SYNERGETIC PARADIGM OF THE MODERN WORLDVIEW

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At the crossroads of the second and the third millennia the humankind is going through great changes in the scientific concept of the nature, socium and structure of the conscience. Formation of the new worldview became possible due to an innovative direction of the scientific thought - synergetics. In developed countries transition to this worldview took a relatively short period: from mid 60s to beginning of 70s (completed by mid 80s), i.e. mainly coincided with stagnation period in the former Soviet Union. Therefore, we are referred to as "countries catching up with the development ..." Our fundamental science which used to evoke envy in the whole world is experiencing functional crisis.

The new worldview allows a human being to begin and continue a dialogue with the nature, to create a whole picture of the world and preserve integrity of the nature (Prigogine I., Nikolis J. and Toffler O.). However, we believe, it is not sufficient. Synergetic paradigm of the modern worldview makes it possible for a human being to restore his/her unity with the nature. In this unity "the absurd and unnatural idea of some opposition between the spirit and the matter, the man and the nature, the soul and the body." (Engels F.)

Modern cognition of the world - nature, socium and conscience - has been developing in the environment of upgraded fundamental principles, a thesaurus of new concepts and recomprehension of all scientific concepts extending boundaries of our conscience. The main result of evolution of scientific knowledge is a phenomenon of self-organization **(Prigogine, 1984:432;Nikolis, 1986:486;Haken, 1983)**. Natural sciences (thermodynamics, biology etc.), cybernetics and system analysis, and recently the theory of management and catastrophe, contributed greatly to the analysis of self-organisation.

A new triumph of natural sciences took place in 1967 with development of the theory of dissipative structures and the development of the essence of the evolution - the phenomena of self-organization - as "the order through fluctuations" which is observed in the least balanced area of the process. However, this modern trend has deep historical roots originating in ancient oriental and antique classical science.

In Kyrgyzstan, the first small publication in synergetics was promulgated in 1990. It presented "unusual", i.e. synergetic, phenomena of social nature that were found empirically as a result of sociological research in 1979 - 85 **(Tishin, 1990:166-167)**. Research in synergetics are conducted by natural scientists **(Rudaev, 1994)**. Processes of detonation of explosives as self-organized complex and open systems are studied by Nifadiev V. and his group since mid 1990s **(Nifadiev, 1998:188)**. In the field of ecology and geology the synergetic approach has been used in the research of Bokonbaev K. and Bakirov A. **(Bokonbaev, 1999:11-14)**. Synergism of reagents in the processes of steel corrosion and hydrogen pick up in hydrogen sulphide has been studied **(Fokin, 1986:983)**. In 1998 a group of researchers from the Kyrgyz National University made a successful presentation of their synergetic research at the II International Conference on Self-Organisation in Almaty, Kazakhstan **(Alieva, 1998:100-101;Tishin, 1990:183-184).**.

Synergetics is a scientific trend, methodological approach, theory of self-organization of complex, i.e. non-equilibrium, non-linear and stable open systems through instability. In synergetics principles of evolutionism are of universal nature, therefore, they talk about evolutionary-synergetic principles. The theory of economic dynamics and social evolution, the theory and ethics of the market order, the evolutionary concept of economic progress and modelling of natural and artificial intellect are all based on these principles. Synergetic approaches are widely used in researches of political, social and demographic systems, as well as during discussions of theoretical foundations of art, culturology etc. This indicates that synergetic methods undergoing formation lead to recomprehension of both natural and social sciences. Natural sciences are becoming more human-orientated while methods of natural sciences are used to analyse problems in humanities. Rational natural scientific method is becoming widely used in humanities forming people's conscience. At the same time it becomes a universal language adequate for philosophy, psychology and art. Synergetics takes a new approach to self-organization of people's unity and to solution of problems of self-organisation of a human being as a being of triple nature - natural, social and conscious (spiritual).

The central concept of synergetics is self-organization. In the history of science and in philosophy this category is close to the concept of "self-development", self-movement and self-creating (creative as opposed to destructive) natural, humane or even "divine" power.

Causa sui - self-action, reason of itself in its own activities, self-organisation are the main ideas of the views of Bacon F. and Decart R., Spinosa B. and Leibnits G., Kant I. and Shelling F., Hegel G. and Marx K., Bogdanov A. and Prigogine I. However, definitions and concepts of self-organization are still far from perfect. This indicates essential capacity of the phenomenon of self-organization. All the existing definitions show only few points of the complex process of self-organization which is so far beyond human thought.

