GEOSYSTEMS AS SELF-ORGANISING BINARY STRUCTURES

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Abstract. All self-organizing systems are binary (paired) structures: if system *X(t)* is formed, system *Y(X,t)* is formed together with it, as its satellite. Binary structures develop due to the flows of matter and energy that come from the environment and then are exchanged between subsystems of the system. Geosystems are described from the point of view of balancing self-regulating relations in the "resource-consumer" system type. Entropy in binary structures cannot tend to maximum. The development process is always directed towards equilibrium with environment and sustainable functioning of the system.

Keywords: geosystems, binary structures, the second law of thermodynamics, self-organizing systems, dissipative structures

1. Introduction By today, there has been accumulated a considerable amount of knowledge about the structure and principles of self-organizing geosystems, which allows us to apply higher levels of generalization. According to modern cognitive interpretation based on objective laws, a newly formed system can be described as an autonomous system, which development is determined by its structure, genetic qualities and conditions of the environment. But there has been noticed and proved in practice one more important feature: the creation of a self-organizing system is accompanied by the creation of its antipode system. The analysis of different heterogenous systems shows that they all have a binary structure (system – antipode system), and if one wants to adequately reveal a system's dynamics, one should always take this condition into account. This principle was noticed a long time ago (Democritus, Plato and others) and is clearly seen in such thing as antonyms: truth and lie – the lie is being created and developed on the base of truth and there is no other way, as one thing doesn't exist separately from the other; rich and poor – wealth is always formed based on poverty and is always accompanied by it, even in the periods of great social disturbances. This law is well seen in moral antinomies as well: evil is formed on kind deeds; one cannot understand evilness if he doesn't know what kindness is.

Modern cognition theory uses dialectics which is based on unity and struggle of contradictions, as an inherent quality of material objects which all are systems. An approach to the geosystems characteristics offered in this article is based on the following: in our opinion, the formation of any system, including man-made, objectively suggests the spontaneous formation and hidden development of another, satellite system, which uses the energy and matter produced by the first system. In other words, when there exists a *producer* X of energy and matter (resource) there always exists their *consumer* Y. At that, despite of antagonistic relations of systems X and Y, they form mutually complimentary synergetic (non additive) unity, which immanently evolves in multiple forms.

Interaction of systems on the predator/victim or supply/demand principle has been described long ago, but it is still considered to be a quality of only biological and economical systems.

The article shows on different examples that this type of relations belongs to the category of general laws and is directly connected with widely discussed scientific problem of reversible and nonreversible development of self-organizing systems. The following question – why, despite of the second law of thermodynamics, different types of ecosystems repeat themselves in form, content, principles of self-organization, have ability to self-reproduction and regeneration – is very important. So, on the Earth, despite of repeatedly occurring global catastrophes, when, according to the second law of thermodynamics, the Earth's systems should as if attain maximum entropy, in reality we have the opposite picture – new systems are formed on the place of destroyed ones, in accordance with the changed conditions, and the amount of entropy of these systems is decreasing in the process of evolution. In our opinion, this is due to the fact that every forming system, using energy and matter in some ordered forms and transforming them into new forms, simultaneously preserves their negentopic qualities. The flows of energy and matter in the Universe, as well in any single part of it, are ordered. This is the reason of expediency, which implies the existence of attractive goals in the development of systems.

2. The second law of thermodynamics, reversible and irreversible processes in geosystems. Modern views on fundamental laws of thermodynamics comprehend the idea of "far-from-equilibrium, dissipative structures", developed by the well-known physicist Ilya Prigogine (Prigogine, 1985; Prigogine, Stengers,

1994). It is said that the second law of thermodynamics directly connects growth of entropy with "positive direction of time" – time is irreversible because of irreversibility of processes leading to the irreversible growth of entropy. Ilya Prigogine declares that "...future will see a growing amount of entropy" (Prigogine, 1985, p. 213), degradation and disorganization in all systems will increase. Based on this assumption, A. Khazen categorically asserts, that "*The main law of nature is tendency to maximum disorder, which is restrained by existing conditions*" (Khazen, 1998, p. 43).

In considering these problems, three important things are missed that should be taken into account. First, the second law of thermodynamics characterizes only the second, final part of the systems evolution cycle – the stage of degradation; it does not apply to the first stage of systems evolution, the period when the systems are being formed, and their size, complexity, variety and other characteristics are growing both in form and content and are qualitatively improving. Naturally, during the system's self-organization period, this process is accompanied by the decrease of entropy $dH \rightarrow 0$.

Second, it should be taken into account, that formation and evolution of integral self-organizing structures is possible only in one case – when the flows of matter, energy and information *(MEI)* coming from the environment or from some other systems, are ordered and negentropic (possess negative entropy), kinetically and potentially. Flows of *MEI* that work randomly, can form only chaos – ultimate uncertainty of development. All known laws governing the evolution of matter are "laws" because they reflect stable, determined relations that equally reveal themselves under the same conditions. They characterize order, some kind of the determined attractor to which any process is naturally directed.

