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Research paper

Design Theory in the Research of Complex Cyber-Physical Systems with Organizational Artistic-Aesthetic and Culturological Structures in the Development of Post-Nonclassical Methodology Based on Nbic-Convergences

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Abstract

In the theory of design, the processes (methodology) are explored of constructing complex cyber-physical systems with organizational artistic and aesthetic structures that arise in the course of civilizational crises in the context of a universal history in the evolution of its culture based on NBIC-convergences.

Keywords: *NBIC - convergence, design, VCIDS, cognitive and bio-technologies, concept.*

1. Introduction

Having crossed the threshold of the new millennium, thanks to scientific and technical progress, mankind is in a state of radical qualitative changes in the field of technology, materials, communications, culture and information, preparing the change of his worldview.

Information has become a global and, in principle, inexhaustible intellectual and material resource of the society entering a new era of civilization development - the era of intensive development of the universal information field and heuristic possibilities of the system management phenomenon. The decisions that determine the future depend on an adequate interpretation of scientific discoveries. Science is not a set of immutable truths, but a scientific method, as only one way of knowing nature. Science is the sphere of human activity, the function of which is the development and systematization of knowledge about being, reality and reality. “The notion of "science" includes both activities for obtaining new knowledge, and the result of this activity in the form of a sum obtained by now scientific knowledge, which together form a scientific picture of the world. The immediate goals of science are the description, explanation and prediction of the processes of events and scene of reality.

As an inalienable independent part of the practical way of mastering the world, science as a source and generator of knowledge is a very specific form of activity that differs substantially from people's activity in the sphere of material production and from other types of spiritual activity in which the result is in principle known in advance and given, as some goal, before the start activity. Scientific activity is legitimately called so, therefore it gives an increment and accumulation of new knowledge, and that is, its result is fundamentally probabilistic and unconventional. That is why science acts as a complex cyber-physical system that constantly organizes, develops and stimulates other activities." From an aesthetic (artistic) way of mastering reality, the carrier of which is art, science is distinguished by the desire to depersonalize the most generalized, universal objective knowledge, while in art and design the results of cognitive, information, artistic cognition are inseparable from an individually unique personality element. Often, art is characterized as "system thinking in images," and science as "systemic thinking in concepts," with the goal of emphasizing that the former develops primarily a sensually-imaginative side of man's creative ability, and science is primarily an intellectual-conceptual one. However, these differences do not mean an impenetrable border between science, art and design, which unite creatively cognitive attitude to being, reality and reality. On the one hand, in the scientific constructions of the systems under study, an important role is played by the aesthetic, emotional element that creates harmony, which is specially noted in many theories. On the other hand, works of art bear, in addition to aesthetic, and cognitive, information and evolutionary load, in the form of cultural code [1].

The decisions that determine the future depend on the adequate interpretation of scientific discoveries and on their fairly accurate prediction, taking into account the degree of regularity in the historical process. All the existing theories of the universe, abstracted by mankind - these are the basic models of system analysis, whether voluntarily or not involuntarily borrowed from three areas - biology, economics and language analysis.

The peculiarity of the current historical moment is that in the XXI century humanity expects the greatest changes for the shortest period of time in comparison with the past.

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The growth of the number of global civilizational risks, conflicts and crises in the context of universal history inevitably affects the evolution of culture, and therefore, on design.
In this regard, design is one of the binding energy and information directions in the fundamental sciences, where one of the main goals of it is the maximum in all humanity of society and its elites by improving their aesthetic consciousness.
Evolution of consciousness has become an urgent need of the time and requires the constant management of it through planning, forecasting and prediction. In the theory of design, as in every science, there is a predictive block, which is the most emotional and exciting. This creative unit, among other things, carries out the prediction, forecast and vector of the evolution of culture through its internal projection, which as a kind of design, artistic and aesthetic activity connects it with the processes of entropy dynamics in the subject area of design objects represented by visual cognitive information dynamic systems (VCIDS), which, as a phenomenon of NBIC convergences, provide optimal hybridization of their properties and communication of information in the organization and construction of life and activities with false cyber-physical systems.

