

PARAMETRIC, GENERATIVE, EVOLUTIONARY, ORGANIC AND BIONIC ARCHITECTURE – A NEW LOOK AT AN OLD PROBLEM

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Abstract

The constant development of all areas of human life forces the continuity of an awareness limited to individual selected issue, but also imposes searches in broader fields of science. The same phenomenon also did not miss the architectural design. Dynamism of changes and participation, among others, mathematics, computer sciences or biology design entered confusion and false perception of the definition of the new methods of design.

The main goal of the article is to organize the principles that govern parametric, generative, evolutionary, bionic or organic design. The basis for distinguishing between these issues is to define the objectives of the initial formation of a solid object. Evolution of changes in modern design techniques is also a great record of the history of human conscious creation of an architectural form

Keywords: parametric; generative; bionic; architecture; design

Concepts unfortunately have this in common that in general use often specify incorrectly some phenomena. Because of the very rapid development of architectural design method in recent years, appellation “parametric architecture” is mistaken with organic architecture, evolutionary architecture is mixed with generative architecture and around this term appears somewhere bionic design.

The introduction of new design techniques in last decades, gave opportunities to design very complex geometry objects, what with precision may be created only in computer version. At some point in architecture seemed that is nothing spectacular to created, architects began to use new techniques which are commonly used in other fields.

The first technique, which has made a quantum step in architectural design, is form parameterization. In contrast to the completely manually method of creation a three-dimensional computer model, in this case the object is created on the basis of equation (parameters) between its elements. Using mathematical method

are described equations between, for example, basic points and the surface based on these points. This method seeks to create a graph hierarchy where the location, shape and size of some objects are dependent on the basic elements. This gives you the opportunity to create a model in which modifications in the geometry of the initial phase of design modify an entire model from beginning to end. Programs which are using to parametric design tools are extremely precise and require very precise construction of the model. This technique allowed for the development of design objects with bspline surface geometry and, unfortunately, are now mainly associated with this shapes. Most of us completely forgot about the possibility of using this technique also in the design of the traditional, rectangular objects. It is worth recalling that one of the most parametric object in the world is a cube. All the quantities occurring in it: the surfaces of the side walls, the length of the diagonal of the side wall, the length of the diagonal of the cube, and the volume depend of from one value: the length of the edge.

A more complex approach to design presents a method of creating generative architecture. In that case, the architect becomes a „architecture programmer“ to limiting use of pencil. Using advanced algorithms, designer describes how to create object that is shape which finally is generated by the computer. Shaping an object form, is done only at that level, which was determined at the beginning by the architecture.

An example of generative design is the structure shown above. With its generating inflicted strength requirements that a structure should have to meet, as well as a similar basic shape is a sphere module. Strength characteristics associated with the determination of the density and the type of filling. This structure once generated does not change.

Development generative design is design of evolutionary, with to the objects created by algorithms added aspect of the possibility change it over time. In other Words: the principles with creating forms rules are modified during over time due to external factors. We are able to predict result of generative algorithms, problem is In the design of evolutionary. We rely on only on interactions made by computer with that case include so many factors. The end result is very difficult to determine before starting the simulation model of evolution.

Both of these methods are based on initial Assumptions, at the expense of created architecture Visual effect. But In most cases, the complicated geometry expression of evolutionary model at the final effect is really amazing.

The structure presented above, although we cannot see it, is in constant motion, looking for the most optimal system of rods, which would meet the given criteria. When we allow this metal structure to “grow”, in the final dimension achieve the effect will not be perfect, but will be close to the ideal system, which, like a living organism in the process of evolution in the most accurate way will suit your requirements.

In some aspect, generative and evolutionary design also uses parameters like a basis for creating objects, but a record form this parameter is different that methods are taken as a separate filed of modern design technology. What connects of the three methods is that fact- they allow to achieve the optimal form of the object, after tested on a short time different shapes and materials. Consequently we are able to satisfactory and quickly adjust our form to conditions with created by us structure should have.