Natural processes of self-organization have been studied for the last one and a half centuries by methods of classical thermodynamics and statistical physio-chemistry using mathematical conceptual apparatus. Special attention should be given to enthropian approach to analysis of thermodynamic processes introduced by Klausis R. (1854). Asymmetry of cause-and - effect relation between **heat and work** was discovered, i.e. breach of equivalency of their transformation. Irreversible process is always associated with increase of enthropy, and only during reversible ideally imagined processes enthropy remains unchanged, then the sign of equality becomes possible in the equation of the Second Principle of Thermodynamics.

Discovery of thermodynamic laws gave an impetus to numerous attempts to one-sidedly bring all the phenomena of nature to modifications of only the energy. “Equilibrium approach” as a strive of an isolated system to serenity, resulted in crisis in the worldview. There appeared “scientific evidence” of degradation of the Great Order - Space, “thermal death of the Universe” and other concepts of the energy picture of the world. Such pessimism was rejected long before the period of energism. In 1872, Boltsman L., and later Gibbs J. established relationship between enthropy and statistics of equilibrium status of the system with the environment. Since then essence of systems obtains probable character, and events lose strict certainty of monosemantics. Probable determination in innovative concepts of Boltsman gave rise to optimism in worldview.

Thermodynamics conceptually rearmed understanding of the world which was oriented towards new understanding of problems of **time** and irreversibility of phenomena. Symmetry of time was violated, “arrow of time” is related to direction of “extending Universe” and increased enthropy. “Arrow of time” expresses the fact that the future cannot always be extrapolated, projected, planned and very rarely directed. Enthropian approach of thermodynamics of non-equilibrium processes to analysis of natural phenomena, for the first time, transfers the prerogative of cognition from substance to relation, link and time.

For the first time, thermodynamics introduced and violated spatial symmetry: non-linear non-equilibrium thermodynamics operates co-operative processes of the whole “ensemble” of events, and spontaneity dominates their evolution. Relationship between reversible and irreversible processes, equilibrium and non-equilibrium structures, regulating open and closed systems through “... chaos - order - ...” is an objective reality with various levels and forms of hierarchical complexity. This is not a generalised philosophical maxim, this is a conclusion of the enthropian analysis of complex systems.

Synergetic develops a new image of the open system. The concept of a system is not always a specific spatial-time related structure the performance of which is determined by its exchange of energy, weight and information with the environment. The system is a certain multitude of coherent, dynamic and interactive processes which

has its own dynamics in time as global complex structure. Complexity of the system may be at the structural or functional level. If structural complexity is determined by increased number of interrelated subunits, by interlinks, changes in density of probability of intensity of interrelations of subunits, then functional complexity is determined by the structure and the essence of the system.

Activeness of the system is expressed through creation of **enthropy** within the system. Its production defines the essence of the system's status. Dynamics of changes, i.e. changing of changes, perpetual lack of serenity contains stability of the system. The essence of it is perpetually changing production (**generation**) of enthropy within the system and its flows into the environment. The system strives towards asymptomatic sustainability - its own **attractor** - through discharge of enthropy and absorption - neutralisation - of external energy from the environment. Any sustainable system tries to alleviate external effects aimed at knocking the system off the balance. This is the summary of the well-known principle of Le Shatelie - Brown. The principle of balance shift is typical of physical-chemical as well as social and even spiritual processes. The entire conflictology is based on and originates from such a generalisation of thermodynamic balance shift. Time and enthropy are determinants of such systems.

Onsager L. made a considerable contribution to development of the synergetic idea. He introduced phenomenological equations and studied symmetry (reciprocity) of phenomenological coefficients. His theory of reciprocity became an important property of scientific knowledge. The essence of this theory is that existing numerous cases of cause-and-effect related determination within openness of the system are dependent on each other - one force takes care of the flow caused by the second potential which, in its turn, is not at all indifferent to effect of the action of the first potential as its "associate" or a "rival." Emergence of enthropy is bilinear function of forces and flows produced by it. E.g., in the case of chemical movement the source of enthropy is conditioned by emergence of enthropy as an effect of reaction, on the one hand, and energy exchange, on the other hand, and as a result of diffusion, on the third side. In the modern world, not mass and energy, information is dominating. Therefore, the society now is called informational.

In very non-equilibrium area of coherence conjugation of non-equilibrium may cause synergetic phenomena with violated symmetry.

The law-governed nature of enthropy production and its organising essence were justified by the theorem of Prigogine (1947, 1977): in the system satisfying correlations of Onsager under external conditions hindering achievement of balance, speed of enthropy production perpetually decreases during the development of the system from start to its static position. And in the static position enthropy stops changing or rather production of enthropy is minimum.