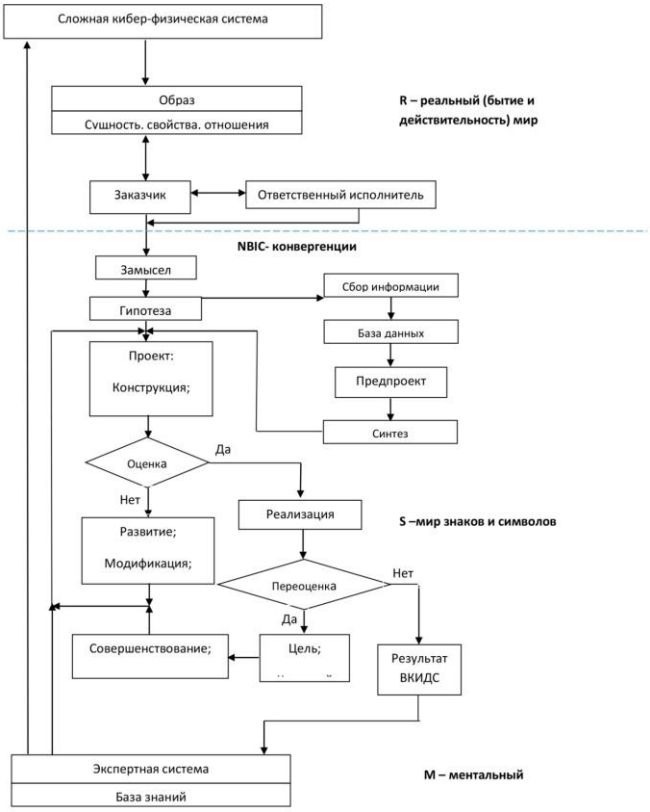


Image 1. The concept of modeling the image of the design object

The VCIDS of the subject area of design, created on the basis of the concept of Pic. 1 [2] and ensuring the existence of the phenomenon of an adaptation maximum in the properties of such elements as: planning, organization, systems with structure, algorithms of succession of actions that somehow provide introduction of:
- Methods of figurative cognitive modeling, forecasting, prediction, optimization, rationalization, upgrade;
- Post-non-classical research methodology;
- Linguistic-combinatorial method of investigation;
- Application in other areas of professional, scientific and creative activity.

2. Cyber-Phusical Systems in Design

Cyber-physical system is an information and technological concept that implies the integration of computing resources into physical and humanitarian processes. In such a system, sensory detectors, equipment, tools, machines and information systems are connected by information-energy relations throughout the whole chain of creating the image of the design object, in accordance with the system approach to solving problems of this kind [3].
At the heart of cyber-physical systems lies a number of key technological trends, including THOM, characteristic of the subject area of design objects. Isolated they are already used in different spheres, but being integrated into a single whole, they change existing relations between scientific disciplines, and they include:
- Large databases, system analysis and synthesis, collection and comprehensive assessment of information from various sources, becomes the standard for decision-making in real time;
- Autonomous robots are industrial works that can already perform rather complicated technological operations;
- Computer vision systems will allow robots to interact with each other and automatically adjust their actions;