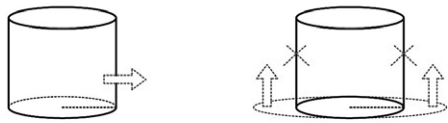
Turning to the bionic way of creation architectural forms we should begin by determining the difference between bionic shapes and organic shapes. To the extent that organic character refers to the appearance and aesthetics of objects and it only seeming to

imitate natural forms, the bionic principles of functioning of organisms and their transfer to human life in the most original, natural version. Entering already in issues of biology architects are trying, in the most accurate way, to map the structures created in nature. This mapping not only applies to the organisms, animal and floral, but also to forms created by plants and animals and their behaviours. To describe mathematically the processes occurring at the level of cell formation, and hence the whole structure in nature is still impossible, but in a more general way this rule uses the form-finding method.

Most of all, this method goes with very reasonable way with material optimization. It is assumed for the creation of structures that are formed using the method of the flow of forces. It is very closely related to the structures existing in nature, which, because of a multimillion evolutions and modification of self- construction are excellent examples of material and construction optimization, which is dictated by the chance of survival and the ease of obtaining nutritional value. This simple rule, of survival at the lowest cost, is increasingly being used in our everyday life. After thousands of years, mankind has reached a point where it is no longer able to create things so original and more useful which can delight us all. It seems that we are becoming more rational come to our existence and we return to the original solution offered us by the nature. On the other hand, only now, at the moment of technological development, we can examine the organisms at the cellular level to detect the basic principle of their operation. Our weakness in this area now includes the inability of mathematical notation of all these processes, which are linked together, and fast processing of data, which in the case of the simulation of natural processes require thousands of iterations per second.

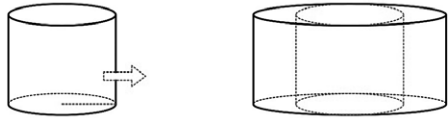
A completely different concept , with respect to methods above , seems to be organic architecture . Organic design only draws inspiration from the natural world and the forms created in accordance with this principle in most cases are very plastic and rounded . Design technique , whose origins date back to the first half of twentieth century, does not specify precisely way how to create forms - it is only the result of the rich imagination of an architect who uses previously observed in nature in shapes which he creates. Incorrect identification of this trend is mainly used for buildings of a smooth line of shapes, which in no way relate to the world of fauna and flora. Also, bionic architecture is incorrectly included to this trend. Organic architecture does not preclude the creation of models inspired by nature with parametric or generative techniques, however, relationships between the parameters of these objects do not overlap with relationships occurring in nature.

CAD WORKING METHOD



each modification results in a manual change basic elements of geometry

PARAMETRIC WORKING METHOD



each modification results in an automatic change of its related components

Fig. 1. Diagram of the difference between designing in CAD and parametric design. Own collection

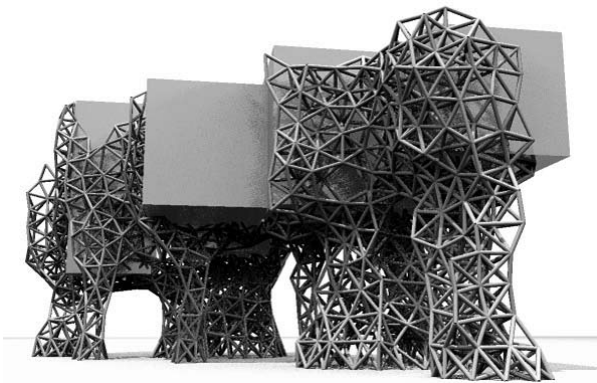


Fig. 3. Illustration of evolutionary metal structure which is changing during the time. *Parametricism*, (2014, January 10). Retrieved from: http://www.parametricdesign.net/wp-content/uploads/2009/06/5boxes_embraced_v2_.jpg

