

Representation of Social Systems as Nonlinear, Complex, Self-Organizing and Closely Related to Biosystems and Mathematical Model of Their Evolution

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Abstract. On the basis of the systemic and synergistic approaches, the features and regularity of the self-organizing systems, it is concluded that the social systems are nonlinear, open, complex, self-organizing systems. The scheme-model of the general structure of the social system is considered. Much attention is given to the interactions of the social systems elements with the biosystems. The graphic model-tree, reflecting the association between the social systems and the biosystems. In connection with that the most significant technologies and the scientific trends, connecting with the biosystems: the genes, the genetic engineering, the artificial intellect, the bio- and nanotechnologies, the biomedicine, microbes, viruses are considered. The futures of the dynamics of the social systems are noted. It is shown, that, with a high probability, the spiral evolutionary processes can occur in the social systems. The mathematical model is presented, that describes the spiral structures, based on the Swift-Hohenberg equation.

1 Introduction

For the research, modelling, forecasting of the processes, occurring in the social systems, it is necessary to clearly represent, what type of the systems the social systems belong to. The systemic and synergistic approaches make it possible to believe that social systems are nonlinear, open, complex, informational, self-organizing systems and, therefore, they have the same features, regularity and properties of the self-organizing systems [1 – 9]. Based on the currently available information about the social systems, one can classify them as the self-organizing systems. The specific properties of the social systems, taking into account the peculiarities and regularity of the self-organizing systems, can be illustrated by the scheme shown in the Figs.1 and 2.

Naturally, the social systems can not be considered as isolated. In reality, the social systems are part of the more complex self-organizing system. The relations and the interactions with the technosphere, ecological-economic subsystems, the educational and cognitive spheres, the digital sphere and the biosystems are determined by valuable information [9]. In self-organizing systems the coherent processes occur due to the exchange of the information in the form of the signals both between the parts of the subsystems and the structural levels [4]. Information determines the environment, in which the subsystems are located and the joint actions of which support it.

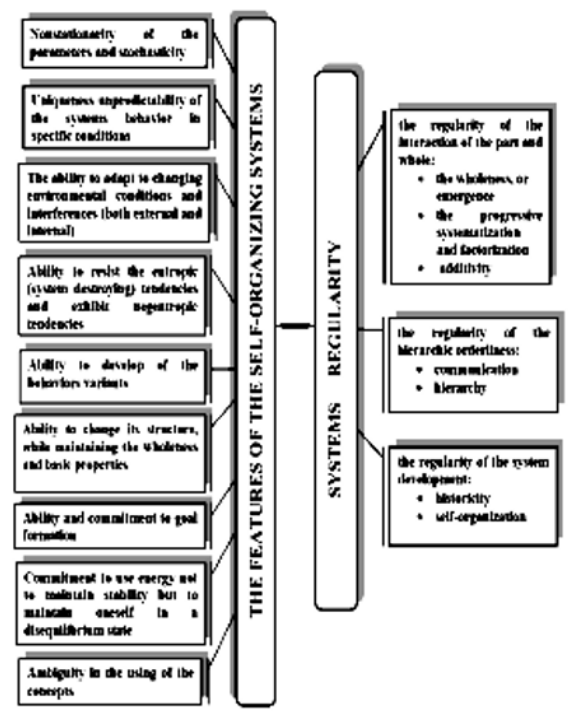


Fig.1. The features and the regularity of the self-organizing systems.

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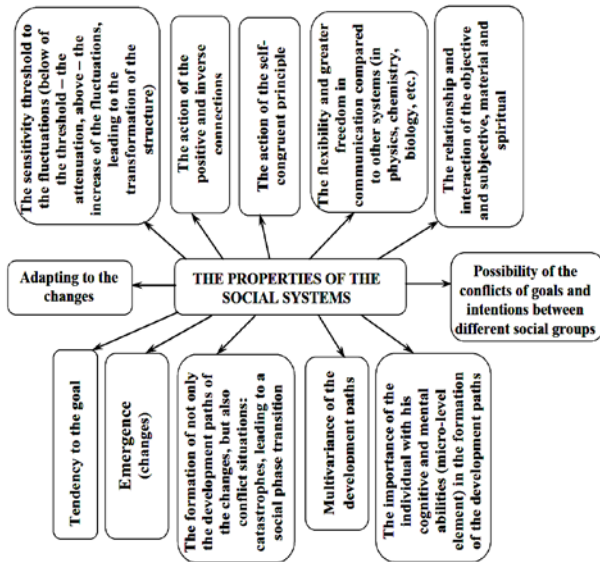


Fig.2. The properties of the social systems.