3. Nbic-Convergence in Design

The development of Nano-, bio-, info- and cognitive technologies can be the beginning of a new stage in the evolution of man - the stage of directed conscious evolution. This optimal proportion of technologies can create new insights in the theory of design and become the beginning of the next round, the realized spiral of the social relay in the evolution of culture and culturology, as complex cyber-physical systems.
Already this new view of proportions prevails in society. It shows that some proportions are not subject to time, while others, which are especially characteristic of the proportions of economic systems, are mobile and dynamic. They are formed under the influence of various factors. These include the most significant ones, such as changes in the socio-cultural and economic conditions of development, scientific and technological progress, changes in the material and spiritual needs of the population, public views, and so on.
Achieving the necessary proportions, proportionality, correspondence, relationships within the boundaries of the organization of any nature is equivalent to increasing the viability of the system and the effectiveness of its functioning. The discrepancy between parts, elements of the whole is called disproportion. Disproportions reduce the effectiveness of the organization, contribute to its destruction.
The law of proportionality began to manifest itself long before its realization and theoretical justification. In its most explicit form, it is reflected in the plastic arts, especially in architecture, which is called the stone chronicle of history.
If in the architecture and design correctly defined proportions provide harmony, beauty and balance of forms, then in the economy and THOM through the use of the law of proportionality, many problems of production and distribution are solved, while their convergence is determined by the law of the techno-humanitarian balance.
The law of the techno-humanitarian balance optimizes and relaxes the consequences that the gaps between technical and humanitarian culture entailed in different periods of human history during the processes of four types of creativity:
- Intentional cognitive;
- Intentional emotional;
- Spontaneous cognitive;
- Spontaneous emotional [4].
This information is supplemented by an insight into the analysis of metaphor synthesis of scenarios of the foreseeable future theory and practice of design, with a discussion of how the fate of a plan-

