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Synergetics: The Path from General Systems Theory to Self-Organization

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Annotation. This article provides a historical overview of the evolution of synergetics as a scientific idea, with an emphasis on its development as a modern general methodology. The author notes that synergetics is the successor to methodological traditions formed within the framework of works on cybernetics and the systems approach. The article indicates that the main foundations of modern synergetics were laid in the general theory of systems and cybernetics. In addition, the basic principles of systems theory are discussed, based on analogies with living organisms, which played an important role in the development of synergetics.

Keywords: historical retrospective, synergetics, methodology, general systems theory, cybernetics, self-organization, modeling, system analysis.

I.Introduction

The purpose of this article will be part of a historical retrospective of the synergetic idea. The object of our research is a relatively closer and more specific stage of the scientific development of synergetics, associated with its approval as a new modern general methodology, the formation of its conceptual apparatus, the formation of the subject and object of research.

It is advisable to look for the origins of modern synergetics, first of all, in the general theory of systems and cybernetics. The common initial basis for all scientific directions that make it possible to establish certain connections is the focus on the methodology for organizing connections and relationships between an object and elements of a system. This simultaneously ensured broad interdisciplinary methodological relevance of cybernetics and systems theory. In this sense, synergetics (the concept of self-organization) can be considered as a successor to methodological traditions formed within the framework of cybernetic and systems scientific efforts.

II. Literature Review

The origins of modern systems theory and systems thinking are traditionally associated with biology and the work of von Bertalanffy, who created the theory of open biological systems in the 60s of the 20th century. Having begun the search for a methodology for studying biological objects, Bertalanffy developed a program for general systems theory. His task was to identify general principles of behavior of structural objects, regardless of their specificity, primary nature and specific forms of relationships between elements. This program was based on the hypothesis of the

existence of a certain systemic dynamic isomorphism. The main emphasis was on the organic nature of systemic order, which contrasted with classical mechanical systems.

Aspects of synergetics with the general theory of systems are both a motive for understanding some universal principles of existence, and the choice as an object of study of open systems that exchange matter, energy and information with the environment. Both Systems Theory and synergetics focus their attention on processes of counteracting the growth of entropy, on negentropic trajectories of system development. But if for the theory of systems genetically related to biology, it makes sense to focus on stable, homeostatic states of system development, on the ability to maintain such conditions, then synergetics expands its subject field, focusing on unstable, unbalanced states. It was here that the influence of spontaneous self-organization was revealed, which became the main subject of synergetics. This required new concepts and new models for describing the functioning of the system. However, the path of research paved by systems theory has been so profound that a number of researchers believe that synergetics can be included in systems analysis [2].

Considering the social and humanitarian orientation of the research, it should be noted that the systematic methodology is very effective simultaneously for the development of various interdisciplinary areas, in particular the humanities. Among the researchers, noteworthy are the searches for those actively working in this direction: M. Abdullayev, D. Bazarov, G. Gaffarov, Z. Davronov, E. Izzetova, B. Karimov, Z. Muminova, J. Ochilov, B. Rakhmonov, G. Sultanova, B. Turaev, F. Usmanov, N. Shermuhammedova, M. Ergasheva, Sh. Kushakov. Most of the above authors explored ideas closely related to modern synergetics in the field of social sciences and humanities. Also, many of our philosophers, who deeply developed the dialectical principles of scientific knowledge in philosophical terms, turned to the ideas of a systems approach.

Cybernetics in its classical and neoclassical forms (along with general systems theory) can be considered a general methodological approach, which brings it closer to research in the field of self-organizing systems. From the point of view of the subject of research, since cybernetics puts the problems of managing a system object in the first place, it would be more correct to compare the synergetic and cybernetic approaches in this context, that is, from the point of view of the management problem.

Control was one of the central concepts of classical cybernetics, and in the early period cybernetics focused its attention on technical (mechanical) systems. Cybernetic systems are systems that are considered from the point of view of purposeful activity, a controlling influence that can lead to an external goal.

