replaced by inventions that contribute in the adjustment of the problem, despite high initial costs, cause the sustainability of the invention contributes in restoration costs when using and investing this technique in various buildings.

An overview of Bionic Science: Described as the science that studies the principles to engineer organs, and apply to human life by finding and creating forms to mimic the plants and animals in nature, especially when the studies based on the level of behavior. The evolution of the structures found in nature over the years has led to selfmodification, it is considered as an outstanding example worthwhile to reach the ideal materials and optimization of construction, in addition to the importance of the vision of simple base that emphasizes surviving with the lowest cost[2].

In addition, a multidisciplinary use and dealing with the principles in biological systems field, and the mission is to simplify the transition from nature according to the functional principles used in nature and employ them technically[3].

The availability of technical development has helped to study organs. Some of those studies got the level of cells with a view to set the basic principle behind the operations carried out which require thousands of iterations per second. In addition to fast processing of data to link these processes with each other therefore, it is considered a weakness in this science due to being a nascent in the academic field, but it is accessible through detailed realistic objective scientific study with privilege in the main purpose [2].

Bionic = Form + Behavior >>> Natural Relationship
That is different from Organic Concept
Organic = Form >>> New Relationship

Architecture and Nature: Nature is characterized as field presents everything in an efficient and errorfree form and gives solutions to environment by differentiating the principles which cause organic evolution and development of relations and algorithms arising from a specific need to be a clear basis for modeling forms in general and architecture in particular. Those principles will enable architects after differentiating to be used in industry and technical field then it is given a scientific feature[4]. The science of nature is the science hides inspiration spiritual of technical practice at the level of forms of plants, behavior of the living, the relationships, transformation, applying and adapting.

Today it has become possible to create links between human, nature and architecture. Architect must find a relationship between the physical body, spirit and human, then build a base of sustainable life on the basis of hierarchy complex disciplines presented by components and elements of balanced nature (such as using less energy through using less materials yet with high environmental efficiency). That is as a solution for coexistence with nature and a response to the need of world to adaptation. The relationship between nature and architecture has become the top epeak (Apexbionic), in order to compensate for the shortcomings of human life which should be in harmony with nature[5]. Therefore, these relations contribute between human and nature in the presence of interesting and creative architecture which will accept the differences in the disciplinary, constraints and freedom, the mind and creativity, nature and technology[4].

Bionic Architecture: Is a group of biological tools and systems found in nature used in the world of engineering and technology and building electronic biology, in addition to another term which is the Biommix architecture. Otto Schmitt and Jack Steal discovered Biommix architecture in 1950, that when they were designing an astronomical enterprise as part of the air station in the United States [5]. It is also a process, which uses new directions and systems for architectural design, that established and existed in the natural environment, and based on a collection of different ideas derived from nature and engineering sciences with a detailed study of the vital biological complex systems, studying of natural forms, then responding to solve technical problems in structural engineering[6].

In general, there are three reliable biological levels for imitation, got in the level of modern technologies and summarized as follow: i. Imitation of the production methods in nature. ii. Imitation of the mechanisms of nature. iii. Studying of the organized principles, which based on the social behavior of neighborhoods and organisms[5].

Another source confirms the importance of different types of systems simulated according to the principles which available in nature.

According to the base, which says that the nature is a rich source for many fields (technical, responsive, adaptive and architectural design), this process is divided into three levels of simulation: i. Simulation of the shape from nature, a traditional way which is described as illogic way. ii. A metaphorical simulation, It is metaphysical way, which means the abstraction of nature with maintaining the basic natural features such as stability and balance. Metaphors in this way are opened to some levels of creativity and can be considered as a strategy[6]. iii. Simulation the laws and regulations of nature then borrowed to build the targeted model. It is considered as a scientific way[6].

Materials and Methods

This paper analyses possibility of utilizing from nature to create natural and dynamic mechanisms to enable the architect to reverse them in the architecture field. After analyzing, the elements of nature where plants are selected in general and the leaf is selected as specific element according to its healthy internal structure and being a separator element between the inner and the outer environment and through there is an exchange of materials with the outdoor environment.

The leaf has environmental specifications which can be reversed in the envelopes of buildings. Those specifications are placed and compared with specifications, which should be considered in the new constructed architectural envelopes then three stages are set to transform from nature to architecture.