etary civilization depends on the characteristics of system thinking and activity, at least two next generations of the society.
In order to investigate these issues in design, it is necessary to involve data from historical psychology, cultural and comparative anthropology, organization theory, cosmology, NBIC - convergence, and generalizing cognitive and emotional models of self-organization, and in each case it is necessary to clearly identify the optimal relationship between the established in practice by facts, theoretical interpretations, hypotheses and design projects.
The cognitive approach asserts that images, thoughts, plans, ideas, etc. exist as a unity and create a cause-effect relationship in behavior, the reality of which is distorted by giving it a new R-S-M format (Pic. 1).
Carrying out purposeful studies of the evolutionary processes of the VCIDS in the design and culture, represented by their essences, properties, relationships and structures in a certain correlation of their elements, the parameters of the methods of exact sciences, futurology, comparative culturology and semiotics, together with the artificial sciences, forms the basis of a unified theory of open, active, dynamic, heterogeneous, developing artificial intellectual systems, in the subject area of design objects and aesthetics.
Therefore, today, scientific research is intended to cover these objects, phenomena and events, in which not only the fundamental laws of nature are embodied, but also human goals with their emotional, sensory perception of the surrounding world. Here it is appropriate to pay attention to one of the modern problems in design, which consists in the need not only to design design objects, but to define and create new diverse philosophical relations between the images of design objects that organize their subject area as a complex cyber-physical scientific picture system of the world [5].
The simple, long-term and gradual emergence of positive features in the synergy of spatial temporal models is replaced by a complex hybrid of engineering and aesthetic creativity of setting unified holistic tasks and their planned solutions in the theory of design in the study of the construction of a complex cyber-physical system of the scientific picture of the world. In this regard, today's research projects and the expected results of long-term scientific strategies adopted due to their social and cultural significance deserve and require careful analysis and synthesis [6].
The VCIDS in the theory of design defines the axiological aspects necessary for scientific research, new energy and information links, creating their new space-time structures, as well as methods for estimating and measuring information, in accordance with the fundamental laws of harmony of nature in preserving and developing humanity, one of the main phenomena of society. The need to consider the images of design objects, how the VCIDS become more and more relevant, relevant and necessary during research. Cognitive distortion of the existing reality in the creation of images of design objects, as one of the technologies of NBIC - convergence - is the essence of the context of the attitude to the methods and methods of obtaining, preserving and multiplying knowledge in the consciousness of society. The meaning of these methods is the analysis, synthesis and management of factors that affect the emotional perception of being, reality and reality. Cognitive methods do not change the information itself, but create the conditions in which it acquires a different quality and turns into a different knowledge, that is, the property of emergence of systems is realized.
Cognitive technologies are methods and algorithms for achieving the goals of subjects, based on databases and knowledge about the processes of cognition, learning, communication, human information processing, neuroscience, self-organization theory, computer information technologies, mathematical modeling of elements of consciousness, topology, design theory and a number of other scientific areas in the natural and humanitarian fields. Cognitive information technologies that describe the basic thinking processes of a person, as well as any forms of human-nature interaction, have a directed vector of the creative construction of the image of the design object in the plot of the artistic composition, either in the statics or the dynamics of events entering complex cyber-physical systems.
They are usually based on fuzzy logic models, neural networks, evolutionary computations, the most promising in describing the morphology of weakly structured VCIDS, which are images and design objects. Assessment and measurement of the processes occurring in them, which are characterized by a large number of aspects, the lack of sufficient quantitative information about their dynamics and statics, as well as unclear boundaries, bifurcational variability of the nature of these processes over time, etc. Cognitive information technologies underlie the creation of VCIDS, the goals of which are to obtain new knowledge, images, and insights in making creative intellectual decisions in the subject area of design objects. The application of the VCIDS can change the very principles of working with artistic, aesthetic and natural-technical information, just as the design of computer science radically changed [7].
Cognitive distortions of the existing reality are all ways of manipulating the creative consciousness, including with the use of new tools that appear with the development of information technologies - artificial intelligence systems, Nano- and Biotechnology [5].
Cognition is one of the important parts of NBIC - convergence and in the theory of design. It represents the following set of methods of research on information processing:
- knowing of natural and human sciences, systems theory, topology and logic, etc .;
- The ability to apply and develop scientific methodologies;
- The ability to effectively optimize objective and subjective cognitive distortions;
- The ability to oppose and polemize in creative discussions;
- The ability to select important information;
- The ability to optimally use all forms of education, including self-education with subsequent transfer and adaptation of acquired knowledge.
The cluster of a single universal language of international communication, language of forms, sounds and colors is created in the subject area of design objects and plastic arts products [5].
Cognitive technologies and simulators are already used in -3D modeling at the design stage of design objects, technological processes of artistic processing of materials. Technologies of large databases allow the use of various simulators in real time (additional reality).
The implementation of new opportunities for civilizational development, emerging as a result of the convergence of these technologies, will lead to radical cultural, social and worldview changes. In particular, this concerns the revision of traditional ideas about such fundamental concepts as life, reason, man, nature, existence. Humanity has to move on to the realization that in the real world there are no clear boundaries between many previously considered dichotomous phenomena and events. In particular, in the light of modern research, the traditional criteria for the distinction between the living and the non-living have lost their meaning; the border between a person as a consciousness-endowed living being and a programmable human-sized technical system is gradually blurred, but the superstructure remains - it is a culture, and between them is a metadisciplinary design.
The result of the mutual integration of information technologies and biotechnologies is computational biology, which includes bioinformatics, system biology, etc., and is aimed at modeling living organisms, from the genetic code to the structure of the organism, its growth and development, up to the evolution of the population. However, the scientific and technological opportunities revealed during the NBIC-convergence will inevitably lead to serious cultural, philosophical and social conflicts, a possible revision of the traditional notions of life, a mind and a man.
The development of artificial intelligence systems (including the solution of the tasks of constructing information and advisory systems in the subject area of design objects, the development of hybrid cognitive structures with extended memory, the tools of cognitive adaptation of evolutionary algorithms, etc.) necessarily

includes interdisciplinary cognitive studies, aimed at understanding the processes of consciousness, memory, learning, experience. It is due to the fact that in the development of intelligent information systems and technologies, in order to increase the effectiveness of decision-making in problem situations, any of these situations is described in the form of cognitive models (cognitive schemes, frames, patterns, strange attractors, archetypes, etc.). As a result, advances in cognitive research are a prerequisite for the development of intelligent information technologies and systems. Not the least in the range of cognitive disciplines is the design philosophy. The philosophical comprehension of those problems that arise in such kind of research, carried out with the application of philosophical and culturological methodology with the involvement of the rich historical experience in the study of cognitive questions, will have a significant heuristic potential and the ability to solve these problems.