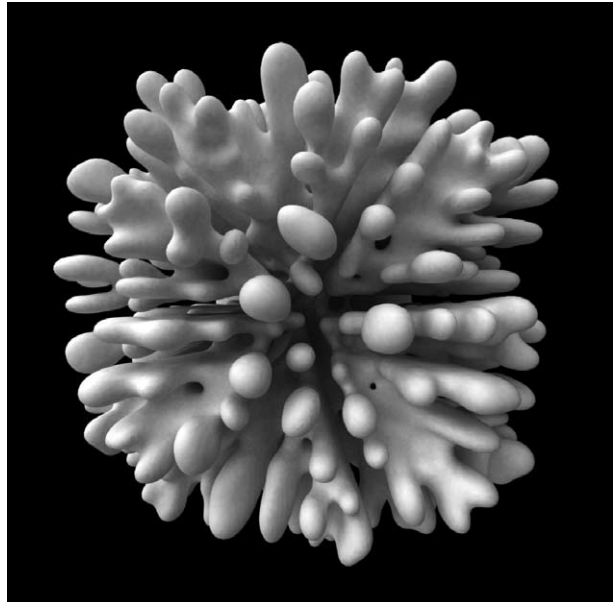


Fig. 2. A simple example of generative structures relating to natural structure;. Nervous System, *Generative Design Work* (2011, October 21). Retrieved from: <http://wewanttolearn.wordpress.com/2011/10/21/processing-toxiclibs-n-e-r-v-o-u-s-and-biothing/>



Fig. 4. The Grand Theatre project, which is the focal point of the Changsha International Culture&Arts Centre, China. ARCH 20, *Changsha Meixihu International Culture&Art Center- Zaha Hadid* (2012, March 07). Retrieved from: <http://www.arch20.com/changsha-meixihu-international-culture-art-centre-zaha-hadid>



Fig. 5. The Beko Building Project in Belgrad, Serbia. Galante Meredith, *Zaha Hadid Reveals Her Zany Plans For A Defunct Factory In Downtown Belgrade* (2012, November 27). Retrieved from: <http://www.businessinsider.com/zaha-hadids-beko-building-in-belgrade-2012-11>



Fig. 6. AA Summer Pavilion was built by students in 2008. *Swoosh Pavilion at the Architectural Association*, (2008, July 14). Retrieved from: <http://www.dezeen.com/2008/07/15/swoosh-pavilion-at-the-architectural-association/>

If you look well, known by all of us Zaha Hadid buildings, in no way contain specific references to nature. Architect's case hand allowed for creation objects that seem to be only a phantom of elements occur in nature. They give us a clear association with the natural world, but are not referring to her perfectly.

Because of the fact that aforementioned techniques are relatively young technologies of architecture design and still being developed, not much projects which use them in 100% we can present. In the architectural objects we can only find single elements, which are created in accordance with these principles. The most common used technology today is a parameterization of the form, which refers to many aspects of creating buildings. It is used, among others, in the optimization of materials, optimizing the shape of the object due to the effect of sunlight or wind, but it is also very helpful in creation of elements with bspline geometry. Due to the complex shapes and forms some of parametric objects required to create an individual construction system of which elements also have a very complex geometry shapes. Construction of these facilities could not exist, at a cheaper version without from panelisation, but primarily without digital fabrication, which allows us in precisely way to produce structural elements.

Projects of parametric pavilions, which are every year built by students of the school of architecture in London, AA, every time use some kind of fabrication system. Very cheaply they can create objects of considerable span with the use of parametric design tools.

In conclusion – not every parametric object is an organic object and not every organic object is para-

metric. Organic architecture is not bionic architecture, and however, can be connected very closely with generative and evolutionary design, in most cases are the result of manual modelling liquid form. However, if in the process of evolutionary algorithms utilize the principles found in nature and accurate way to determine the natural processes, then the most we deal with the use of biometric in architecture.

And that is after several centuries of environmental degradation it becomes a source of inspiration for us to reduce the cost of our existence on Earth. After a time when we were staring blindly at the new technologies, we more often look not only at what we eat and how we take care of the purity of the environment, but also try to find a way of economic survival. The only question is how quickly we can restore the natural processes over which nature has worked for millions of years of evolution since of the earth beginning?

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