Third, conclusions about dissipation of energy and irreversibility of development are usually made on the basis of one system, quite often technical, artificial, and separated from Man as its creator, which is actually wrong, if we are going to strictly observe the definition for self-organizing systems. All technical systems, including cybernetic ones, are parts of self-organizing socio-economic systems, which organize both the order of the technical systems operation, and the order of energy flows for them.

"We consider ourselves as an advanced variety of dissipative structures and we "objectively" prove the distinctions between the past and the future" - writes I. Prigogine (Prigogine, 1985, p. 214), but he does not take into account, that, at the same time, we should consider ourselves or any other integral system as an associative structure-ensemble, where, at initial stages of the system formation and evolution, integration and concentration of MEI prevails over the dissipation. In fact, due to this, integral structures, while processing MEI as an ordered flow coming from the environment (hence, negentropic), are organized into two qualitatively different forms:

1) Newly formed ordered and, hence, negentropic flow $q(t)$, discharged by the system into the environment and described as $q(E)=Q(t)-M(T)$, where Q – amount of MEI in the flow coming into the system, M – amount of matter, energy and information for the organization and development of the system itself;

2) The second form presents the material system itself, which occupies a certain volume of the environment and possesses individual features that, in their turn, influence the condition and dynamics of the environment (the system of a higher rank), i.e. the system in question becomes a component of the environment structure.

The ordered flow of MEI coming from the Sun to the Earth, is, in fact, not dissipated, but concentrated in an infinite number of different systems, from ecosystems of land and water areas, to microorganisms and bacteria, and is almost completely absorbed by the variety of systems functioning at the expense of each other and for each other. And, thus, all integral, structurally ordered, self-organizing structures should be called *dissipative - integrative* systems.

Prigogine connects "positive direction of time" with the second law of thermodynamics, and this is the direction of entropy growth. But "*the arrow of time*" is not about irreversibility and entropy growth, but about formation of the *new*, which is different from the *old*. *The arrow of time* is connected with *irreversible negation of the old by the irreversible process of creating the new*. Exactly because of this there exists order in the Universe, and chaos appears at times when the old order, which is no more corresponding to the existing conditions, is replaced by the new one. Thus, chaos characterizes transition of the system from one state to another, qualitatively new state.

Based on the above statements, we can state that in the development of all material (and even abstract) self-organizing complex structures two types of processes simultaneously occur: the flows of integration and accumulation of matter, energy and information (MEI) and the flows of MEI dissipation (formation of chaos).

3. Self-organizing systems have binary structure. Self-organizing systems represent paired (binary) formations: if system *X(t)* is formed, system *Y(X,t)* is formed together with it, as its satellite. System X provides energy for system *Y(X,t)* and defines space and time limits for it (Fig. 1). System's dynamics, as of binary structure, is supported, on the one hand, by the flows of matter and energy coming from the environment, and on the other hand, by their exchange between subsystems forming the system. We call the flows of energy, matter and information (*MEI*) received by system *X* from the environment as *F-flows*, and the flows going from system X towards system *Y* - *D-flows*.

