

## Visual Perception of Architecture and Innovative Scientific Trends

Dubinsky Vladimir Petrovich and Jafari Haghghi Saeed  
Beketov Kharkiv National Academy of Municipal Economy,  
Marshala Bazhanova St., 13, Kharkiv, 61000 Kharlar Oblast, Ukarina

---

**Abstract:** The study deals with the problems of human perception of object-spatial environment as well as innovative approaches to the analysis of this process. To identify innovative trends in the analysis of processes of visual perception of the object-spatial environment by a human.

**Key words:** Architecture, perception, information, innovation, environment, human

---

### INTRODUCTION

**Formulation of the problem:** Currently, developers of artificial intelligence pay a lot of attention to the role of emotions in the process of cognition of the outside world and as an incentive for intellectual and objective activity of the individual. And in this context not only Homo sapiens is considered as an individual but also cybernetic systems having a certain freedom of choice. It is believed that the computer system no matter how difficult it is will strive to achieve stasis after performing the program embedded in it. And these are emotions which do not allow living organisms to stop and degrade.

Proportionality between the works of art and peculiarities of human perception, the “nature” of his hearing, sight, etc., is a source of aesthetic pleasure, giving the work of art its value. Aristotle for example in his discourses about painting or poetry, sculpture or music have always been fascinated by clarifying the most “optimal” ratios permissible by the originality of each of the arts which would create the works that would have become “proportional” or “adequate” to human perceptual abilities.

**The extent of studying of the problem:** Works of following personalities induce the interest for present study: (Davydov, 1980); Khaken (Hacken, 1985; Chernavskiy, 1990; Ivanitsky *et al.*, 1994; Borisyuk *et al.*, 2002; Galushkin and Neurocomputers, 2000) and some others. These scientific works reveal the principles and processes of visual perception of the object-spatial environment by a human being as well as innovative approaches to the analysis of this process.

### MATERIALS AND METHODS

There are several methods in the art, the use of which leads to an increase in the degree of self-organization of artistic works to an increase in information density. This is an introduction of attractors and special effects to the structure of the works, the introduction of comic situations (the humor and wit) and the transition from unimodal to multimodal, mixed states. The extent of studying of works of art self-organization assessment problem, its complexity, informational density has just begun and to date there are no universal assessment techniques.

**Informational structure of perception and new research directions:** New direction has appeared in the theory of dynamical systems a dynamic chaos. Now with the help of mathematical models it is possible to investigate the mechanism of unpredictable (random) effects. A special role is played here by the chaos that appears, takes a finite time and then disappears. It is at the stage of chaos (more precisely at the exit from it) when a new valuable information appears. (Chernavskii, 2000; Chernavskiy, 1990). At this stage, there is a moment in which the generation of valuable information is most effective.

The alternation of stages of the order and the chaos is a characteristic feature of all developing systems. This is not surprising as the birth of new information happens in all developing systems. Such alternation of stages corresponds to the well-known triad of Hegel's: “the thesis”, “the antithesis” and “the synthesis”. The same thought for exact sciences (i.e., for the theory of dynamical systems) was formulated not so long ago.

In recent years such discipline as neurophysiology was developing rather successfully. It is an important fact because the process of creation as a special case of thinking process, takes place in the real neural networks of a human. Therefore, exploring the phenomenon of creativity in the framework of the natural sciences, it is necessary to imagine what processes occur in the brain at the biochemical, cellular and neural network levels. Currently, these processes at all levels mentioned are studied quite well (Ivanitsky *et al.*, 1994).

There are new areas in recent decades there appeared new trends: recognition theory (Borisjuk *et al.*, 2002) and neurocomputing. The ultimate goal of these theories is the prediction of the behavior of surrounding objects. Nevertheless, they are very different from the theories in the usual sense of this word. The main difference is that the prognosis is being made not on the basis of axioms and inferences from them but on the basis of precedents. A set of precedents is called "training set". The requirement for proof of loyalty of the prognosis is absent in the theory of recognition. The similarity criteria are used instead. The main task of the theory is the answer to the question what the object looks like. To do this, it is necessary to know the signs of the object and compare them with the signs of objects from the training set. The prognosis is based on the situation: the behavior of the object is similar to the behavior of its prototype in the known cases.

Neuro-computing (Chernavskiy *et al.*, 2016) is new and rapidly developing area of science. This is a technology of creating an information processing systems (e.g., neural networks) that can autonomously generate methods, rules and algorithms in shape of adaptive response to particular conditions of operation environment information. Neuro-computing represents a fundamentally new approach to the information processing system discussed in the framework of this approach. This technology includes parallel, distributed, adaptive information processing systems capable to "learn" processing information, acting in the information environment. Thus, neuro-computing can be seen as a promising alternative to programmable computing, at least in those areas where it is possible to apply.

