METHODOLOGICAL ASPECTS OF MODELING COMPLEX SYSTEMS

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At the end of the 20th and beginning of the 21st centuries, fundamental changes took place in the methodology of science. The complication of the world means that it has become clear that the traditional methodology of science (for example, reductionist methodology) cannot adequately reflect the knowledge of its laws. Therefore, it became necessary to develop alternative methods for studying the phenomenon of complexity.

In these conditions, it is required to find new rational methods of researching reality. It should be noted that in modern epistemology and methodology of science there are attempts to develop such paradigms as complex dissipative systems (I. Prigogine), complex self-organizing systems (G. Haken), “complex-systems thinking”, “science of complexity” (K. Mainzer), “Paradigm of complexity” (E. Moren) [1].

At the same time, in the study of the phenomenon of complexity, “Theory of Complexity”, “Theory of Nonlinear Dynamical Systems”, “Theory of Catastrophes”, “Theory of Bifurcation”, “Theory of Chaos”, “Theory of Fractals”, etc.

The integration of sciences in the cognition of complexity should not be carried out only in the form of expanding links between the sciences, that is, be their mechanical totality. In this case, it will have no methodological significance. The integration process between the sciences should demonstrate the integrity of the structure of science, the emergence property should appear, a new qualitative state of the system should appear.

The advantages of an interdisciplinary approach are that if a separate science (scientific discipline) investigates an object by the method of mono-theoretical thinking, using a unified theoretical scheme, then interdisciplinary science is based on a poly-theoretical, systemic style of thinking, examines the studied subject and phenomenon in a dialogical / polyological way. As a result of the study, it was concluded that the modern picture of the world takes on a very complex form, a very complex methodology is required to display it.

When modeling objects of cognition as a methodological approach, the linear paradigm is based on the classical picture of the world that has dominated science and philosophy since the 18th century, Laplace's determinism. The core of the linear paradigm is Laplace determinism.

In this paradigm, an object is viewed as a strict mechanical structure. According to this, any state of an object can be determined unambiguously.

For example, V.V. Vasilkova argues that classical science is based on the following way of thinking:

- chance is removed from scientific theory, it is considered secondary, has no fundamental significance;
- the properties of the whole are explained by the properties of its parts;
- science is knowledge about stability and balance, disequilibrium and instability are understood as negative and destructive forces;
- the processes occurring in the world are reversible in time, therefore their further fate and future are predictable for a long period of time [2, p. 25-26].

The study made the following conclusions on the methodological standards of the linear modeling paradigm:

- the influence of any process is directly proportional to its result, that is, “the cause is proportional to the effect”;

- the idea of the complete determinism of objects and phenomena of the world (Laplace determinism). According to this, the next state of any system can be uniquely determined, predicted;

- strong factors affecting the system are taken into account, but minor, random factors are removed. The consequences of minor impacts are negligible. The linear modeling paradigm is based on linear thinking.

Non-classical (post-non-classical) science is based on a new way of thinking in the knowledge of the world. According to this:

- the subject of science is not only general, repetitive, but also random, individual and unique processes;

-… matter is not inert, it itself is a source of self-movement and has internal activity;

- in the display of the world, determinism does not deny randomness - they come into mutual agreement and complement each other. If at the point of bifurcation randomness and uncertainty dominate, after choosing the path of development, thanks to the power of determinism, the system will be at the stage of highly stable existence;

- development is multivariate and alternative;

- development occurs through (due to) disorder, therefore, one should not be afraid, and also one should not deny the role of fluctuation, chaos in development, chaos is not only destructive, it is at the same time constructive;

- the development of the world occurs according to the laws of nonlinearity, that is, it does not happen cumulatively in stages, the pace and direction of development are not set unambiguously [3, p.30].

The paradigm of nonlinearity is broader than the paradigm of linearity and is adequate to objective reality.

Consequently, the paradigm of nonlinearity opens up wide opportunities for holistic, systemic, poly-paradigmatic study, knowledge of the object of research.

Based on the above, we can give the following definition of nonlinear modeling:

Non-linear modeling is a type of modeling that takes into account non-linearity, non-determinism, random connections of the system, as well as the multi variance of the evolution of the system, and through this is based on knowledge.

The role of the fractal paradigm in modeling complex systems is great. A fractal is an element of a nonlinear picture of the world, it has great conceptual significance in modern scientific knowledge.

