

# **BIOMORPHISM AS A DESIGN INSTRUMENT OF ARCHITECTURAL SHAPE -A DISCUSSION ON MORPHOLOGICAL CONCEPTS**

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## **ABSTRACT**

Being inspired by the nature around as designers is getting to be a trend of recent progresses in architecture. In this sense a great deal of notions related to life and living organisms are joining in the design terminology. The designers' interests are getting intensive on the natural environment and living beings around. It might be commented that this relation is based on the human being's awareness of the rapid destruction of the ecology which is caused by his irresponsible interferences.

By aiming biomorphism the designers' work on architectural shape isn't a safe process at all. The risk by realizing the organic formations can cause the mimicry in design which is called as "bio-mimesis". So the designer's causeless imitations could impair the performance reaching the right decisions. The formations of the organisms in the nature are open to probable changes or transformations in relation to the steps of their lives. The adaptation of this dynamic process which continuously renews itself in the living environment should be critical in architectural thinking models.

The paper aims to discuss the adaptability of the logic of such ecological dynamics to the architectural design based on 'variability' and 'flexibility' concepts.

**Keywords:** Biomorphism, biomimesis, architectural shape, ecology.

## **1. INTRODUCTION**

Nature has inspired researchers and architects with its endless fascination of phenomena to create new approaches in design and solve difficult construction and/or design problems. Natural analogies are used frequently in science, where explanatory principles are derived from observations of biological phenomena, oftentimes allowing or inspiring the generalisation of those principles beyond the scope of the initial observation. Theoretical models derived from biological phenomena such as organisation, adaptation, selection or complexity, oftentimes catch the attention of architects and designers, who are interested in achieving or relating their work to these phenomena (Fischer, 2008).

Many of the pioneering architects have been strongly influenced by the same properties of living structure and its biomorphic forms. Antonio Gaudi studied nature's angles and curves

and incorporated them into his designs. Buckminster Fuller's geodesic dome, Ferie Otto's lightweight structures are some of the most influential examples in design for autonomous forms. Otto, leaves a legacy of examining nature, especially spiders' webs, as a source of inspiration for tent-like tension structures. Also in the most of designers' works like Santiago Calatrava, Jhon Frazer, Greg Lynn, Zaha Hadid, UN Studio, NOX, Asymptote the source of forms is the living organisms. The outcome is evidently very successful, but even more is possible, looking at nature as a role model. On the other hand, biomorphism as the sole objective can lead to projects which take the sole form as the only reference (Gruber, 2008). In some cases mimicking the form of organisms in architecture leads to funny designs of shapes, such a duck, an elephant, a banana, a pineapple, a human being, etc.

In the process of creation of architectural design and shape it is needed to comment how to use the nature in the formgiving process in architectural design. Associating the dynamic and complex structure of nature/life with the dynamic structure of the present day world; and forming a new architectural language will be the most effective way to make right decisions.

## 2. BIOLOGICAL WORLD AND BIOMORPHISM

Architecture has always been in an interaction with the biological world and it has established metaphoric relations with these organisms. Therefore the first architectural examples are mostly direct copies of natural forms. This conception called as biomimesis (bios: life, mimesis: imitate) which is used in today's architectural shape design is mostly a kind of imitation of natural forms, sometimes existing in exaggerated and funny images.



Figure 1. The Big Duck Figure 2. The Elephant Building Figure 3. The Big Pineapple

Nature creates a rich inspiration source in many disciplines and in architecture, too. The organisms in nature with their unique characteristics are giving the researchers special ideas in problem solving and designing. The biological world is living its dynamisms in complex structures by getting new balances every time. Designers' causeless imitations are hindering the success of making right decisions. Nowadays, biomimesis is being discussed in most parts of literature. In the book "Biomimicry: Innovation Inspired by Nature", Janine Benyus (Benyus, 1997) tells about the experiences which human being had gained by observing the natural world as a model. Now it is time to learn from the experienced events as a criterion for analogies and as a mentor giving ideas.

The architects' interest in natural-living processes and dynamic systems and their related concepts keeping the characteristics as the variability, changeability, complexity, non-linearity etc. is the integration model of the architectural designing style depending on form and space as leading arguments. Scientific inventions and also architectural point of view have changed the meaning of the architectural space concept and architectural shape. Now the architectural space is determined with the characterizing dimensions as variability, changeability and flexibility, but not with the fixed static qualities (İnceköse, 2008).

The concept "biomorphism" dealt within this work does not include only the structure of living organisms and their transferring to constructive logic of shells, but also the whole process of architectural space design.