The new approach does not require ready algorithms and processing rules the system must "know how" to develop the rules and modify them in solving specific information processing tasks. For many problems where such algorithms are not known or are known but requiring significant investment in software development, neuro-computing provides efficient, quick and easily implementing parallel methods. It shall be noted that the

inverse problem to identify the algorithm designed by the system through its analysis is also not without the interest.

Of special note are the works conducted under the direction of Zinchenko, devoted to the research of principles on the use of virtual reality technology in the development of innovative methods for the study of human cognitive processes.

The task to be solved by present project is the study of Cognitive Processes (CP) of a human using Virtual Reality technologies (VR). Development and testing of complex Virtual Environments (VE) as well as the development of techniques for recording the responses of the observer in these environments allow obtaining new data on the fundamental laws of human behavior in the solution of cognitive tasks. For selected areas of research of cognitive processes, a software, modeling complex dynamic virtual environments had been developed and tested. For the first time, there has been carried out a systematic review of studies of CP conducted using VR technologies; main methodological features of the CP research carried out in the VE have been identified; the software that simulates the complex dynamic virtual environments including environments that simulate stressful situations have been developed. There have been researched the abstract 3-dimensional visual illusions of lightness, the methods of evaluation of disorders of the vestibular apparatus by using VR technology and recording eye movements have been developed and besides there have been conducted a study of the processes of spatial visual attention in 3D scenes and so on.

**Neuro-marketing:** The concept of neuro-marketing was first developed by the psychologists of Harvard University (USA) in the 1990's. It is based on the assertion that the main responsibility for human mental activity mainly lies on a subconscious, i.e., uncontrolled area of the brain consciousness. This makes it possible to manipulate a given area in order to "imprint" relevant reactions to the brains of people as deep as possible.

Neuro-marketing is a marketing which uses different effects on the human brain incentives to induce the desired effect. This may be incentives that influence through sight, smell, touch, taste buds, memory, social skills of people, their values, etc. These can be word (sentences) smells, music, substances that can affect the brain in the right direction (such as hormones) touching parts of the body, the human gaze, images, photos, etc., all that is able to connect to human brain on a subconscious level and call "something" that can lead to the expected and desired action.

Neuro-marketing may be associated with methods of attracting attention. If attention is drawn, the person begins to show curiosity. But drawing attention to a single object may divert attention from something else. Curiosity as well as the desire to trust is inherent to the human nature itself. Both these features make a person vulnerable, able to act in a way that is beneficial to someone else but not always to the person itself. And sometimes person doesn't even realize it which means that subconscious level brain is active at the moment.

All new and unexpected is able to draw attention. Therefore, striking headlines in the advertising texts are so effective. And the same can be said about the contrasts. Contrasts (e.g., in advertising texts) are always psychologically attractive. Journalists may say that use different styles in advertising texts is inappropriate but marketers would reply that it is not only possible but necessary because it is one of the ways to achieve contrast.

One of the most famous neuro-marketing technologies was developed in the late 1990's by the Harvard professor Gerald Zaltman and was patented as Zaltman Metaphor Elicitation Method abbreviated to ZMET). This method involves the process of probing the human subconscious with sets of pictures (appropriately chosen). They can cause emotional positive response and help activate hidden images, metaphors, stimulating the purchase.

The field of neuro-marketing conducts studies that may help explaining the behavior of people. Neurologists possess numerous tools such as images of brain which help to understand why people react to one or another phenomenon in certain way. According to this fact, it may be suggested that "magical" ways of influencing human behavior may be found. At least, Paul Zak director of the center for research in neuroeconomic claremont graduate University and a team of Swiss researchers think so.

The shop consult company have carried out the research in accordance with the concept of human perception. Group of scientists (biologists and specialists in shop internal design) have found out that choosing one or another product (service) people mostly rely on what they see and on their emotions. This gave the researchers a reason to conclude that it is necessary to reconsider traditional approaches to customers to take a new look at them and their perception.

When conducting scientific research in the field of neuro-marketing, the monitoring of following human body parameters is widely used: blood pressure, heart rate, skin moisture, the angle of rotation of the pupil of the human eye when making decisions.

## RESULTS AND DISCUSSION

**Results of the study:** It is to be recalled that for many centuries works of art are causing a positive emotional response in people of different ages and social conditions. This is a good evidence in favor of the theory that the basis of common reactions is common biological, physiological, mental structures and processes. In this regard, hypotheses are expressed that aesthetic pleasure is caused by the object that satisfies the needs of a harmonious whole. On the contrary, the violation of these principles causes a negative reaction. In addition to this general condition for the optimum organization of the perception of the object, others more specific conditions may be detected as well. Certain relation of order and disorder, certainty and uncertainty must be maintained in the object so that, it would cause interest. Prolonged exposure to excessive ordering of the environment influences as negatively on the nervous system as the poorly ordered one such impact leads to the desynchronization of the nervous system.