The main concepts that serve as theoretical models of such systems are the concepts of “feedback” and “input-output”, while the state of the system is always considered as the result of some influence. Cybernetic thinking is based on linear mechanical thinking, and this is a serious discrepancy between cybernetic and synergetic approaches. Classical cybernetics can be considered one of the

foundations of scientific thinking, aimed at the subject-object relationship of man with the Universe, at the conquest of nature. And this is an inevitable result of scientific and technological progress. Such an asymmetry in the relationship between the Universe and man seems not so strict in a systems approach and is completely unacceptable from the point of view of a synergetic worldview.

The term "self-organization" originally arose within the framework of classical cybernetics and is primarily associated with the research of Ashby [3]. Since this term has led to a significant change in its meaning in the chain of semantic changes that arose in the conceptual framework of synergetics, inconsistencies in its use are still observed.

Since cybernetics, like Systems Theory, focuses on homeostatic, stable states of a system, the concept of self-organizing and self-organizing systems comes from the idea of a system's ability to independently ensure the stability of its homeostatic states. This is a type of self-healing, self-tuning, self-development, with the help of which the system provides itself with a successful and most optimal operating mode.

Self-organization in such systems is ensured by internal control capabilities and is understood as a certain adaptive strategy that makes it possible to move the system away from the destructive growth of entropy without going beyond its existing qualitative accuracy. It is here that the interests of cybernetics and synergetics collide, and "cybernetics works with systems on the border of the entropy paradox" [4], while synergetics explores the systemic order and organizational processes that arise after overcoming this entropy barrier.

In other words, in cybernetic systems self-organization can be described as a state in which the system "everything is self-organizing," whereas in synergetic systems self-organization can be described as a state in which "everything is self-organizing." The mechanisms of such a transformation are as fundamentally different as the answers to the question about its subject. In the first case, this requires a certain control unit (subsystem); in the second, a new order arises spontaneously as a result of spontaneous cooperation of system elements, the emergence of their coordinated interaction and is not directed by any external influences, but is predetermined by the internal properties of the environment.

The views of neoclassical cybernetics, which we find much closer to the synergetic understanding of self-organization, are not found in the works of Wiener. Wiener, in his "cybernetics" and a number of subsequent studies, is interested in processes occurring in living organisms that are nonlinear, from simple linear thinking, on which classical cybernetic research is focused. Wiener even uses the term "synergistic integrity" and represents the result of a nonlinear reaction of biological organisms [5]. Wiener points to the random nature of the formation of areas of self-organization, characterized by a decrease in entropy, and argues that they are not closed objects in relation to the external environment and retain their stability, being quasi-equilibrium.

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Researchers of Wiener's creativity note that his observations reveal the foundations of synergetic imagination. "...It is with Wiener's cybernetics that the formation of neoclassical and post-noclassical models of the Universe and the emergence of a modern general methodology for studying multi-level, hierarchical and self-organizing systems of complex, developing objects in the surrounding world are associated" [6].

However, within the framework of cybernetics, these ideas of Wiener did not receive serious continuation, since the entire strategy of cybernetic methodology is focused on working with teleological systems, and system reactions studied by synergetics can be classified as non-teleological. Thus, the concept of control underlying cybernetics was radically changed within the framework of synergetic systems

III.Methodology & Empirical Analysis

Despite all of the above differences in the field of synergetics and cybernetics, along with systems theory, cybernetics allowed the emergence of research directly related to the concept of synergetics or self-organization, and gave rise to the need for a general approach to the study of processes of change in internal order in complex systems.

It is very difficult to accurately determine the range of works directly related to the history of the formation of synergetic ideas. That's why we'll only focus on looks that can be considered classic. This was noted in the first place by almost all authors of scientific studies related to synergetics. This list includes Prigogine's thermodynamics and unbalanced processes, the theory of dissipative structures, Haken's theory and synergetics, Eigen and hypercycles modeling.

Since the 40s of the 20th century in Belgium, Ilya Prigozhin has been working in the field of chemical thermodynamics of irreversible processes. His research was motivated by the "chemical clock" - a constant, oscillating chemical reaction that occurs in an open chemical environment. Based on these works, Prigogine and his colleagues formulate the concept of dissipative structures: the theory of the emergence of structures in an open environment under conditions of constant dissipation (scattering) of energy into the external environment and replenishment of energy from the external environment. This theory is considered by the authors as an addition to classical thermodynamics; the second law states that the movement of all systems does not change in the direction of increasing entropy and, therefore, destruction of structures. Prigogine considers the emergence of dissipative structures as the movement of a system that occurs under certain conditions in the direction opposite to the direction given by thermodynamics. In 1971, the first fundamental work on the theory of dissipative structures was published [9]. Studying dissipative structures, Prigogine emphasizes the possibility of transforming an unbalanced flow into both spatial and temporal structures.