Thus, the analysis of the philosophical and cultural problems arising in the framework of interdisciplinary cognitive research in the field of intelligent information systems and technologies is extremely topical. Its successful conduct will not only have a fundamental importance for the modern theory of design, as a science, but also a direct practical value for solving a number of applied problems in the field of the development of VCIDC.

NBIC-convergence is the integration of four fundamental branches of knowledge related to nanotechnology, biotechnology, information and cognitive technology (pic. 2).

The term "NBIC-convergence" was introduced in 2002 by M. Roco and W. Bainbridge, the authors of the most significant work in this area, the report of Converging Technologies for Improving Human Performance, prepared by the World Technology Assessment Center (WTEC).

Thanks to NBIC-convergence, there are prospects for a qualitative growth in the technological capabilities of individual and social development of a person. At the moment, out of the four technological areas, the most developed are the information and communication technologies. Most often, it is these technologies that supply tools for the development of other technologies through the possibilities of computer modeling of various processes [7].

In general, the interaction of NBIC-technologies is multilateral and has a fundamental character.

In the theory of design, individual combinatorial solutions of constituent NBIC-convergences create innovative trends in creating images of design objects.

In this work, the systemic capabilities of co-and bio-components have been studied.

Cognitive information technologies that describe the basic human thought processes, as well as any forms of human-environment interaction, are aimed at constructing images of design objects.

They are usually based on models of fuzzy logic, neural networks, evolutionary computations, are most promising in describing weakly structured systems characterized by a multifaceted process occurring in them, the lack of sufficient quantitative information about their dynamics, as well as the vagueness, variability of the nature of processes over time, which is much characteristic of humanitarian disciplines, that is, it has a direct relationship to the theory of design, etc. [8 - 11].

Currently, cognitive research has been given special attention, the corresponding scientific communities have been established (the Cognitive Science Society, the Hellenic Cognitive Science Society, the Interregional Association of Cognitive Studies, the Center for Cognitive Programs and Technologies of the RGGU, the Scientific School of Professor L. Zhukova). International forums, Olympiads and a conference on the development of cognitive sciences, which certainly belongs to design.

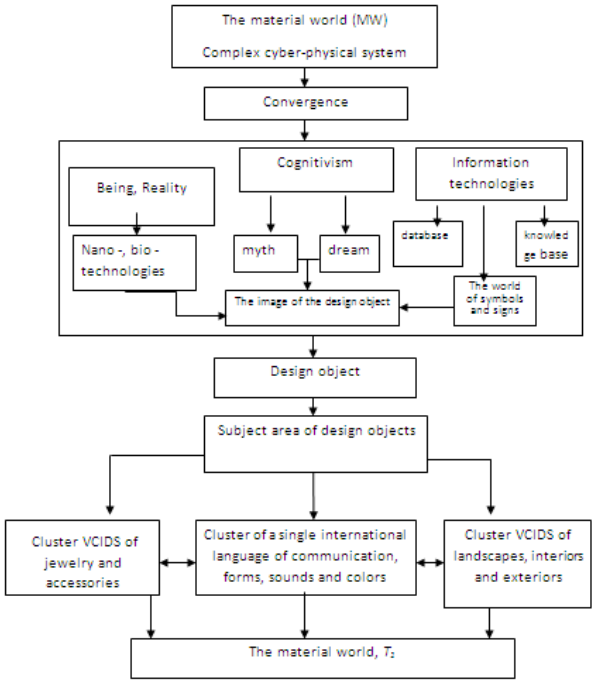


Image 2. NBIC-convergence

Biotechnology in its context at the moment has two directions (one of them in the theory of design) and also gives:

- Tools and theoretical basis for the development of computer technologies;
- Morphology and color for images of design objects.