### **3. DYNAMISM OF LIFE PROCESS VERSUS STATIC ASPECT OF THE ARCHITECTURAL OBJECT**

Living organisms are always in a flexibility in their form and positions. Living processes are difficult to interpret because they are non-linear dynamic phenomena. "Everything that is static is condemned to death; nothing that lives can exist without transformation" (Nio, Suybroek, 2009). Nature's complex forms and systems are seen in the evolutionary processes. The biological form of lives includes the birth, the progressing- and the ending phases or getting in new balances.

Looking at biological systems we can notice that complex multi-cellular organisms have physiological systems that enable them to adapt to changes in their internal and external environment. These systems adapt the organism to changes that would otherwise disrupt its efficient functioning. The physiological and other adaptive systems also enable the organism to adapt to internal and external changes that occur as it develops from an egg into a fully-grown organism. Again, in the absence of these adaptive systems, the changes could damage the organism, and disrupt its proper development (Dinur, 2008). For example snakes and some reptiles change their skins in order to give chance to grow their bodies. The scales on their skin don't have the flexible structure for growing up. So at some intervals in its life the snake has to leave its old skin because of the body size, which is growing up. Turtles like reptiles periodically pour out the ceratin plaques and extend these plaques because their tortoisshells are limiting their growing up (Tubitak, 2009). As for example of some living organism the silkworm has different images during its whole lifetime from egg-larva-caterpillar-cocoon to butterfly by metamorphosis. And some insect change their shells during metamorphosis. As in the world of fauna, the plants are following a life cycle from seed to trees. The whole ecological environment gives another examples of metamorphosis. The environmental conditions are intending to get into new balances by ending the living positions because of erosions. Some matters change their states as solid-fluid-gas. Generally the nature is living in a dynamic process by renovating itself for progress.

The question that we can now ask is how can architecture (non-living structures, such as buildings) reflect such complex living processes in a way which is not just based on formal considerations?

Our current view of architecture rests on too little awareness of becoming as the most essential feature of the building process. Current architectural structures represent a planned descriptive organization of selfinterest (architect's will) where forced structures result in a

static form. The outcome (architectural form) is predicted and even if it has the ability to adapt (e.g. removable partitions, self cleaning glass) such adaptation will be limited and stereotyped because it is not an outcome of a generative process (Murrani, 2005).

Outer environment conditions which surrounds the building is not in the static characteristics, there is a consistent change in users' needs in the life process. The shape and structure of the architectural shell, which has the function keeping up of a certain balance in the internal environment, is confronted by the changings of environmental conditions and user needs during the time. The fixed qualities of the building resulting from its material and production will cause some other problems and lead to more energy consumption for providing comfort conditions (Gür and Aygün, 2008). Therefore the adaptability to changes and new conditions should be an important criterion in designing architectural environments defined by the concepts "variability" and "flexibility".

### **3. USE OF THE ARCHITECTURAL SPACE: VARIABILITY-FLEXIBILITY**

#### **3. 1. Variability Of Space**

Variability as an architectural concept, is used frequently today. During the growing and developing of societies, the personal and social needs of comfort bring new architectural regulations for emerging of new environmental issues.

Generally the physical life of buildings is longer than their functional life. When the architectural object's functional life ends its economic life, its continuity has to be provided by distinguishing another function. To ensure compliance with the new functions, the spatial characteristics of the structure must also be taken into account. The wide-spanned constructed interior spaces are suitable for collective uses, where the narrow-spanned ones are for singular uses. By revitalization of an architectural object the decision of choice for the new function is important. In this regard, "variability" means providing continuity of the construction for next uses of different functions by undertaking the least modifications.

Some of wide-spanned constructed buildings in İstanbul, like İstanbul Modern Museum and Rahmi M. Koç Museum are very typical examples of the variation operation. The first one was modified from a cargo warehouse of the seaport to museum building, the other one was used before as an alcohol warehouse of a tobacco factory, till it was modified to a museum building. Now after the restorations both are used for cultural and artistic activities with their interior spaces and yards. To extend and improve the life of existing buildings, beyond the protection of cultural heritage, they exhibit an important economic and environmental approach.

#### **3.2. Flexibility Of Space**

Today's architects, designers and manufacturers are responding to the increased demand for "flexibility" with a wide variety of solutions. Flexible buildings are buildings which are literally designed to change. A flexible building must be able to accept different infills and its users must be able to easily adapting to their surroundings. By using a flexibility strategy based not only on the structural design of a building and its components but also on its installations, it will be possible to make a distinction between permanent and variable aspects, and between a

long life cycle and a short life cycle. Such a strategy will help achieve a better match between supply and demand (Geraedts, 2001). Additionally, flexibility is a highly integrated notion of space, program, and users.