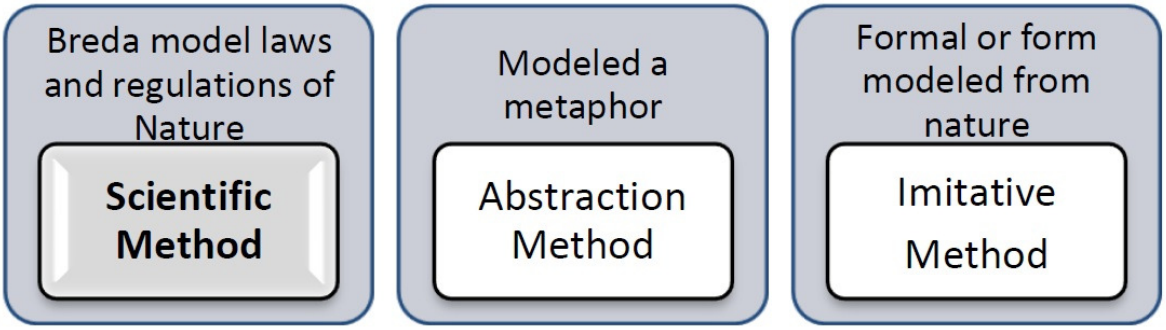

Figure1
Illustration of the three levels of simulation methods from nature[6]

Results and Discussion

Analysis phase: The goal: This phase aims to study the natural element, which has been chosen for the simulation (Leaf), and then study the shape, structure and engineering as well as the functional principles.

The expected result: Applying the practical interest in the level of mechanism and shape of the selected item.

The content: the element selected and dissected using graphics and a number of references, information from books, the internet and previous research in this field. The purpose of this is analysing of shape, structure, documentation and registration through the images.

The evolution: according to the group of stages starts by showing the element content through autopsy studies, in the terms of form, structure, then the formal specifications, structural and functional principles. Finally describing the potentials and possibilities in the item.

There are some photos taken by researcher to illustrate the state of leaf in different phases.

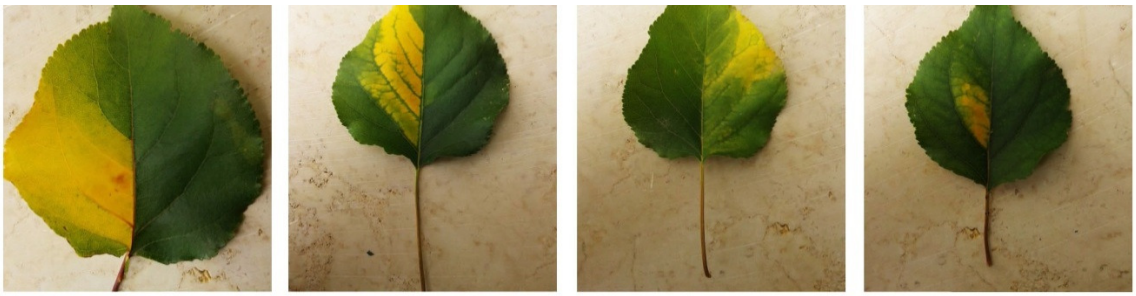

Figure2
Image illustrates stages of the transmition of leaf from summer to autumn showing the different places of yellowing. (14.11.2014)

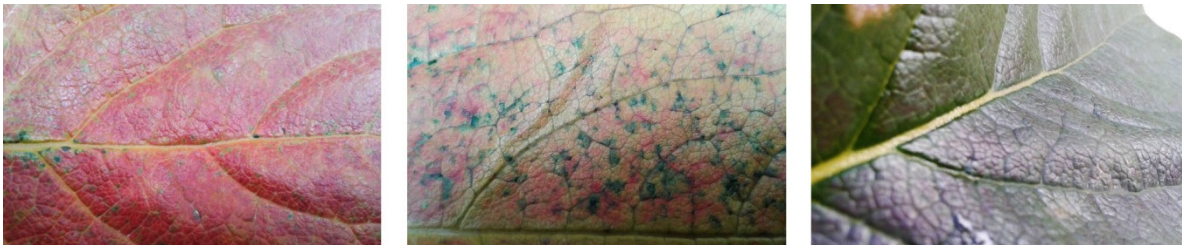

Figure3
Image illustrates the stomata with main and minor veins. (14.11.2014)