Ladovsky have stated that there is a mediating mechanism between a man and his emotions. However, he saw this mechanism in the universal law of economy of forces. "With regard to savings of the order of sensory, mental energy, he wrote no one says anything about it. I believe that this economy is the basis on which modern architecture is to build its theory. If the architect serves to emotions, he should serve them in a way that these emotions would not be wasted".

Aristotle correctly supposed that unity, harmony and perfection are not only categories for works of art but also are categories of its perception, experienced by a human. A work of art should not only be united and integrated, harmonious and perfect "in itself" but to have all these qualities while being perceived and experienced by public.

"The work of art should be perceived as a holistic, harmonious and perfect object "for others", it should be recognized and acknowledged in this way by its audience".

According to Aristotle, a work of art at the same time is equal and unequal to itself because it appears as though bigger than itself in the sense that it essentially cannot be reduced to the internal structure of its own inherent elements. "It is the structured set of aesthetically significant elements "plus" their perception that is "plus" their interaction with something located "outside" the object itself but is more or less proportional to the object".

It is appropriate to recollect the discourse of Davidov about the autonomy of the classic work of art:

the ratio of the work to itself can be measured by the public: it is possible only through the act of perception. Only by going beyond its own limits and entering the "game" with the perceiving abilities of the public, only including a foreign element (the element of perception "from the outside") inside his ideal sphere can work assert itself as a self-sufficient and "self-finalized" one as an aesthetic Truth, "playing love with itself" (Hegel)".

Obviously, the architecture shows its valuable properties in the same way, only being perceived by a human. An analysis of its structure is possible only taking into account the laws of perception of architectural form. Therefore, one of the most important prerequisites to understanding the processes of formation of a holistic architectural image is the psychology of perception. The author believes that there is a close link between psychology and architectural composition and their correlation has scarcely been studied, it is not formalized and developed.

A complex, multifaceted nature of architectural form requires an analysis of the dialectical relation of all its components. And one of the most important prerequisites to understanding the processes of formation of a holistic architectural image are aspects of the psychology of perception. Disclosure of laws of perception is at the intersection of art and science problems.

#### **Visual perception as an informational process:**

Perception of a form as a special case of epistemological processes is an informational process. Architecture is one of the most informative systems. The strength of the emotional impact of the architectural work is proportional to the number of new, unexpected information contained therein. This means that the more the new architectural art solutions and techniques in the architectural work, the more interesting it is a person, the greater contains the information. In other words, the information contained therein where there is a variety of dissimilarity difference. Moreover, the claimed information is a reflection of diversity. The emergence and accumulation of information requires at least two conditions:

- The condition of choice. For choice to be possible, you must have a set of stable stationary states to which a developing system can move
- The condition of memory. The information resulting from random choice should be stored

Qualitative theory of dynamical systems allows formulating the difference between the concept of selection and choice. If there are several steady states, we are dealing with a choice. If the steady state is the only

one, we can only speak about the selection. Information arises only as a result of memorizing a random choice. The selection results only in implementation of previously saved information and no new information emerges. Therefore, information can only appear in nonlinear systems where there is a point of bifurcation and branching of solutions in which occurs a random choice.

Let us refer to the problem of the use of information in the creative process. The essence of the problem can be understood on the basis of the thermodynamic approach. As is known, the entropy in thermodynamics expresses the degree of uncertainty, the degree of lack of information about the state of the microscopic system. Information, on the contrary, characterizes the extent of our knowledge about the system. Flow of information in the system leads to a reduction of its uncertainty, i.e., reduces its entropy increases orderliness.

In the developing systems of wildlife (both biological and social ones) a flow of information reduces the number of choices, reduces search in process of achievement of the desired stable state in this environment. For example, in biological systems, the flow of information takes place in the process of sexual crossing and it speeds up the rate of biological evolution in comparison with the evolution of inanimate nature, reduces the time needed to the organisms to adapt to changing environmental conditions. It shall be noted that only strictly defined (valuable) information is needed to reduce the choice. Special mechanisms were created by nature to filter such information. Thus, in sexual crossing may take part only partners of the same type, otherwise the reception of information becomes impossible. The problem of the content of information (its quality, meaning and value) is one of the central problems in synergy nowadays and we'll come back to it later.

In artistic creation activity, the share of a random choice of course is very high. The end result of the creative process in art is very much determined by the personality of the researcher, his past experience, his environment, etc. Therefore, to fully understand the work of a writer, composer, artist, you need to know his biography to know the era in which he worked. That is why we are interested in any new facts related to for example, Pushkin's life with the people around him. Thus as a result of art is the emergence of new information and in that it is similar phylogeny.