As regards the creation of flexibility within a space, we can say that there are many researches in this field. In its simplest form, changeability in terms of structure is realized via dividers that can be folded or pushed and this is called static flexibility. On the other hand, spaces in continuous flexibility are divided into zones and separated into two one being “server” and the other “served”. Flexibility is provided through portable walls. It is important to achieve dimensional coordination and take decisions related to grids. For, this operation enables different elements to arrange relations with each other and the whole and prevents disorder. (B. Tuncel and Z. Altınok, 2009).



Figure 4. Andrew Maynard's Fluid Habitation (mobile space within the space)



Figure 5. Andrew Maynard's Pre-Fabricated House (modular form)

On the other hand, regarding another type called growth flexibility, emphasis is given on the capacity of adding up new spaces for different functions. Additionally, growth of space on the timescale of minutes and hours can easily be enabled by deployment and movement. Movement capability of kinetic structures, facilitate the adaptability of space. By approaching building design with a new design strategy, such as that motion, space is more flexible with a convertible structure that can respond to the requirements of any human activity (Korkmaz, 2004). Reusing of the architectural space can be realized in two ways. “Variability” makes the functional life of the object as long as its economic life by some remaining physical

transformations on its construction, for other kinds of uses in the next times as long-term modification. Short-term modifications on the architectural space allows different kinds of short-term using which can occur reversibly in a diachronism in time. The “flexible” organization of the space has to be designed with the open-plan applications such as movable equipments. In The Pompidou Center designed by Renzo Piano and Richard Rogers all spaces are planned to be open in order to ensure flexibility most effectively.



Figure 6. The Pompidou Center

The building projected as a school is used by the students and other people in different time periods (Kim, 2008). The building mainly consists of two parts: permanent programs and temporary spaces. The permanent programs are equipped by proper building systems as to perform intended functions. In the temporary space, by changing the relations between the permanent bands the flexibility of this building is achieved.