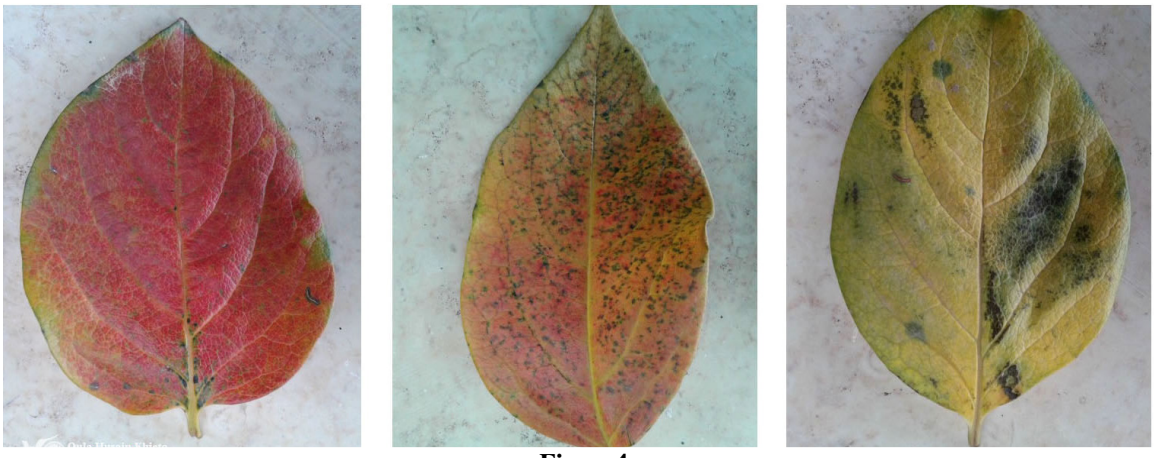

Figure4
Image illustrates the change of the colors of the leaf. (14.11.2014)

Some results in the level of studying and analysing the leaf as a specialized element of plant: i. The most important feature of a plant in the universe that it needs little to ease the internal invisible movements and maintain the continuation of the plant private laboratory and to resist the ambient conditions of surroundings, namely water, and a little mineral salts (Minerals Salts), and sunlight (Daylight). ii. Showing the morphology of leaves and anatomical changes helps plants to adapt with surrounding which leads to specialization. iii. The anatomical structure of the leaves contributes significantly through spaces exposed to light in gas exchange with outside air and water absorption of the base in a way that allows to cool the plant and provide thermal comfort. iv. The leaves are considered as security regulators for thermal comfort of plants. v. The leaf is characterized by internal network of veins, which works like vessels, tanker of water and other materials, this type of network differentiate from one to another according to the need and the prevailing climatic conditions. vi. Thermal regulation of temperature of the leaf plays a basic role in the change of shape. vii. The development of the shape of leaf is connected with the angle of solar radiation, vertical falling sun and that is leads to the breathing processes at high rates as a result of greater overlap both of CO_2 and sunlight (i.e. successful interaction), and the angle which is less than vertical leads to less overlap then breathing in smaller quantities. viii. Any group of stomata pores is considered a device on the leaf surfaces to control the transpiration, so that is leads to the loss of water only to the extent required for this process. ix. The pores Stomata are considered the links between the external and the internal structure of the surrounding, the way to move all of CO_2 needed for photosynthesis, and the installation of water needed for transpiration and respiration. x. The guard cells that surround Palmsam are considered the control keys to open and close the pores through plant respiration, which is necessary for movement and alternating between (swelling and shrinking). xi. The guard cells respond to variable environmental conditions by improving gas exchange and providing efficient dynamic to change its size under the influence of changes in the concentration of CO_2 and light intensity, humidity and drought, as well as the formation of the hormone abscisic. xii. Guard cells control the flow of CO_2 and water loss[710].

Left, schematic cross section of the leaf, indicating the order of different types of cells and the proportion of Mesophyll cells about, which is 30_ 40%[11].