Around the same time, in the 60-70s of the 20th century, the German physicist G. Haken conducted intensive research in the field of laser physics. Haken and his collaborators discovered that at low current power, the laser behaves like a regular lamp, but at a certain power limit, a new phenomenon occurs: the laser self-organizes.

As a result of these observations, Haken is faced with the problem of the emergence of harmonious behavior of system elements and order parameters in connection with this activity. As a result, he took up a research project called synergetics, in which he planned to study various physical and chemical systems far from equilibrium, as well as the observed processes of spontaneous formation of spatial and temporal structures. Haken believes that this state is similar to the Darwinian principle of survival at the level of any systems in nature and even at the cellular level [9].

IV.Results

In connection with the sources of A.A.'s synergetic conceptualization, special mention should be made of Bogdanov's tektology, which is a deeply developed organizational theory written in the 20-30s of the 20th century. In it, problems of order, organizational structures, principles and mechanisms for their implementation, formation and development are central themes [11]. Especially in the last years of the 20th century, when a "tectological" revival arose in Russia, many authors expressed a tendency to see in Bogdanov's theory of development a "prelude to synergetics." Shalaev comes to the following conclusion on this matter:

1. At the beginning of the 20th century, tectology can be historically recognized as the first most organized form of development of a systemic-synergistic world.

2. Many of its elements (including ideas of organization and self-organization) predetermined the scientific meaning and problem area of systemic synergetic research in the mid-20th century.

3. An important feature of tectology is an attempt to synthesize the practical and theoretical functions of scientific methodology, especially relevant today in connection with the global problems of human existence [12].

In addition to Bogdanov tectology, we can consider that all of the above studies belong to the first stage of developing the concept of self-organization. The second stage in the development of the concept was the awareness of the commonality of research programs that took place in the early 80s of the 20th century.

The impetus for this was, in fact, the establishment of random connections between the founders of the concept. Only purposeful activity. done by von Foerster. Having familiarized themselves in detail with each other's work, Prigogine, Eigen and Haken determined the commonality of the mathematical apparatus that was initially used to model the special problems that interested them. Only after this there was a shift in emphasis on the subject of research as one of the key moments in the history of conception.

The problem of self-organizing order becomes primary from secondary and is

considered as having an interdisciplinary nature not only in physics, chemistry, biology, it can be found everywhere. The main core of the future research program has been formed - the concept of self-organization [8].

The object of research carried out within the framework of this program is various open nonlinear systems of nature that are far from thermodynamic equilibrium. The main subject of the study is the processes of spontaneity of ordered structures, occurring at points of critical value of the parameters of the system, manifested in the sudden (spontaneous) and spontaneous occurrence of interaction between the elements of the system.

An important aspect of these processes is their non-teleological nature, that is, an orderliness that arises in a non-targeted manner. Target systems, which are the object of study of classical cybernetics, can serve as a general background for highlighting the properties of the object on which synergetics is focused. Although, unlike cybernetics, the problem of controlling such systems is not considered here as the main task, the fundamental difference in approaches to the problem of control in target and non-target systems is obvious.

In a cybernetic system, organization (order) arises as a result of targeted management influences from hierarchically higher parts of the system, and the point of application of such influences is the organizational structures themselves or the processes of their emergence. In synergetic systems, such control is absolutely ineffective, since the system has the ability to create its own structure of order, its own. Some analogues of control actions can be observed by influencing the system parameters. This determines which path the process of self-organization will take. If cybernetics bases its management actions on the principle of negative feedback (elimination of deviations from the goal, suppression of fluctuations of deviations), then synergetics connects its ideas about the new order with the effect of positive feedback, a sharp increase in small fluctuations at critical points, transforming them into resonant states according to the entire system.