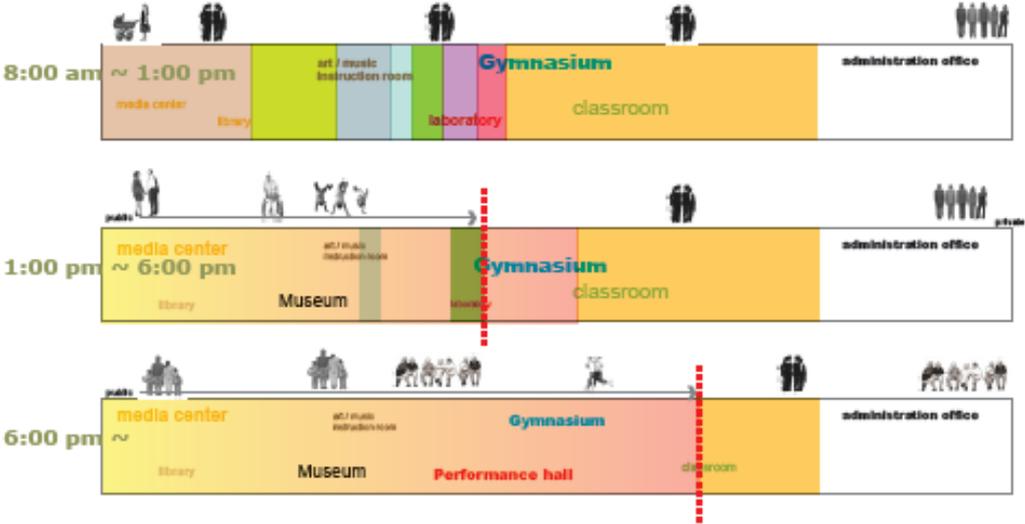


Figure 7. Design strategy for flexible use of the building

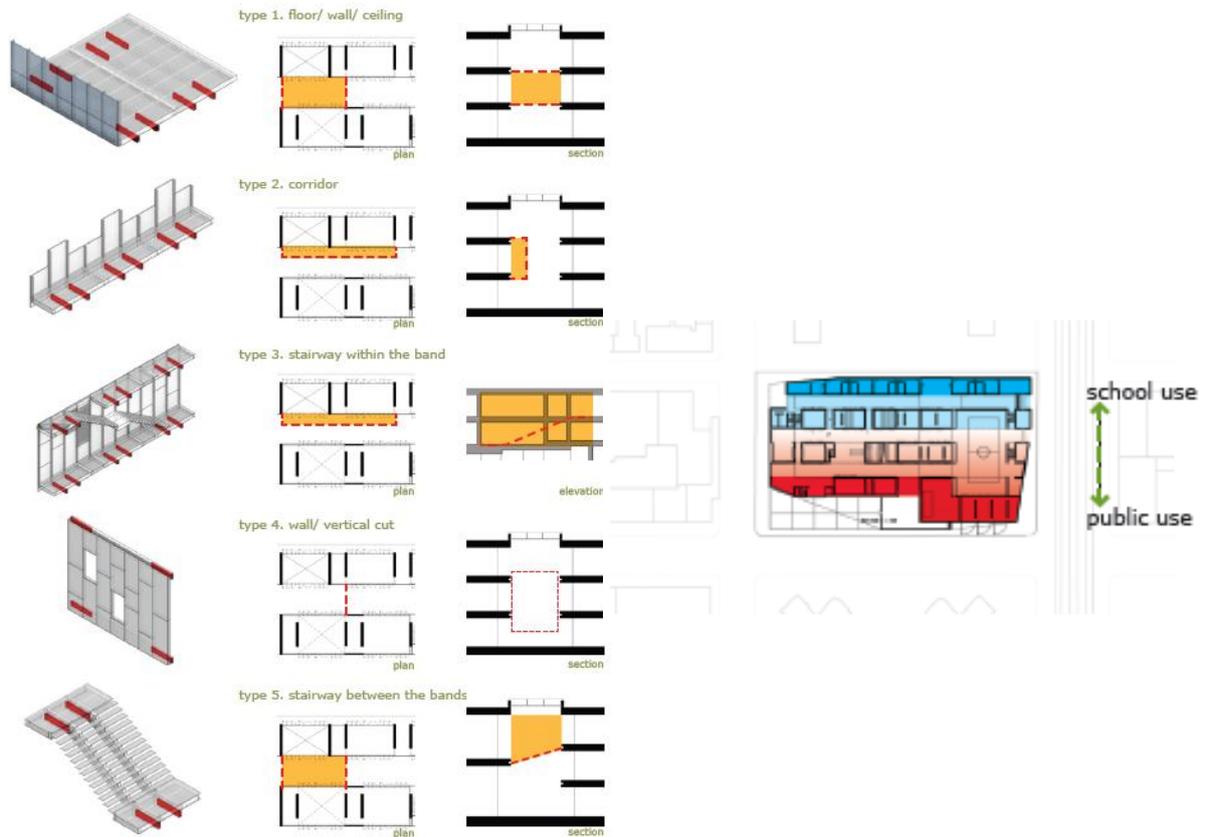


Figure 8. Construction of temporary connection

Diachronic use of space for different functions is the main logic in the traditional Turkish house. The houses were built for extended families. Fathers, mothers, children, sons and daughters in three generations are gathered in the same dwelling. The room is the core unit of the dwelling which is used for the different functions such as living, eating, working, sleeping in the following periods of the day.

#### 4. FLEXIBILITY OF SKIN

The dynamism and searching for new balances in nature should be an evaluation topic for designing of architectural space and its shape. The architectural object which has to give shelter to the human user has the mission of to obtain the comfort conditions by covering the users' needs, while the environmental factors are in a continuous change in its system. For controlling their dynamically running effects on the structure and the shelter, the building's skin needs an automatized balancing system according to happened circumstances, as called "flexibility".

#### 5. NEW SEARCHES IN ARCHITECTURAL DESIGNING

Researching the logic of comprehension and the principles of processes in nature are the main application tools of the design strategy in architectural environment. Advanced technologies and improved elements and components harmonize the relation of interaction between the

natural variants and the fixed space conditions of the architectural object. Also, the building skin can show a dynamic structure with its features that building skin is able to open, close, change its color and mutate, like the living organisms.