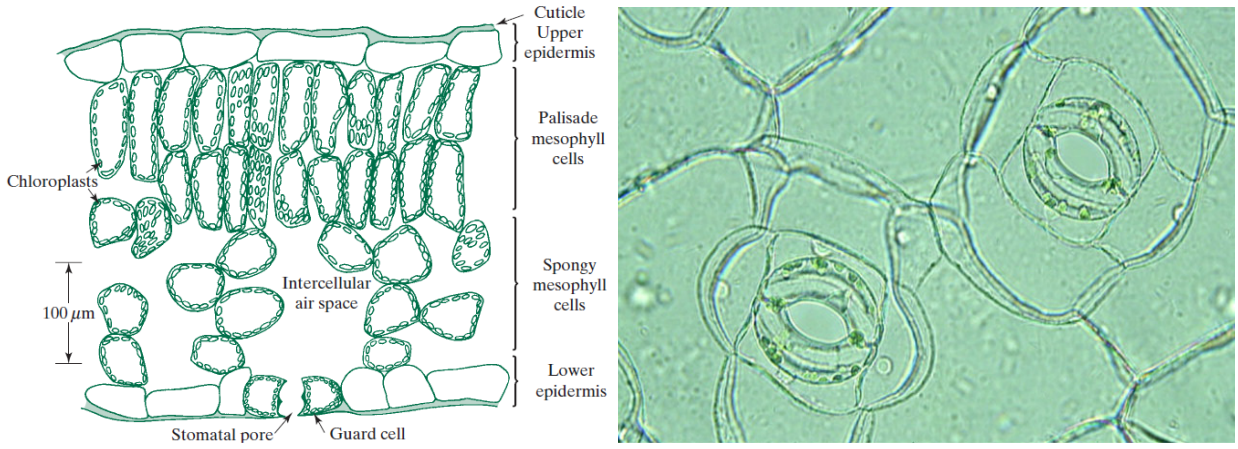

Figure5
Right, the pore surrounded by two guard cells, it shows the state of cells with swelled case, the pores are opened[12]

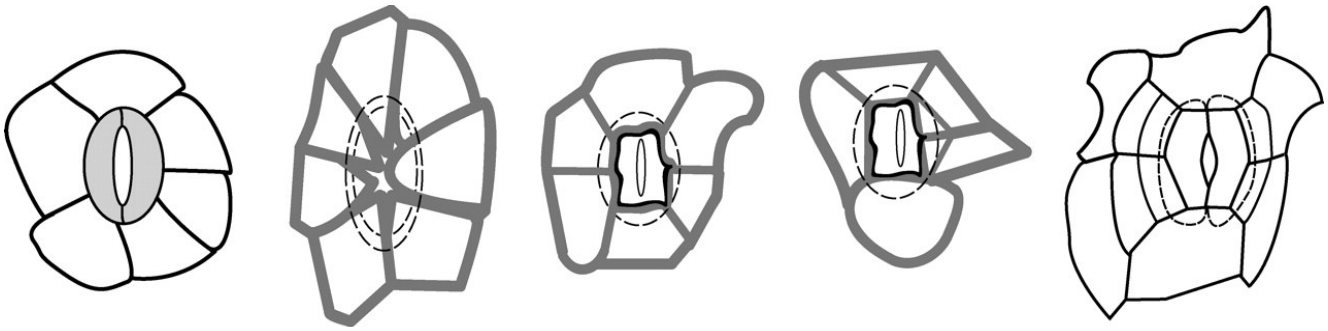

Figure6
The evolution of pore clusters of plants seed cells[13]

Transformation phase: The goal of Phase: This phase aims at indepth understanding of the principles and relations between the form and construction, as well as the functional principles.

The expected result: mechanical architectural Model, envelope of stomata able to breadth and stenosis by an appropriate heat for occupants.

The content: According to the results of the analysis, the purpose will be producing a physical or digital model based on analysis of previous natural principles.

The evolution: According to the group of procedures starting with an introduction and progress throughout the results of the analysis then planning and production of mechanical model.

Detailed Transformation phase: Title of invention: An external architectural envelope adapts with climate changes and simulates form and structure of the leaf.

The purpose: Mechanical external envelope for an architectural space through the biological mechanism analysis of adaptation of leaf with different climatic conditions to secure internal environment with high quality then provide a compromise for influencing factors of the temperature and humidity factor, ventilation and lighting.

Through the study of previous biological levels as well as forms of imitating, it is observed that the described invention is located at the second level for Bio mimicry of mechanisms, and takes the third level of imitation of laws and regulations of nature pattern, which falls within the scientific methods. This method gives better results.

The difference between the traditional architectural envelope and natural envelope of the leaf, which has been studied.

The expected attributes from the intended envelope, and the corresponding ones, which is presented in the leaf.

For the implementation phase it will depend on the results of the transformation phase by setting special table identifies the simulated replicable elements in the form or structure, then replacing the natural elements by artificial elements and materials. It assigned to the subject of other research.

Results: Nature is the foundation of the universe and there is a strong relationship between nature science and architectural field. Bionic is derived from nature to generate architectural and technical elements, those elements should be creative to serve the occupant of space whatever needs of requires are.

The process of innovative design, which is inspired by nature, should pass three basic stages, as following: i. Analysis phase: analysis of characteristics and structural features available in the natural world, which contains the construction, form and function. ii. Transformation phase: disconnect public and private principles in this phase through the process of abstraction. iii. Implementation phase: the implementation of principles that are selected then approved as components and actual products and systems in innovative architectural design level.

The purpose of this division is to enhance the design process and ensure the achievement of project objectives tables, where each stage based on the results of the preceding stage.