The information determines the order parameters, that characterize the levels of the system. As a result of the information exchange both the system and the subsystems can pass from one stable state to another, that is, from one attraction to another.

Nonlinearity means the multivariance of the system development paths. The social systems are multi-levels. Macro level, on the one hand, in many situations determines the behaviour and the structure of the parts of the system at other levels (meso, micro, nano), and on the other hand, individuals, groups, subgroups, subsystems can influence on the system as a whole. Thus, the structure of a social system can be represented by the following general the scheme-model:

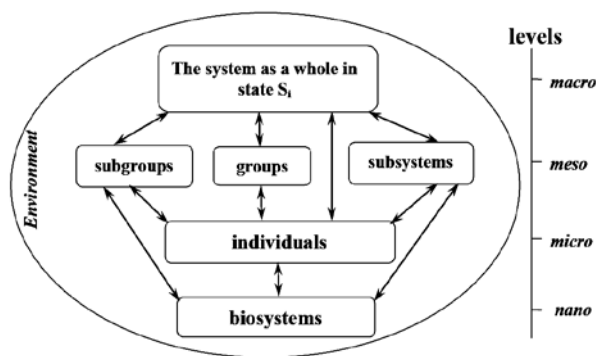


Fig.3. The scheme-model of the social system structure.

In modern conditions, the society has to solve complex problems in connection with the necessary transition to a new level of the development, which is determined by the environment, that is, by all components, the development of new technologies, the managerial problems solving, humanity's entry into the digital sphere, associated with artificial intelligence.

On the one hand, an individual (person) is a single element of the society. That is a microparticle of the complex self-organizing macrosystem. The place of the individual in the surrounding world. In the universe has been discussed for a long time in various directions. The

individual (person) is by nature dualistic: it is necessary to distinguish between biological and social components. In the beginning, the biological evolution of man and the evolution of the social relations proceeded in parallel. The present time is characterized by a slowdown in the biological evolution and an intensification of the evolution of the social relations, the collective intelligence of humanity and an increase in the role of the social valuable information. The rate of the development of modern technologies, the technosphere is a head of the slow development of the individuals, psychics, the social institutions and the technology of the managerial decisions assumption [10]. A person is connected to the society through the culture, economy, ecology, technology and religion. The complication of the technology leads to the complication of the social relations. In such situation in order to conserve a person the society in the process of the self organization must develop new approaches, that allowed a person to orient in the changing reality, which is possible with the help of the science.

2 The graphical model-tree, demonstrating the social significance of the biosystems

Presently, the influence of the biosystems on the social systems and humans is of particular interest. The connection of almost all components of social system with the biosystems is shown in fig.4

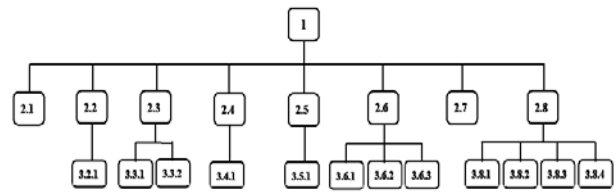


Fig.4. The graphical model-tree illustrating the social significance of the biosystems [5]. Where: 1. Biosystems, 2.1. Artificial intelligence. 2.2. Gen and genetic, engineering. 2.3. Nanobiotechnology. 2.4. Microbes and viruses. 2.5. Individual (person). 2.6. Biomedicine. 2.7. Environment (biosphere): the state of the atmosphere, water basins, soils. 2.8. Biotechnology. 3.2.1. Biological weapons. 3.3.1. Biorobots. 3.3.2. Molecular devices. 3.4.1. Health of the society. 3.5.1. Society. 3.6.1. Public health. 3.6.2. Intellectual biomaterials. 3.6.3. Pharmacology. 3.8.1. Bioelectronics. 3.8.2. Bioindustry of enzymes. 3.8.3. Environmental biotechnologies. 3.8.4. Cell industry.