This theorem expresses essential basics of evolution. At the same time it has a methodological significance which is especially important for operation, selection and optimisation of ways of developing complex systems in nature and recently in the socium. The way to sustainability goes through development of the system of internal fluctuations of spatial-time related instabilities called dissipative structures. A paradoxical combination is observed: chaos of order and order of chaos. Transfer from one level of such hierarchical complexity to another is not spasmodic but evolutionary. It disseminates and conserves generated energy. Therefore, the principle of openness is not limited by comprehensive exchange. Openness is establishment of communicative relations as an evolutionary element and existence of a creative element.

Symmetry of the status during the process is violated unequivocally, and a threshold of instability will be established. One or more fluctuations begin "pulling" the system which became "active" as a result of conjugations and interrelations. Increasing power of this attraction is conditioned by the development of a **strange attractor** as the basis of localised fluctuations into some spatial-time related organisation (**fractal**). These sporadic roamings are particularly "viable".

Fluctuations, earlier perceived as useless fact, occasional thing, carelessness or misunderstanding, are not perceived as an experimental fact and grow to become a macrostructure. Now it is a constructive element determining the future of the system. Fluctuations are predecessors of alternative ways, suggest a development strategy and cause **bifurcation** of processes and their cascade in time and space. Bifurcation create and then support dynamics, and obtain a new constructive and organising function. All these are conditioned by internal savings of generated enthropy. Fluctuation nivelates laws of average statistics, rejects collectivism of mediocrity and elevates singularly new things, sings a hymn to the talent of each individual by praising everybody's ego!

Hence, synergetics under the **system** presupposes strive for unenthropical instability as a result of the trend of maximum deviation from equilibrium and chaos as the state of maximum enthropy. In synergetics, chaos is associated, first of all, with the idea of chance and chaotic variability of deviations from the norm. Chaos means unpredictable behaviour of elements (subunits) of the system deprived of harmony and order with maximum possible extent of disorder and maximum possible number of degrees of freedom, an examp le of which in the nature is physical vacuum.

Synergetics differentiates two types of chaos: **undetermined** - there are so many particles, degrees of freedom, events and objects that it is difficult to determine with reliability and validity and relate cause and effect, i.e. formalise cause-and-effect relationship. Such chaos and its laws were first described by Einstein A.

The second type of chaos is **determined**. It is caused not by occasional behaviour of great number of elements in the system but internal essence of non-linear processes and their unpredictability. The determined chaos has its own order of alternation "... - chaos - order - ..." If the attractor of undetermined chaos is a part of phased space

where this event takes place more often, then the **strange** attractor of determined chaos is of higher order within which the system has, as Anre Puankare put it, the highest sensitivity: excitability and high communicability of the entire system. In the social area the best example of the strange attractor is passionarity in ethnogenesis according to Gumilev L. The strange attractor, which brings a multitude of chaotic changes into order, gives the system and its development a great power: increased viability and constructivity or explosive death and destruction.

Openness of the system as strong non-equilibrium position of self-organised systems is determined by strive to preserve integrity of its structure as well as self-renewal and self-production. This dynamics has been called "**autopoezis**" (1973). This concept refers to live systems. An autopoetic system in the process does not produce a new product, it renews its own structure involved in continuation of the same process and justifies the continuity.

The modern world needs a harmonious synthesis of culture, as a humane transformation of nature, socium and spirit that are integrated in essence but are traditionally opposed to each other in our integrated worldview. The new paradigm - synergetics - confirms the integrity of laws, principles of evolution of the nature, humankind and spirit, and therefore, integrity of the world.

Worldview nature of the modern synergetic paradigm depends very much on the solution of additional two problems. The first is multy-aspect problem of **measure**. The second problem depends on the solution of the first, it is a problem of **mathematical** expression (description) of phenomena, processes and relations in the dynamics of self-organisation under research.

Researchers realised long ago that any science becomes real science if it widely uses mathematical means, and if discovered laws and trends are expressed in a mathematical form. In the 20th century it became more common for natural sciences, and to less extent, for social sciences, and in an embryonic form for sciences about thought process. A philosophical basis for such a statement is simple. Any object and phenomenon of the world has both qualitative and quantitative definiteness at the same time. Quantitative definiteness has always been a prerogative of mathematics irrespective of the type of science studying the definiteness of its object and the subject.

In synergetics the problem of measure is an acute one. We learned to measure information in bytes, energy in erg and joule, electron in volt etc., no need to mention about weight measures. A unit of measure for enthropy is not clearly expressed although in some cases amount of enthropy can be determined, and we can talk about its increase, regularity and decrease. One of the elements of measure is rate setting. For instance, probability of the event is measures from 0 to 1. In synergetics, science about self-organisation, the problem of measure or rate-setting is to be solved yet. It may be reasonable to introduce a unit of measure for enthropy as a general measure of

diffusion of energy, information and the substance. And such a unit could be called **enthrop**.

