

# Bio-Architecture

## Introduction

Every living organism on Earth represents a perfectly functioning system, well adapted to the environment as a result of the millions of years of evolution. The structures of biological systems be they beehives, termite nests, the cell membrane or other organelles-are available to humankind. The unraveling of the microcosmos and macrocosmos must provide new dimensions in architectural models and city planning. We may avail ourselves of nature as both an inspirational model as well as a view of the progress of bio-materials and a means to break away from stagnant patterns and realize the expanded possibilities afforded by technology and bios-centered thinking.

## Bios Patterns and Images in Architecture and Designing

Living things can be considered in architectural terms. Bios can be used in a variety of architectural projects. Of particular importance are the structural patterns found in living organisms. Some of the biological structures of potential use in architecture are:

- the spider's web which represents a very economical, light network construction;
- the beehive, whose honeycomb pattern consisting of hexagon and pentagons has attracted designers, architects and painters;
- the anthill resembling a building in its internal arrangement, complete with underground rooms, with each of the internal compartments performing its own function;
- the silicon body of a sponge whose complicated pattern of rods running crisscross provides for a strong and elegant construction to be used, for example, in designing huge containers for water or oil;
- the cell membrane, a double layer of lipid molecules coating a living cell has already been used in what can be referred to as micro-architecture. Biotechnology is currently dealing with biosensors, the minute measuring devices containing enzymes and biological catalysts of chemical reactions.

Currently, bio-architectural models and patterns are acquiring increasing importance. Thus on a new scientific and cultural level, we are actually returning to the age-old tradition of using the images of animated nature in works of art, buildings, ships, etc. Ancient arts incorporated a lot of anthropomorphic or, depending on the culture, zoomorphic, images. The style of Greek architecture was influenced by the idealized image of the human body. Over the last decades, biological patterns were used in different types of constructions. This trend in architecture was called bionics. Roofs of stores and markets were designed on the model of a plant leaf with its veins.

## Biological Basis of Aesthetics: New Dimensions in Architecture

At present, bio-architecture is ascending to a new level, as it can benefit from recent biological developments. They have provided new insights into the biological basis of perception into the operation of the brain as it processes information from the sense organs. Apparently, the brain has its biologically-based likes and dislikes. This depends on whether a given image conforms to the built-in perceptive patterns of our mind or not. These built-in subconscious images, inborn or developing in early childhood, have been moulded by biological evolution.

Of particular importance are color images. Each color, each color combination carries a specific message for our brain. We subliminally associate the green color with flora. The green range of the light spectrum is optimal for vision and the green color is pleasing to our eyes. We have grown accustomed to this color in the course of evolution. It indisputably exerts a beneficial influence on us. The influence of other colors may be favorable or unfavorable. They can produce unexpected psychological effects. Colors can accelerate or decelerate time. This means that it can cause humans to overestimate (grey) or underestimate (brown) the duration of time intervals. Colors may induce the feelings of warmth (red) or cold (blue). Promoting bio-architecture implicates research and practical application of biologically-based laws of perception.

In this connection, an important task for the architects and designers is to attain compatibility of the patterns they use with biological requirements and psychological needs of the people. Bio-compatible patterns have long been employed in constructing and decorating churches and temples. Moreover, a number of religious symbols conform to the patterns of both the bios structure and human perception.

## Employment of Bio-Materials

Introducing new bio-architectural designs can be accompanied by extensive use of biological materials. New potentialities for bio-architecture have been recently opened up by the development of the following:

- microbial biotechnology. Microorganisms economically produce substantial quantities of valuable substances. Chitin, the substance

combining strength, flexibility, and resilience, can be employed for different purposes ranging from artificial substitutes of body organs to high-quality paper. Until recently, chitin was only produced from crayfish and crabs. Their extensive consumption could pose environmental threats. However, microscopic fungi can efficiently produce chitin in a fermenter. Another valuable substance also usable as construction material is the fungal product pullulan. Such substances derived from biological objects possess an important advantage over conventional synthetic materials as they are biodegradable;

- genetic engineering. By introducing suitable genes into bacteria yeast cells or cultivated plant/animal cells, we can make these cells synthesize substances to be used in bio-architecture. Mollusks contain a valuable construction material with adhesive and anti-oxidant properties. This substance can be used in repairing ships, in surgery and dentistry. However, 1 kg of it is currently obtained from as many as 3,000,000 mollusks. But the gene responsible for the production of this material has already been isolated and is being introduced into a bacterium. It is expected that the microbiological synthesis of this product will be a more efficient and low-cost technological procedure. Producing artificial skin by means of genetic engineering would undoubtedly contribute to designing new models for ships or buildings. Research on this project is currently in progress. Recent application of genetic engineering to plants gives us hope that properties of plants such as flax can be improved.