Table1
The difference between the traditional architectural envelope and natural envelope of leaf

Traditional Envelopes of buildings	Natural envelope derived from leaf
It is simple known system.	Depending on sustainable development of complex systems.
At the level of walls, It will be (stone, blocks and concrete).	Adaptive system with climate changes.
At the level of opening, glass supported by a supportive network according to the measure and size of the opening either plastic, steel or aluminum.	They have multiple layers and high degree of specialization, with high functional differentiation.
Somewhat heavy.	Very light substances.
Some items can be recycled (brick and stone).	Can be recycled.

Table2
The Attributes expected of envelope, which designed, and Possibilities that exist in the leaf

Expected attributes in the envelope	Possibilities that existed in the leaf
It might be called: Adaptive envelope (Conditioner wall). Alive envelope (Alive wall). Casing capable of breathing (Breathable wall). Environmental Monitor (Environmental controller), which can control through its movement and its sensitivity to climate factors (temperature, humidity, illumination intensity and the amount of carbon dioxide) to amend the degree of ventilation and heat of the internal space at the same time. Responsive envelope (Responsive wall). It has the ability to respond to the mechanism by technical way with sensors for manual control. Required: **Stomata envelope** that can expand and tight according to the appropriate heat for occupants.	**The leaf can:** Adapt to different climatic conditions. Be described as a living yearround except for the falling of them dies because of their inability to endurance. The combination of factors (light intensity, temperature, humidity, air speed) are responsible of respiration and transpiration and control the transpiration process. Where the water vapor is launched by transpiration process to the outer environment, and take the necessary carbon for installation and then put oxygen. The function of the thermal regulation of the leaf is characterized by an internal structure intact. Separator between the biosphere and the internal structure of tree to affect the whole elements of climate, which also respond to changes in humidity and temperature. Respond mechanically to all changes.
Control the amount of light within the architectural space when it needed to breathe.	Controls the amount of light required for the photosynthesis according to the need of plants to breathe. The adaptation of leaves to improve the capturing of light is an important factor to change and develop its shape.
It Changes its color according to the external climatic conditions (media).	The ability to change color according to the seasons based on the movement and the amount of water and sugars inside.
It is a particular Modular with cell porous and nonporous networks. The nonporous cells polarize the light required for Space (direct polarization through movement) The porosity be able to open and close for breathing, ventilation and modification of temperature and humidity (indirect polarization).	The bottom layer of the leaf contains set of nature shapes of cells. It is interspersed with veins as well as other differentiated cells by guard cells that control the closeness and the openness of the surrounding pores. The pores _ (Stomata) are the link between the external environment and the internal structure of plant, the way to move all of CO_2 needed for photosynthesis, and the installation of water needed for transpiration and respiration.
A natural light materials	It is made from natural light materials
It must be multilayers for adaption (transformation from case A to case B).	It has multiple layers and a high degree of specialization
Multifunctional.	Multifunctional.
A distinct architectural form.	With a distinct architectural texture of the leaf.
The provision of energy consumption depending on the natural energies with the exception of the energy necessary for movement.	Total depending on natural energy
Organic and sustainable with long age.	Sustainable**.**

After searching and analyzing, it is possible to suggest the following results as primary concepts for designing: i. The possibility of designing a separate external envelope with characteristic to make the internal architectural space, more free. ii. The possibility of adding the features of sweating and breathing that are existed in the leaf to the envelope, which intended to be designed. iii. The possibility of adding the property related to organization of CO_2 gas levels within the architectural space. iv. The possibility of designing a sustainable, adaptive, responsive, and movable envelope, which would regulate temperature, humidity and emerge natural quantities of lighting to architectural space similar to the photosynthesis process in the plant. v. The possibility of provide the envelope with feature described in the vertical movement of a group of cells around axis to conform to the deviation of the sun angle with reflectors to reflect the radiation to the internal space, and thus illuminated architectural space as much as possible in summer and winter. vi. The possibility of supplying

the envelope with electronic sensors to external temperatures and is working to modify the internal temperature of the architectural space. vii. Supply the envelope with an electronic circuit, which connected to a central sensation, and generate the required energy to move the cells when it needed. viii. Providing the cells with textured natural flexible rubber or polymers, which are possible to fit the movement in both cases of total and partial opening. ix. Adding moisturizing properties for the envelope through installing the water element and move vertically within the space in the middle part of the envelope. For example, it is possible to provide the envelope with water tank in the bottom. This water climbs through hollow tubes to spray droplets, and therefore during exposure to the sun turns to steam enters the space to be wet.

Conclusion

This paper showed the importance of nature to import sustainable elements and the possibility of application in the field of architecture which indicated by the item that has been studied (leaf) which also is considered as an adaptive element and can be used to design an adaptive architectural envelopes as in the Table1, 2.

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