Microbes and viruses can be concerned to the nanobiosystems, which, as the experience and history of the development human society have shown, affect society (epidemics, new diseases, the fight against which leads to the development of new technologies in medicine). Microbes and viruses are the self-organizing systems, and have the property of the self-defense, manifested in the fact that they mutate under the influence of the man-made preparations to fight them. This is the danger to society on a global scale from the point of view of the nation health. In addition, microbes

and viruses may be used to create bacteriological weapons. Currently, the history of the coronavirus demonstrates, how viruses can affect on politics, the economy, the medicine, the market, culture, education and the social-relations, medicine.

Genetic and the genetic engineering are the scientific direction, appeared at the convergence of the sciences. By now, the nanotechnological results, achieved in these areas the significant and promising results for the future of the humanity: the study of genes and gens modifications, and DNA structure. The manipulation with genes, with their subsequent introduction into the organisms cells make it possible to fight which incurable genetic diseases, to create new generations of drugs, to receive the genetically modified products, widely discussed in the scientific world about, their usefulness and danger. The negative results of the noted above developments are the following: 1) the development of various kinds of biological weapons, which are a threat to all of the humanity; 2) works in some laboratories in the world to create chimeras which are unknown how they will end for society.

The biotechnologies [11] on the one hand, also contribute to the development of the biological weapons types, and, on the other hand, solve the agricultural problems, develop alternative ways of obtaining energy, are used to combat environmental pollution, in the food industry. The cellular engineering, associated with the cultivation the cells and the tissues in vitro, plays an important role in the study of the interactions of cells in the tissues, the mechanisms of the emergence and the medical treatment of the cancers, in the breeding work and the creation of new drugs.

The bioelectronics allows the development of the unique, high-precision, control and measuring methods in scientific research, medicine and industry. Biotechnology, in practice, straightens, the seemingly insurmountable differences between production, person, biomicrocosm and allow considering the following chain: biomicrocosm → person → society → production → nature.

In due time, the computer, information, technological revolutions were widely discussed. The present time is characterized by the convergence of the sciences, technologies, digital revolution, which are actually based on the results of the previous revolutions. The formation of the digital sphere is associated with the developments in the field of the artificial intelligence the results of the brain structure studies, the mechanisms of the brain functioning, the achievements of the neurophysiology, the mechanisms of self-assembly of the molecular structures, information transfer in the biosystems, the automatic assembly of viruses, etc [10, 14].

The digital sphere, digital technologies will open the digital world to the humanity and the individuals, change the relationships between the individuals and society. In this connection, it should be noted, that the digital technologies contain, dangers for humans, since the society development can follow the path of consciousness manipulating. The future will show, how the society, the economy, the politics and individual psychology will be transformed.

The biomedicine is a direction, which is successfully developing in the health care and pharmaceuticals. Mutating microbes and viruses pose ever more complex problems for the biotechnologists. The development of the intelligent biomaterials is of great interest in the biomedicine. Such materials are of the natural origin (for example, collagen, keratin) and are used to obtain implantable products, that take into account individual characteristics and are used in the surgery. With the help of such biomaterials, important problems of the interactions of cells with the surfaces of implants and the biological environment are solved, ensuring compatibility with bone, blood, and antibacterial properties. By this means the intellectual materials help to improve the health of both the individual and society as a whole [12].

In the field of the nanotechnology, in increasing frequency more attention is given to the structures and the properties of the biosystem (molecular complexes, enzymes, DNA and RNA molecules and the like), as a result, the direction of bionanotechnology was formed [12 – 15]. So, for example, the natural biosystems copies are reproduced in the form of the combinations of the sensors, detectors, indicators, actuators; the rotaxane molecules are used to create molecular memory. For creating the nanodevices, molecular structural blocks have been developed: bisaminoacids, from which bispeptides of a given shape can be constructed. It is planned to create the nanodevices, capable of the assembling, according to a given program, nanomachines similar to the ribosomes, capable of synthesizing protein molecules from amino acids. The combination of the bionanotechnology and artificial intelligence is used to create of biorobots, that have already been found the application in the socially useful activities.