We shall mention briefly some aspects of mathematisation in synergetics. All the processes of classical thermodynamics are expressed through only five differential equations in quotient derivative. One of them is for determining the chemical potential. Such "easy" mathematical expression is not achieved yet for other synergetic processes. Choice of a specific mathematical apparatus and an appropriate language for description of an object or process is important to solve this issue.

Determination of stability or instability is important in research of thermodynamic processes, equilibrium and non-equilibrium states. Thermodynamic instability as a theory of local equilibrium was developed at the end of 19th century by Gibbs J. Stability is widely investigated through approximation of non-linear processes to locally linear. However, such a technique is not strict and sometimes can be erroneous. Currently the first and second methods of movement stability according to Lyapunov A. are especially popular in synergetics. This approach appears to be more natural, developed, universal and "simple." In the 1960-70s Kyrgyz mathematicians made a certain contribution into the development of movement stability according to Lyapunov **(Imanaliev, 1972:356; Imanaliev, 1974)** However, there is no and may not be general definition of stability or general methods of research of this state that could be used for all occasions. Therefore, research of synergetic processes and states of open and non-linear systems started in a wider field of qualitative theory of differential equations. It became a basis of the theory of dynamic systems, variational calculation and the theory of optimum management. Apparatus of this field of mathematics allowed us to imagine analytically a phased space of state of any physical system. Further development of mathematical methods in description of dynamic and synergetic processes, especially of probability - statistical order resulted in development of stochastic methods, on the one hand, and in development of the apparatus of pseudodifferential operators or, in other words, integral - differential equations. Solution of different class of sums with marginal conditions and deviated parameters became of special importance. Kyrgyz mathematicians actively continue their search in this area.

Currently the theory of unclear systems has become a new mathematical approach to analysis of relations between non-equilibrium states and dynamics of structure **(Orlovski, 1981)**. Sometimes they are called vague systems or systems with uncertain parameters. It was found that unclear parameters are capable of "absorbing" unexpected events in the processes with human beings' involvement, e.g. in management of dynamics of complex social objects. A number of technological and unmanaged processed with effects of regimes of aggravation, conflict or catastrophe; with diffusion, localisation, chaos, strange attractors etc., prompted researchers to set and solve a series of problems of flexible programming or, in other words, robust **management**. The important point here is structural sustainability of management.

Management is conditioned by hierarchy (pyramid, cone, cone spiral or other) of different levels of a complex system with a number of uncertain parameters. In this case the top is management of the entire **structure** of the system whilst the lower levels are management of the **dynamics** of subsystems.

There were numerous attempts to develop a general theory of systems, in particular, a theory of unclear systems in the form of classical integral-differential, variational, algebraic, topological and other approaches as well as within mathematical theory of categories and functures **(Mesarovich, 1978)**. Theoretical-multitudinal and especially theoretical-categorial approaches allow us to study the system as a whole at a more strict and abstract but less detailed level. In this respect a well-known scientific paradoxical contradiction is effective: the wider the concept, the narrower its content. This contradiction has not been solved in a paper on application of the theory of categories in system sociological research **(Tishin, 1990:91-99).** However, we believe, the long-term future of development of mathematical methods of synergetic processes analysis belongs to the categorial-functional paradigm.

In conclusion, we would like to mention another fantasy mathematical synergetic worldview. J. Willer stated that "for the whole of his life Einstein dreamt of creating a theory the essence of which he formulated in his works: **in the world there is nothing but twisted space** ..." Geometry, only a little twisted, describes gravitation. Geometry, twisted in a different way, describes electromagnetic wave. Geometry with a new type of excitement gives magic material - space - for construction of elementary particles. And there is nothing heterogeneous "physical" in this space. Everything in the world consists of geometry **(Tishin, 1990:37-46)** (16, p.64). At a "distance" of 10^{-34} cm and less (and at a "duration" of 10^{-15} sec. and less) "quantum fluctuations of geometry of space" are so unusual that concepts of measure and determined typology would not work, they become idle and "disappear." This, obviously, causes the need to construct new mathematical apparatus - topological space with changing and "self-organising" continuity and "metrics." The typology itself is likely to have a topological character - typology of typologies. And metrics will probably be studied not as a distance between A and B but as a branch of interrelations between A and B - processes, phenomena, relations etc. Another picture is expected with huge density -10^{-95} gr /cm^3 and higher. It is obvious that with such parameters (10^{-34} cm, 10^{-15} sec., 10^{-95} gr /cm^3) "?-? language" of classical analysis and "language of outskirts" of modern typology are too weak to describe any process under such unusual conditions. However, such quantum-geometry-dynamic and superspatial ideas, although born, have not intensively developed yet.

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