Any valid final result of the scientific work does not depend on any subjective, individual or random factors. Of course, there is freedom of choice in scientific creativity as well and problems and methods of research can be selected, the very course of the creative process is

largely determined by the individual characteristics of a scientist but the result is always predetermined as it reflects the objective natural processes. Scientist reveals the information contained in nature but does not create new information and in this sense, scientific work is similar to ontogenesis. However, in the process of technical creativity, in the work of designers and developers of new technology comes the creation of new information as any technical structure inevitably contains personal traits of its creator.

In the process of selection the new often emerges as a new combination of the old and memory is needed to keep that old material for further creation of new combinations. DNA molecule is an example of such a structure with the memory of random choices.

The product of architectural activity is also a certain structure in which the space, materials, shapes, etc. are interconnected elements. Information relating to this construction has a certain level of complexity but this complexity is inferior as a rule to the complexity of the scientific information. And the artistic information is much more accessible than scientific information as artistic information is addressed to psychological structures that arose in evolution much earlier than the structures that perform logical operations.

Haken has tried to unite the information with the theory of dynamic systems. Informational message in this context is considered as one of ways to transfer the dynamic system from one attractor to another. The parameter of order plays the role of an informant about the state of a difficult system because thanks to the appearance of this macroscopic variable, there occurs a giant compression of information; there is no need to describe the status of each element of self-organized complex system.

The validity of Hakens statement that the order parameter is the most informative part of a complex self-organizing system can be clearly illustrated by the works of art. In many of these works the order parameters are the most improbable and unexpected events. But such events according to the classical definition of information are the most informative because the probability of their realization is close to zero. It is no coincidence that names and designations of such events are often brought in titles of artistic works.

The first attempt to estimate the amount of information contained in the text (scientific, artistic and business) has been taken by the founder of information theory, Claude Shannon in 1945. Subsequently, effective algorithms have been developed for computers, allowing estimating the density of information of any even small-volume text.

These studies suggest that a scientific text has the lowest density of information and the information density of a literary text (studied fiction and poetry) was higher than both the scientific texts and newspaper reports.

Paul Locher proposed to measure the information richness of paintings using Information Rate Scale (IRS) containing sixteen semantic scales such as "simple complex", "well-known the new", "symmetrical asymmetrical", etc. Studies have shown that the results of evaluation of the rating of information saturation of paintings are practically independent of the expert skills and therefore can be considered objective. Preliminary studies have shown that abstract painting has a slightly higher rating of information saturation than realism. This result may indicate that the appearance of an abstract painting with its inherent unusual, unpredictable and ambiguous interpretation is a particular manifestation of the general principle of the evolution of art which consists in the fact that in the course of this evolution there is a growth of information saturation (information density) of works of art.

## CONCLUSION

The continuum of accumulated ideas and innovations related to the knowledge of the perceptual process allows developing principles of cognition of architectural harmony on a brand new level of knowledge. In our times, it has become possible to isolate the objective component of the complex interplay of millions of nuances and perceptions about the subject of dozens of generations of scientists and artists. This is not Pushkin's verse: "I checked up harmony with algebra". This process is more similar to the process of self-awareness but on deeper, more fundamental levels. It should also be noted in particular that billions of options for creation of beauty make all attempts to automate the creative process meaningless. A striking example is the sudden crisis of parametric and fractal art and architecture. The sharp rise of interest which ended in just as sharp cloying with forms, devoid of deep, multilevel filling with the sense.

Herein lies the significance of emotions not to give the mind and consciousness stop at the certain level of progress of knowledge and perception.

## REFERENCES

- Borisjuk, G.N., R.M. Borisjuk, Y.B. Kazanovich and G.R. Ivanitskii, 2002. Models of neural dynamics in brain information processing the developments of the decade. *Phys. Success*, 45: 1073-1095.

- Chernavskii, D.S., 2000. The origin of life and thinking from the viewpoint of modern physics. *Phys. Success*, 43: 151-183.
- Chernavskiy, D., 1990. Synergy and information. *Znanie*, Saint Petersburg, Russia, Pages: 117.
- Chernavskiy, D., V. Karp, I. Rodshtadt, A. Nikitin and N. Chernavskaya, 2016. Synergetics of thinking: Recognition, autodiagnosis, thinking. Moscow State University, Moscow, Russia. <http://istina.msu.ru/projects/8824217/>.
- Davydov, Y., 1980. The Concept of Work of Art in the Works of Plato and Aristotle: Culture and Art of the Ancient World. M Publishing, Beirut, Lebanon, Pages: 250.
- Hacken, G., 1985. Hierarchies of Instabilities in Self-Organizing Systems and Devices. Synergy, Perth, Australia, Pages: 424.
- Ivanitsky, G., A. Medvinsky and M. Tsyganov, 1994. From the dynamics of population waves formed by living cells to neuroinformatic. *Success Phys. Sci.*, 164: 1041-1072.