The next stage in the development of the concept of self-organization is considered by researchers as a consequence of globalization, which occurred at the end of the 70s of the 20th century. I. Prigogine (“from being to being”), Mr. Haken (“the secret of nature’s success”), t. The works of Eigen (“the game of life”) were written, which reflect on the universality of synergetic ideas, as well as the possibility of their effectiveness in economics, ecology, politics and even aesthetics.

The transfer of ideas into these areas is often metaphorical in nature, but characterizes the process of active popularization of the ideas of synergetics. Gradually, the idea of a new scientific view of the world was formed, the foundations of science, its ontological and epistemological foundations as a whole were revised [8].

V. Conclusions

Of course, such an extension could not be unanimously accepted by the scientific community. Many, including Eigen himself, were very cautious about

applying synergetic models and ideas to other areas of science, especially non-scientific ones - politics, culture, ecology. But these processes of synergistic expansion would not be so successful and fast if there was no social need for them. The ideas of the concept of self-organization serve as revolutionary and encouraging against the backdrop of civilization, nuclear confrontation, the ecological problem of domination and subordination, and the related priorities of human rights.

References:

1. Rizaev I. I. The structure of the social system as the basis for the self-organization of society //Scientific and Technical Journal of Namangan Institute of Engineering and Technology. – 2019. – Т. 1. – №. 7. – С. 190-195.
2. Усмонов Ф. Н. Рациональность и традиция в развитии науки //Инновации в технологиях и образовании. – 2016. – С. 349-353.
3. Ergasheva, M. Kh. The synergistic nature of the struggle between good and evil in Zoroastrianism / M. Kh. Ergasheva // Theoretical & Applied Science. – 2015. – No. 9(29). – P. 28-32.
4. Rizaev I. Synergetics in Social Systems and its Possibilities //Global Scientific Review. – 2022. – Т. 10. – С. 62-69.
5. Turaev B. O. Muhammed ibn Musa khorezmiy the owner of non-linear thinking //International Journal of Philosophical Studies and Social Sciences. – 2022. – Т. 2. – №. 4. – С. 47-61.
6. Грачев М. Норберт Винер и его философская концепция // Общественные науки и современность. —1994. — № 6, — С.119.
7. Sultanova G. S. The essence and nature of postnonclassical scientific thinking //Школа Науки. – 2019. – №. 3. – С. 21-22.
8. Mardonov R. The role of social and humanitarian disciplines in the professional development of students //Conferencea. – 2021. – С. 17-21.
9. Prigogine I., Prigozhin I., Glanddorf P. Thermodynamic theory of structure, gravitation and fluctuations. — N.Y., 1971.
10. Хакен Г. Синергетика. Иерархия неустойчивостей в самоорганизующихся системах и устройствах. — Т., 1985.
11. Salievich K. S. Digital Economy: Concepts And Reality //Thematics Journal of Social Sciences. – 2022. – Т. 8. – №. 2.
12. Yuldashevna Y. D. Science and Its Significance in the Process of Forming Spiritual and Moral Values //JournalNX. – 2021. – Т. 7. – №. 04. – С. 248-253.
13. Муминова З. О. Синергетический анализ духовного бытия человека //Credo new. – 2015. – №. 2-2. – С. 8-8.
14. Yuldasheva, S. (2021). Interactive Methods of Teaching Children and Its Theoretical Basis and Personal and Professional Development of a Teacher. https://doi.org/https://doi.org/10.22214/ijraset.2021.38895
15. JAMALOVA N. Pedagogical Conditions for the Development of Individual-Personal Characteristics of Students of a Higher Educational Institution

//PINDUS Journal of Culture, Literature, and ELT (PJCLE). – 2022.
16. ХАККУЛОВ Н. К., РИЗАЕВ И. И. Цифровая культура и неприкосновенность личности //Новые технологии в учебном процессе и производстве. – 2023. – С. 605-606.
17. Ризаев И. И., Хаккулов Н. К. ВЛИЯНИЕ ЦИФРОВОЙ КУЛЬТУРЫ НА НЕПРИКОСНОВЕННОСТЬ ЖИЗНИ ЧЕЛОВЕКА В ОБЩЕСТВЕ //Оргкомитет. – 2023. – С. 342.