The developer of the theory of fractals is the mathematician, Professor Benoit B. Mandelbrot. However, the historical and theoretical foundations of the fractal approach are associated with the Swedish mathematician Helge von Koch, as well as such scientists as D. Peano, G. Kantor, B. Bolzano, K. Weierstrass, F. Hausdorf, A. Renyi and others. For example, Koch calls a curved line a “monster” because it does not conform to the straight and straight shapes of traditional geometry. Such forms are of a pathological (unnatural) nature. Such forms do not correspond to the objects and methods of Euclidean geometry and are forms of a non-linear world. It is known that classical science does not study nonlinear objects.

Until the 70s of the XX century, the fractal approach from a mathematical point of view was first implemented by the mathematician Benoit Mandelbrot. He changed the concept of a mathematical “monster” to the concept of a fractal. Benoit Mandelbrot gave the following definition to the concept of a fractal: “A fractal is a structure consisting of parts that are in a sense similar to the whole” [4, p. 16]. According to Mandelbrot, the real landscape is not even, that is, in our world there is nothing even and in the shape of a circle, everything has fractal properties. Consequently, the doctrine of fractal shows that measurements of objects and phenomena are not even, uniform, do not correspond to measurements with whole numbers, but have fractional measurements.

The concept of a fractal expresses disorder, a transitional state of evolving objects, an intermediate state means a state between two stable states.

Fractals are always associated with the concept of chaos. First, both of these concepts are mathematical theories, studying the uneven structures of the real world. Secondly, fractals determine the structure of chaos [5]. Thirdly, fractals are a new language that mainly expresses the form of chaos [6, p. 215-242]. Fourth, a fractal allows you to find a pattern in chaos [7]. Consequently, fractals are part of the chaos.

In classical science, the concept of chaos is considered equivalent to disorder and uncertainty. However, in post-non-classical science it is argued that in chaos there is a certain order, and it obeys a certain pattern. But it is difficult to find this pattern. The purpose of the study of chaos and fractal is to find patterns in an unknown and completely chaotic system. Even in chaos, one can find the interconnection of phenomena. This connection is a fractal. In other words, in every disorderly, uneven, there is also a straight line, stability, order.

Fractals also exist in the social sphere. At the same time, we can say that in human being, the manifestation of fractality exists in a spiritual, psychological, moral form. The ancient Indian epic "Ramayana" says: "In every hair of Rama's body there are many worlds similar to ours." This thought demonstrates the fractal properties of the world, that is, the embodiment of the principle “one in all, all in one”.

We can recognize that fractal structures exist in art, literature, music, architecture and visual arts. EV Nikoleva asserts the existence of cultural fractals in the theory of culture.

From the above, we can draw the following conclusion that being is built on the basis of fractality (invariance). This means the manifestation of the fractal pattern of being. The fractal approach is concerned with modeling this pattern.

According to the fractal methodology, the world and a person have fractal properties. This is the repetition of information over and over again at each level of the fractal structure, which is a certain pattern.

As a result, we can conclude that the fractal paradigm is one of the heuristic productive models in the cognition of complexity. That fractal is a definite model of cognition of complexity.

Bibliographic list

1. See: K. Mainzer, Complexity and Self-Organization // Synergetic Paradigm. - M .: Progress-Tradition, 2000; Mainzer K. Complex thinking: Matter, mind, humanity. New synthesis. - Moscow: Book House "LIBROKOM", 2009; Morin E. Method. Nature of Nature. - Moscow: Progress-Tradition, 2005.
2. Vasilkova V.V. Order and chaos in the development of social systems: (Synergetics and the theory of social self-organization). Series: "The World of Culture, History and Philosophy" - St. Petersburg: Publishing House "Lan", 1999. - pp. 25-26.
3. Vasilkova V.V. Order and chaos in the development of social systems: (Synergetics and the theory of social self-organization). Series: "The World of Culture, History and Philosophy" - St. Petersburg: Publishing House "Lan", 1999. - P. 30.
4. Mandelbrot B. Fractal geometry of nature. - Moscow, 2002. –P.16.
5. Khitsenko V.E. Chaotic regime as the formation of behavior of a self-organizing system // Paryadok and chaos in the development of social systems. - Tomsk, 1998.
6. Sterwart I. Daos God play Dice? The mathematics of Chaos. Basil. Blackwell Inc., Reprint 1990, pp. 215-242.
7. Zhukov D.S., Lyamin S.K. Living models of the outgoing world : fractal geometry of history. Monograph. - Tambov: TSU im. G.I. Derzhavin, 2007.