

THEORETICAL ASPECTS OF ENGINEERING DESIGN

ТЕОРЕТИЧНИ АСПЕКТИ НА ИНЖЕНЕРНИЯ ДИЗАЙН

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Abstract: *This report describes an attempt to represent some theoretical aspects of Engineering Design based on the viewpoint of General Theory of Systems. Knowledge in Engineering Design is formed as a result of a complex and interdisciplinary training in engineering and artistic disciplines. Theoretical knowledge is equally directed to a wide variety of different scientific and artistic fields. This is necessary to form methods that allows parallel and systematic summary of the required theoretical knowledge. On the other hand, General Theory of Systems is just such an interdisciplinary science that tries to summarize the knowledge in different areas and present them in a form, useful for specific aspects of science and practice. Considered of the General System viewpoint, the theoretical knowledge in Engineering Design would acquire a comprehensive and universal nature, which itself will contribute to improving the quality of students education in the field and to better their professional realization.*

Keywords: ENGINEERING DESIGN, GENERAL THEORY OF SYSTEMS, THEORETICAL ASPECTS, KNOWLEDGE, INTERDISCIPLINARY.

1. Introduction

What is “Design”? In this simple question people can find several different answers. This is because everyone gives individual understanding of the word “Design”. Hence, there are many ideas for theoretical base of design. What is it? Purely artistic or project activities, or any compilation of them, which is leading the artistic and the other is a minor addition, ignorance of which can be excused with excessive artistic attitude of the designer.

Another reason of considerable importance for uncertainty about the Design and understanding of its nature as a profession and in particular the Engineering Design as such is widely disseminated claim that the theoretical basis of the Design is Aesthetic.

If this was enough at the time of formation and establishment of Design as a profession, today is no longer enough. Aesthetics is still and always will be an integral part of Design, but parity with others rather than leading. Therefore, the moment is ripe for finding another theoretical basis for Design that can bring unique concepts and principles to its essence based on his integrative nature. Should seek scientific theory that manages to combine all components of design – technical, artistic, ergonomic, etc. One such theory is formed in the 50^s of the 20th century General Theory of Systems (GTS).

When people, who dealing in the Design, realize the need to rethink their profession and its specificity, will realize the necessity of going beyond the boundaries of their field. Then it will form a new thinking, new insights on Design, unusual for one who is determined style and object at the time of its formation as a profession. [7 <http://www.kaminata.net/post577315.html#p577315>] This realization is possible by using the philosophical categories and philosophy of science, which will bring the theoretical basis of the Engineering Design of a new theoretical level.

Once the Design is complex, interdisciplinary concept, the methodology of this study should be the same range. As mentioned, a good theoretical basis for Engineering Design because of its versatility and wide range may be GTS. According to current understanding, it is placed alongside mathematics and philosophy as a fundamental science, which has application in all aspects of cognition. GTS is inseparably linked with systemic–structural approach to science.

The tendency for understanding of Design as a unity of diversity determines the use of the system approach as a means for realizing the need to overcome the contradictions in the notion of Design.

2. Nature and characteristics of the products of Engineering Design from GTS viewpoint

Design product – material or virtual – is the unity of form–function–material. This is achieved with in–depth knowledge of the three compositing components. Way for its creation is a creative, constantly repeated, open process, beginning with the birth of an idea, concept development, design, build and aesthetic arrangement of the components and elements that make up the product. However, today this is a necessary but not sufficient condition for obtaining a good and useful result. Besides creative, process of creating a product is also engineering, and one does not contradict the other. Long ago, has been developed and studied engineering creative works, but this is not mean a mechanical compilation of the two. On the contrary – there is need of deep and clear understanding of the principles and laws in Fundamental, Engineering and Applied sciences.

In this context, each design product is appropriate to consider as a specific system, i.e. as a unity, consisting of components and elements, which are incorporate in the structures, which are determined by different types of connections and performing within the system defined and strictly deterministic functions.