3 Some development in research on social systems and the possible mathematical model of their evolution

Under the internal or the external influences, the relations between the elements of the social systems can change while maintaining their main qualities. Under the influence of small fluctuations, the social system will adapt to such changes and maintain the structure as a whole. If structural changes exceed a certain threshold of "the sensitivity", the social system can go into a chaotic unstable state, when new internal relationships between elements are formed and the control parameters change. The dynamic social systems in their development pass through the bifurcations points, at which the changes in the stability and the transitions to the new equilibrium states take place. If after passing the bifurcation point there is one variant of a stable state, then the evolution of the social system is predictable, but if a multivariate situation develops, then the evolution uncertainty appears.

In practice, in the dynamics of the multilevel nonlinear social systems, auto-oscillations can form. Irreversible processes can be superimposed on the cyclic

processes, and the spiral evolutionary processes are likely to arise [8]. The interaction between the elements of the social systems and their interactions with the systems as a whole is carried out through the information exchange. In the social systems, the conditional and unconditional informations are generated. Valuable information is of great importance for the evolutionary processes [9].

According to H. Haken [16], the public opinion plays the role of the order parameter – the governing parameter which subjugates, the individuals, spreads throughout the system, determining the interaction between the ordered structure and the individual elements of the system. Based on the above – mentioned it is possible to propose for discussion the mathematical model describing the spiral structures based on the Swift–Hohenberg equation:

$$\frac{\partial u}{\partial t} = -(\Delta + k^2)u + f(u), \quad f(u) = \beta u + \varepsilon u^2 - u^3 \quad (1),$$

In the general case, this equation describes the behavior of the system near the bifurcation points, the phase transitions, where β – is a parameter, that determines the proximity of the system to the instability threshold, $\varepsilon < 1$ is a parameter, depending on the environment properties. A special case of the equation (1) in polar coordinates for a homogeneous solution $u = 0$ leads for the vector $r = r(\varphi)$ to the equation of a logarithmic spiral, reflecting the evolution of the social system:

$$r = r_0 \exp(\varphi \cdot \text{tg } \theta) \quad (2),$$

where θ – the angle between the radius-vector of a point on the curve and the tangent to the curve at this point.

4 Conclusion

The systemic, synergetic and informational approaches used in this paper allow drawing the following conclusions:

(1) the social systems are complex, open, multilevel, nonlinear, self-organizing systems that are in an equilibrium stable state with the coherent interactions of all their parts due to the exchanges of the information signals flows;

(2) for the self-organization processes the conditional, unconditional and valuable information play both functional and controlling roles.

The transitions of the social systems from one state to another can occur under the external and internal influences such as oscillations, which can be of two types:

(1) small oscillations that change the structures and the behaviour of the subsystems but preserve the system as a whole;

(2) oscillations exceeding the system sensitivity threshold and causing the destruction of the structure of the system as a whole. In this connection the dynamic of the social system development can be represented as follows: with small fluctuations the system is capable of

the self-healing, and when the system structure is destroyed, a chaotic state is formed, in which it gets to the bifurcation point and randomly chooses a further development path (without external interferences).

In this manner, the prediction of the social system behaviour is difficult, and when modeling the self-organizing, complex social systems, the following factors should be taken into account: (1) all processes occurring in the social systems are self-consistent probabilistic; (2) when modeling such social systems, it is practical to use a probabilistic approach (for example, the mathematical formalism of Markov random processes), modern theories of oscillations and waves, game theory, theory of the decision making [5, 17 – 20].

When studying and modeling all levels of the social systems, one should take into account their connections with to biosystems. Currently, there is a global coronavirus attack on all levels of the social systems. It is clear that viruses and epidemics can be used in the management of the social systems. Many fields related to the biosystems (genetics, biotechnologies, bionanotechnologies, etc.) can influence the dynamics of the entire social systems, individuals and control of their evolution.

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