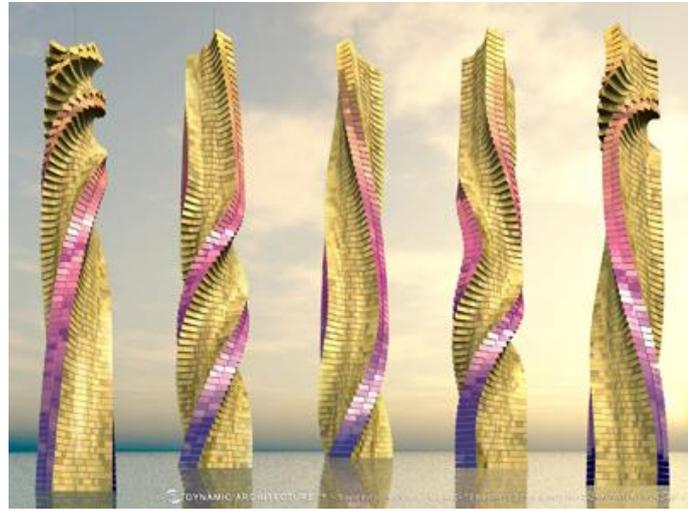


Figure 9. The rotating solar house Heliotrop      Figure 10. David Fisher's Dynamic Tower



Figure 11. Santiago Calatrava's Hemispheric

The integration of the building skin and the building mechanics is of vital importance in the goal to successfully translate and realize innovative facade concepts. The self-regulating, polyvalent skin, in which the many tasks of the building skin are carried out by a thin, multi-layered and multi-functional external skin structure, is one of the visions that points to a possible direction in future developments. The regulation and adaptability of the skin must be achieved with control systems that are intelligently planned and easy to operate (Schittich, 2006). For example, Habitat 2020 (Basantini, 2008) is a future forward example of biomimetic architecture that fuses high-tech ideas with basic cellular functions to create 'living' structures that operate like natural organisms. This nature-inspired approach to city living looks at the urban landscape as a dynamic and ever-evolving ecosystem. Within this cityscape, buildings open, close, breathe and adapt according to their environment. The exterior has been designed as a living skin, rather than a system of inert materials used only for construction and protection. The skin behaves like a membrane which serves as a connection between the exterior and interior of the habitat. Alternatively, the skin may be considered as the leaf surface having several stomata, cellular openings involved in gaseous exchange and transpiration in plants. With these developed systems it is aimed to use up

minimum energy and maximum “adaptability” in the ecological medium which is shared by the man-made objects and the nature, which is called “ecological sustainability”.

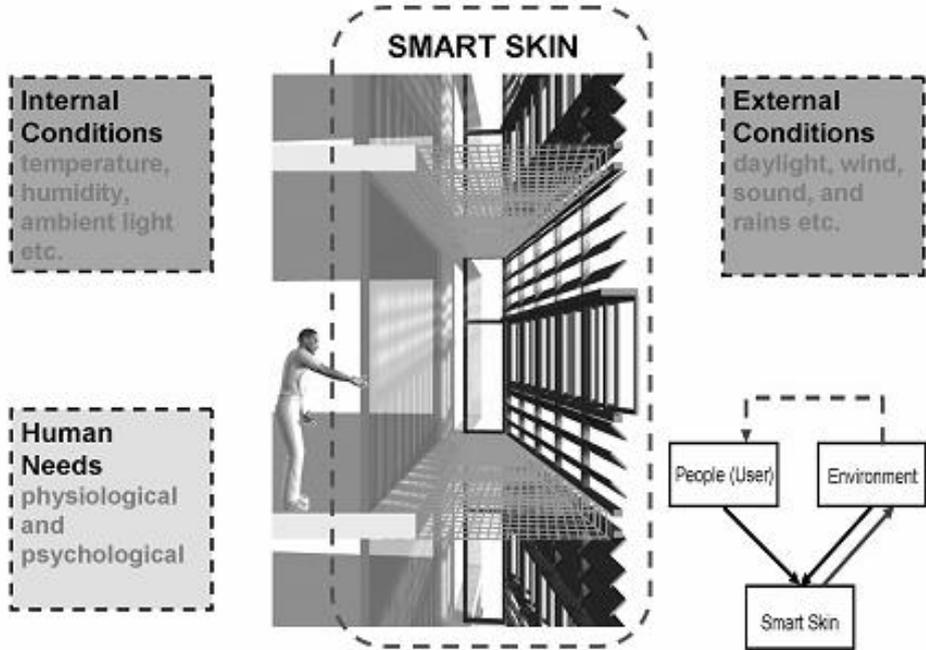


Figure 12. Building skin in respond to external and internal conditions



Figure 13. Habitat 2020: Future smart ‘living’ architecture

## CONCLUSION

Adaptability capacities of the biological world in its dynamic running, is interpreted as a model of “variability” and “flexibility” of the architectural object. This process is depending on the self-organizing of the architectural objects and elements like in the life of the nature. Scenarios edited in programs of smart systems are being conveyed to morphological criteria, which cause the automated function “flexibility” of architectural space and form.

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