The result of the mutual integration of information technologies and biotechnologies is computational biology, which includes bioinformatics, system biology, etc., and is aimed at modeling living organisms, from the genetic code to the structure of the organism, its growth and development, up to the evolution of the population. However, the scientific and technological opportunities revealed during the NBIC-convergence will inevitably lead to serious cultural, philosophical and social conflicts, a possible revision of the traditional notions of life, a mind and a man.

In particular, the development of NBIC-technologies threatens to blur the line between living and inert matter [12], between the thinking and rigidly programmed system. It can be assumed that Biosystems are constantly in a state of directed evolution and in the future will correspond to the current needs of the world community.

At the beginning of the 20th century, the concept of the vital world (Lebenwelt) was first formulated in world science. According to this concept of the inner world of a living being, the external world is determined for him. At the same time, the introduction into a certain external environment of habitat causes the formation of features of the inner world. The inner and outer worlds are in a relationship of mutual coherence, forming into the whole world of a living essence.

For individuals of different biological types of systems, their typical life worlds are characteristic. Because of the large differences in space-time scales and the physical forces acting at their level, information-energy links and natural phenomena and events, the life worlds of biological species can practically not overlap, be almost completely isolated or are determined by very long chains of interrelations. But the worlds of individual individuals can differ to a certain extent from each other because of the specific nature of the real external environment and the specifically formed set of internal properties of the individual. With the passage of time, the idea gained new development within the framework of synergetic, in particular, in the concept of tempore and bodily approach in cognitive science [13].

In this situation, it becomes necessary to translate the problem from the language of words and symbols to the language of images and back, which makes it possible to see the problem from different sides in a multidimensional space, to isolate invariants in it and, thus, to seek its solution. This forms integral and unified representations about the object, as complexity, skeleton, construction, symmetry, background and others.

With all his experience, his whole life, a person forms a certain model of the world (virtual world) in which he himself is represented as a complex cyber-physical system with an integral structure that differentiates into separate various nondeterministic subsystems and elements with a functional metaphor, in this case with respect to the morphology of flora and fauna. This model is the central part of the cognitive abstraction of human life and consists of the following blocks: intellect, memory, axiological aspects, value structures, including motives, goals, attitudes, and ideals, norms of censorship, cultural codes and emotional reaction systems for information protection of the individual (barriers and filters).

Personality features are manifested in images, motives, attitudes, purposefulness of behavior, values.

In world science there is no common opinion about what consciousness is. As a result, three structures are distinguished: brain, mind and consciousness.

We can consider a model of higher-level mental processes. Usually, mental processes are characterized by the key words "perception", "attention", "memory", "thinking", "language", "emotions", "movement control", and then the structure of equivalent equations will have the form where A1, ..., A7 - characteristics of perception, attention, memory, thinking, language, emotions, movement control; E1, ..., E7 - change of these characteristics, respectively. Equations determine the interaction between the various components of mental processes within our model. From this model follows the need for a control unit for manipulating arbitrary coefficients, which can be considered an analogue of the higher mental structure - the personality.

4. Conclusion

A change in the socio-cultural context in which the theory of design, as science has acquired new characteristics, is associated with transformations occurring within scientific knowledge. Involvement of new images in the WCDC and the accumulating array of databases and knowledge form a scientific picture in complex cyber-physical systems.

In the development of the functionality of the scientific picture of the world at the present stage of its evolution, it is characterized by a sharp increase in the emergence of system properties, an increase in the relative importance of interdisciplinary research, which is determined by the theory of design [14].

Complex cyber-physical systems cover whole industries and countries with different speed and culture in different directions.

Industries with a wide product line, where technical aesthetics and design necessarily exist, benefit from the flexibility of cyber-physical systems and productivity growth. Obtaining high quality products is possible from the use of large databases and systems approach, continuous improvement of technical and economic indicators and product functionality.

In general, more flexible, quick and effective ways of obtaining high-quality goods at objective prices, leads to an increase in the economy, skilled jobs and ultimately changes the competitiveness of companies and regions.

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