The categories of wholeness, systems, structures, elements, relations and functions are subject to examination of GTS. [3, 4]

Design products are a separate class of systems. On the one hand, they should be regarded as individually, i.e. product for itself as a complex system, and on the other hand as integral part of the system product–user–environment.

Hence, there is formed a complex problem for the understanding of the products as an indivisible wholeness in itself, and again an indivisible wholeness of the product–user. Each of these relationships has its own characteristics and peculiarities.

Design products independently and in relation with the customer should be treated as complex systems with many hierarchical levels. Therefore, for each product are valid system properties and can be applied systematic criteria, and all transactions inherent in any system.

The creation of each Design product is the result not only from a strictly defined algorithm, but also a reflection of factors, not suitable for rigorous and unambiguous prescription. They are reflection on the one hand to the achievements of science and technology in the advancement of humanity, and on the other hand – of personality, character and level of education and intelligence of that/those who create them, and the degree of spiritual maturity of

their users. It does not pass the economic and social factors, but they are a more general feature that is part of these individual ones.

In addition to meet specific human needs, Design products should reflect the characteristics and interactions between different cultural, aesthetic, ethnic and even religious beliefs and traditions to consumers. It is important to combine knowledge of material and spiritual, expressed with certain parameters and properties, as well as symbols and signs expressing the meaning and message addressed to the user.

The Design product is an intermediary between users and designers, presenting their views on culture and the world. [5] I.e. product of the Design work is simultaneously reflection, result and resource of education of many factors, shown in figure 1.

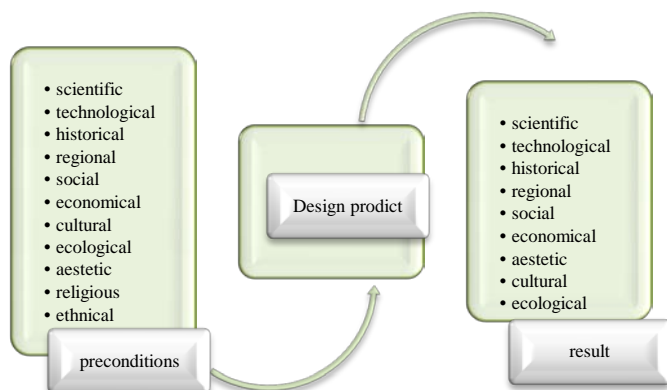


Figure 1 – Design product as precondition and result

Another major precondition for the base of GTS is a unity of Design products such as subject/object–property–relationship. Design products, real or virtual, in themselves represent an object, possessing certain properties and having regard to other objects that can be both products and their users, i.e. products consumers, who in their turn also have some properties (nature, knowledge, values, etc.) and enter into a relationship with their environment. This closed and endless cycle resembles the Paradoxes of Zeno, but as they have their decision, also shown dialectical problem can be solved by GTS.

The other argument for considering Designer products such systems in the GTS viewpoint is that in this theory are many studies conducted regarding the new concepts about the nature of categories such as composition, harmony, symmetry, projection and others, i.e. concepts that appear traditional in art and design.

Basic categories of GTS are: element, system, structure, connections, relationships, etc. The composition is considered as invariant characteristics of a system. By definition, all systems have the structure or composition, not just distinctive aesthetic qualities. This gives reasons to distinguish the composition of the harmony, which usually in the examination of Design products in viewpoint of Aesthetic, taken for the theoretical basis of Design is not done. In GTS viewpoint a composition is characteristic of the wholeness of a system, while the harmony reflects to the “consonance”, i.e. aesthetic aspects of the relationship between the elements that set up a system. In other words, each system has its overall structure, which can be harmonized or not.

Another important property of Design products and basic art category is symmetry, which in GTS is seen as a universal property of the real world. Without denying the fact that symmetry is the basis of aesthetic perceptions of people, in general, it is operated with a limited number, and moreover, simple symmetries. With the GTS are deduced a multitude of complex symmetries, closely associated with Design products.

