BIONICS – BIOLOGICALLY INSPIRED DESIGN OF ENGINEERING

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Abstract*. Bionics is an interdisciplinary field of research and transpositions of models created by nature in innovative human technique and technology. It concerns many fields of activity: architecture, technique, design, etc. Bionics represents the basis for the development of many innovations of various spheres of human performances, as well as in design and engineering, being used in the creation of new forms and texture imitations, in finding chromatic solution or imitation of the properties of living organisms. This application helps humans to create new concepts of industrial design inspiring from nature and to understand the function of certain products to find better solutions of their utilization by consumers. It can have a scientific educational reason, with the emphasis on interdisciplinarity, as well as a special thinking and educational behaviour for students, the nature being an inexhaustible source of ideas applicable in designing modern industrial objects, involving the implementation of ecological thinking with the emphasis on protection biodiversity perceived through bionics as a source of innovation for human civilization.*

Keywords*: biological inspiration, product design, applied bionics, structural bionics, neurobionics, industrial design*

Introduction

In the last decades, the natural sciences, namely biology, physics, chemistry, have known a tremendous development being materialized through the emergence of "frontier" sciences such as: biophysics, biochemistry, bioengineering, bionics, bio electrochemistry, bio cybernetics, Biomathematics etc. One of these sciences is bionics, among the youngest but with a rapid rise in the last two decades. Many inventors or engineers have designed objects or products, techniques and systems after animals, insects and plants throughout the centuries. Copying from nature has distinct advantages in design and engineering. Most living creatures now on the Earth are the product of two billion years of evolution, adapted to all the changes of their habitat. This shows their survival and resistance to all the changes they have been experienced throughout the time. Thus, humans are trying to generate new industrial things which can take properties of nature, making them durable, maximally functional, ergonomic and attractive, as the nature is. The direct imitation of nature is the easiest way to create things, but this is often difficult if not impossible, because of different reasons: size, structure, materials etc. Bionics researchers have found that it is more advantageous to understand the principles of how things work in nature than to copy the details in the way they look natural. So, Bionics is the field where we can find simply solutions to complex problems.

1. Definition of bionics and its object of study

The term of bionics leads to the thought of biology and mechanics or electronics due to its morphological structure: the base word “bio”, coming from Greek, which means “life”, so biological and its suffix “ics” or “nics” from mechanical or technical. Indeed, there is a connection between the two fields, biologically and technically, merging into a new field, in that of borrowing or transferring ideas, concepts, applications from biology in technique or technology. Thus, a definition of bionics could sound like this: bionics is an applied discipline of biology that is inspired by knowledge of the structures, functions and processes of living organisms in order to transpose them into practice as

technical or technological solutions. In other words, bionics or biological inspired engineering is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology [1].

Regarding the etymology of bionics, several terms have been used to name this interdiscipline, some being consecrated, others less. Often used: bionics, biomimetic, these terms describe more clearly the intention of studying alive structures from nature and transposing them in technique solving a variety industrial tasks.

Although the terms bionics and biomimetics are used as synonyms, in English bionics is perceived as referring more to the applied side related to the human body – a combination of biology, electronics and mechanics. The term bionics was finally introduced by the American air major Jack E. Steele in 1960 at the first US Bionics Symposium held at Wright-Patterson Air Force Base in Dayton, Ohio and with this, it definitely removed all the ambiguous terms.

In order to describe widely the object of study of bionics we may refer to its main branches or directions as follows [2]:

General bionics. This branch has obvious connections with biology, biophysics and biochemistry, which has the main task of exploring structures and biological phenomena significant for solving technical problems.

Systematic bionics. It has the purpose to systemize the result of bionic research, preparing the processes and systems for specific applications. This branch represents an "interface" between general and applied bionics.

Applied bionics. It aims to advance proposals, projects, models or prototypes of products or installations for different fields of activity: electronics, informatics and communications, construction and architecture, machine construction, technologies of chemical manufacturing, energy, materials science, etc. Applied bionics is the most mobile branch of bionics, developing extremely quickly, divided in many sub-branches:

Structural (configurational) bionics, which aims to use structures and biological forms in architecture, vehicle construction or fine mechanics (the design and construction of smaller precision machines, often including measuring and control mechanisms). For example, many warehouses were built based on the morphological principle of some diatoms, which economically uses construction materials, offering maximum space. Imitating the skin of dolphin, a cavernous coating (laminflow) was made for ships, which equipped this way, the forward resistance has been reduced by 50%.

Neurobionics, in which the concerns mainly focus on the processes of bio systems which transform directly and with high efficiency the chemical energy into electrical energy, as is the case of electric fish, also into light energy and into mechanic energy [3].

Chemo bionics, which directs its efforts in several directions such as: metal enrichment of some marine plants and animals, hydrometallurgy with the help of microorganisms, genetic manipulations on microorganisms in order to produce effective drugs, hormones, etc. and simulating the osmotic processes of natural desalination (as in the case of seagulls) to obtaining drinking water from seawater or hyper filtration of brackish waters at low costs.

Neurobionics or informational bionics. Due to the evident progress made in neurobiology regarding the clarification of the processes of reception, storage and information processing by bio systems, the weight of research has shifted towards neurobionics. The neuron is researched assiduously from both a structural point of view, especially functional. Although its mode of operation is not completely known, the so-called neuorhistorians began to be glimpsed. Neurohistorians are active circuit elements with performances much higher to those already in use. It is expected that the realization of such devices will lead to the conception of a new generation of computers much more flexible and versatile than the current ones.

2. The applications of bionics in industrial design

Human has long been possessed the intrinsic imitation capability when making objects for use. Some animals, insects or plants with specific appearance and characteristics are the targets for imitation. The most important aspects of nature, which present an interest for industrial designers, are: the forms, colours, structures, functions, textures, sounds of the natural things and others. Therefore, the researched object becomes a source of useful information in the designing process, such as combination of colours, texture, structure etc. The designer uses selectively its features principle and applying all the useful characteristics providing new ideas, principles of function, methods and approaches for design. The bionics makes the designing process much easier, helping designers to better understand how certain details work, which ones we can change in the creation process and which ones not due to their natural properties.

Industrial objects designed after animals or plants are accepted to be more reliable functionally, because their concept of design is already based on some calculations, principles of structure and function, and offers practical use in human's life. For example, the designer who creates a new concept of airplane tends to develop the designing process considering the form of birds or insects. Because bionics increases the interest of product design there are a variety of product forms which eliminates the cold of household products (image no.1) and others, the boring items from our life (image no. 2) making them colourful for example, soft, pleasant to the touch (image no. 3), with rounded and warm shapes (image no. 4), in other words according to the preferences of different types of consumers, even children.

Figure 1. (image nr.1 – electrical kettle) (image. nr.2 – phone case) (image. nr.3 – cup) (image. nr.4 – SCARAB car)

Conclusion

The nature makes every natural existing form clever with unique shape, color, texture, structure and function. In product design, using bionic principle, the research and application of natural biological form are carried out, based on concrete or abstract bionic means, by extracting, simplifying, evolving the form features of researched object. Design inspiration and creative thinking of designer is triggered. Fully exerting, the designers' creative imagination will transform the product form design into a functional product, generating positive emotions and performing simulating natural beauty, so greatly improve the product value.

Bibliography

1. https://en.wikipedia.org/wiki/Bionics
2. GHEORGHE, V., POPESCU, A. I., (1990): Introduction to Bionics, Bucharest, Scientific Publishing House.
3. OPRIȘ, T., (1999): Bionics – Nature Engineering, Miracol Publishing.