## Urban Design and Global Planning

The concept of bio-architecture can be also considered from a global perspective. Whole cities and city complexes, as well as regional and ultimately global infrastructure can be designed in conformity to the needs of bios including both bio-environment and human beings. Bio-aesthetics is also prerequisite for developing a new attitude towards landscapes. They include both bios and the non-living objects such as rocks. In order to use the land in cities and in agricultural areas more reasonably, it is necessary to evaluate the potentialities of a given landscape and its characteristic features. "Maintaining the aesthetic appearance of the landscapes also helps to maintain a healthy and functional environment." If the decision has been made to establish a new town, then its architectural style and spatial pattern should conform to the landscape and to particular type of bios inhabiting it. Cities represent the "most materialized form of society's interaction with the natural environment." Therefore, an environment-friendly urban policy should play a crucial part in preventing environmental deterioration and in maintaining and promoting bios. The structure of living organisms, their constructions and the organization of their communities can provide valuable ideas for creating a biopolis incorporating bios models and balanced city planning projects.

The Ecological Urban Restructuring project, envisaging mitigating or solving the environmental crisis, suggests a number of measures to be taken for achieving heating energy and water economy, garbage recycling and more efficient elimination of auto exhaust gas pollutants. In particular, it proposes to cover unused surfaces in the city courtyards, facades and roofs with vegetation. This would have the following beneficial effects:

- a 10-fold increase of the city green surface;
- dust and pollutant absorption;
- concentration and humidity increase;
- noise absorption;
- partial local self sufficiency-growing herbs, vegetables, lettuce.

Restructuring cities in terms of ecology involves a number of values and concepts such as:

- focus on human personality, promoting both personal individuality and communication;
- active involvement of local communities, democratic participation of all the inhabitants in each group of houses, in each Ecological Neighborhood, in addressing bios-related problems;
- imitation of bios, of the operation of natural ecosystems through production cycles and waste-free networks; applying the chain or tree concepts which envisage overall consideration of the whole turnover of matter in production and consumption;
- choice of city or city district location on the basis of landscape values, for retaining the aesthetically appealing landscapes their natural state. It is desirable to achieve conformity between the locality with its bios, and the city design and architectural style;
- combined arrangement of private apartments and public institutions, so as to attain a creative mix of residential, work and leisure activity on a small scale the Qualified Density concept;
- each city should retain its identity and personality, cultural and historical heritage.

Global consideration of bio-architecture involves forecasting the future pattern of human settlements on Earth. It is inevitable that the rapidly growing human population will make use of every habitable area on the globe. As these concepts become applicable, humanity will finally accept the settlement pattern termed as Ecumenopolis (Ecp), the universal city. We and our descendants will have to choose between several possible variants of the Ecp. Professor Papaioannou has elaborated an optimal strategy for the establishment of the Ecp. In terms of this strategy, Ecp must be supplemented by the universal garden, Ecumenokepos (Eck). Eck is defined as the systematic linking of all the spaces between the built-up areas, spaces used primarily for maintaining and promoting bios. These open spaces should be ordered along a hierarchy, "starting from the smallest individual garden (or even a pot of flowers), finishing with the largest uninhabited areas (wilderness) of the planet". In this way, the Ecumenokepos represents a continuous, coherent global bios sanctuary, whereas the Ecumenopolis proper is arranged in a

discontinuous fashion.

"Nature is the most economical and ecological architect. Its products are harmoniously placed into energetic and material cycles optimally adapted to local conditions. Builders, architects and city planners should learn from "nature's intelligence." Whereas other domains of modern biopolitics primarily aim at achieving functional harmony with the bio-environment, bioarchitecture pursues the goal of establishing structural and visual harmony. This harmony will enhance the importance of the ancient comparison of the whole world with one masterpiece of architecture, with one sanctuary incorporating the human settlements and the Ecumenokepos.

### Objectives:

- to bring out the importance of biological patterns and bio-materials for architecture on different scales and levels of design;
- to consider the biological basis of human perception and behaviour, the ways to satisfy the needs and demands associated with them;
- to present new possibilities and new scopes in restructuring urban and agricultural areas, as well as human settlements in general, in accordance to biopolitical principles.
- to introduce the notion Biopolis as optimal strategy leading to the realization of bio-architectural patterns

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