The result of the work of the designers is a product – material or virtual. This product consists of direct or indirect bound together elements that have some relationship to each other and are combined into integral whole forming composition, which

corresponds to the sixth criteria for systems, describing complex systems with multiple hierarchical levels.

The creation of Design products can not be achieved without passing through a stage of project.

In the field of philosophy of science project is regarded as a step in the process of cognitive transition from material to ideal, and vice versa – figure 2.

This figure shows that the project process in the broadest sense is objectify ideas. [2]

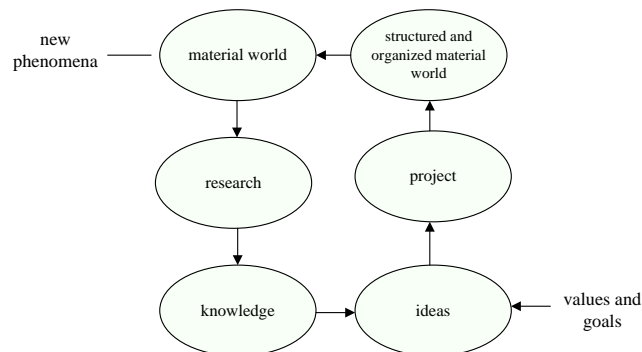


Figure 2 – project form Philosophy of Science viewpoint

A main aspect in the project process is the initial definition of product features and performance of system–functional analysis. This is the system–integrative aspect of Design product in connection with his versatility, which is a subject of study of many different sciences. Systemic–functional analysis is directly related both to the functioning of the system as a correlate wholeness and in its operation or behavior in the environment. In most cases it is necessary to know the structure, the laws of interaction of subsystems and elements, the relationship between the properties of elements and integrated properties or functions of the wholeness, how to act or conduct, interaction with other systems and the system environment. [6]

The creation of the Design products should always begin by defining the function, i.e. identification and definition of the system. The definition must include information for the primary purpose of the product and the conditions under which it will operate. Saying by other words – there is necessity of creation to a multilayered quality “portrait” of the product and then to recreate all its details.

In GTS viewpoint Design product can be regarded as a categorical model built by the unity of many different theories on nature, science and principles. It is result of the development of the absolute idea, system theories, systematically organized categories – art, science, technology, philosophy. Genesis of the idea of the Design product is the result of so–called sensory awareness, based on cultural, historical and ideological forms. Depending on whether it is necessary to creating an entirely new product or improving existing, the project process goes through the process of creation or termination of the object. [7 <http://www.kaminata.net/hegeloviyat-ontologichen-model-t56059.html>]

Designer products today are not only material but also virtual who possess many of the characteristics and properties of material, but have their own, extraneous to the material. Design product has become from a result of the artistic–aesthetic and object–practical area to integrative, complex and multilevel systems, principles and laws which are described by GTS and should be seen through its prism. [2]

Each Design product consists of a number of different parts, which in turn constitute a separate system, constituting a wholeness in itself and in some respect to other autonomous systems and thus gets complicated hierarchical level, which ensures wholeness – the final product.

Presentation of Design products such as object–system and in this connection – manifestation of their complex and multi

hierarchy properties is a prerequisite for referral to the methodological requirements of CTS.

Conclusion:

Each product of the design activity – material or virtual – is the result of knowledge and skills in various fields of science, technology and practice. The end result is a compilation and inseparable unity of scientific, mathematical, physical, technical, artistic, aesthetic and ergonomic features that are connected together by some relations and within the existing laws against those elements, called in common “law of composition”. Suitable theoretical basis for studying and understanding all of them is General Theory of Systems.

Application of GTS as a theoretical basis for Engineering Design will contribute to new understanding of Design as a profession, specifying living standards, making the increasingly higher requirements to extending technologies and sitting is an incentive for new technological elaborations and discoveries.

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