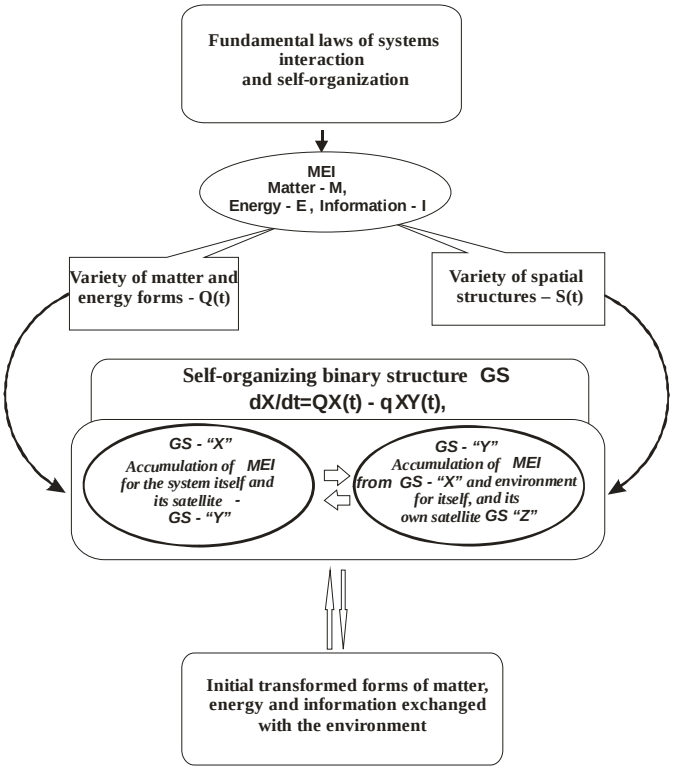

Figure 1. Structure of functional relations in binary geosystems

Energy in F-flows ("*energy for itself*") is accumulated in different substances (of which system X is formed) and is used for the own system functioning. The amount of MEI accumulated in a geosystem is limited by the system capacity. Thus, if in *F*-flow energy $Q(t)=const$, $\Delta M(t)\rightarrow 0$. Energy in *D*-flows is a forcedly given "*energy for satellite*", in the amount of $q(t,M)\rightarrow Max$. Formation of a satellite geosystem is objective, immanent property of all self-organizing systems. Appearance of a new geosystem created by F–flow, inevitably results in the creation of a satellite geosystem and D–flow of MEI, feeding it. Thus, all self-organizing systems, including socio-economic, in addition to their other known characteristics, can be considered as binary structures and their dynamics can be described based on balancing relations, known as "resource-consumer" or "predator-victim" relations (*Pozdnyakov,*]. We can call it a new general principle, according to which *the system size M (t) is proportional to the difference of the amount Q(t) of MEI coming into the system from the environment (F-flow) and the amount q (t), going from the system to its satellite systems (D-flow)*.

$$dM/dt=Q(M,V,t) - q(M,t) \qquad (1)$$

M – output characteristics of the system; *Q*- amount of energy in *F-flow*; *V*- ecological capacity; *q* – amount of energy in в *D*-flow created by the system *X*; *t*- time.

Component *Q(M,V,t)* characterizes the process of *MEI* accumulation in system *X*, which asymptotically fades as capacity *V* is approached. Component *q(M,t)* characterizes the process of *MEI* accumulation by satellite system *Y*, which also fades as the capacity is filled, but this capacity is created by system *X*. Thus, satellite system *Y* inhibits the geosystem development, acting as negative feedback. Interaction of elements included into *GS* (its subsystems) *X(t), Y(t)* and *(St)* is directed towards the balance of *MEI* consumption, characterizing dynamically equilibrium mode of development. This mode on the development phases plane corresponds to the limit cycle – attractor.

According to this principle, subsystems $X\leftrightarrow Y$ included into GS functionally depend on the regulated characteristics. System Y always tends by its size to X and, in fact, its size acts as a negative feedback. Another type of negative feedback is conditioned by the environment capacity (V(t)) – the more it is filled, the slower is the system growth by different parameters.

3.1.Development cycle of geosystems. Due to the reasons described above, development of geosystems is cyclic. The cycle consists of three stages:

1 - *initial, transitive mode* of system formation, when the system grows, accumulating MEI, and the system entropy decreases, $H(t)\rightarrow min$.

2 - *dynamically equilibrium mode*, when the systems $X\leftrightarrow Y$ are in the coordinated self-oscillation mode – $\Delta H(t)\approx 0$.

3 - *transitive period on the recession stage of the system evolution* – system degradation and changing due to non-receiving MEI. At this, the amount of MEI accumulated inside the system decreases, their amount in D-flow exceeds that in F-flow, and the system entropy grows.

The first two stages characterize *GS* as a *reversible system* evolutionary developing in the open cycle – its limit cycles are changed depending on the form and quality of *MEI* in F-flows and capacity *S(t)* of the environment.

The most important issues must be considered in interrelations of systems X and Y.

1. There exists a development limit for system X, determined by the environment capacity in which the system develops. As the capacity is being filled, the energy amount E_x in F-flow decreases: at $E_x \rightarrow 0$ and $E_y \leq E_x$, $X(t) \rightarrow optim$, because, in relations between X and Y, a mobile equilibrium is established between the energy contained in F-flow and the energy consumed by system X.

2. The development limit for system Y is determined by the capacity of system X. Therefore $E_y \rightarrow E_x$, but as $E_y \leq E_x$, the system enters into the mode of dynamic (mobile) equilibrium of energy.

For these reasons self-organizing systems should be referred to *self-oscillatory operationally closed homeostatic structures, having the ability to restore the condition of dynamic equilibrium if it is broken.*

4. Dynamic equilibrium in inert binary structures. Spontaneous reversibility is not a rare phenomenon, and can occur not only in biologic and socio-economic systems, but also in inert environment. Let's take some examples.

4.1. Formation of planets. As I already wrote in earlier works (Pozdnyakov, 1994, 2007), the conditions for planets formation were created only in the plane of the ecliptic, where the gas-dust cloud, under the influence of gravitation from the Sun, was structured into spiral sleeves. All particles from regional parts of the cloud moved to the center of gravitation along spiral trajectories. Since the mass *m(t)* of forming planets (planetesimals) and the acceleration *g(t)* were increasing during the movement, the radius *R(t)* of the spiral was decreasing to some value $R = const$, conforming to the conditions:

$$GMm/r^2 - mV^2/r = 0. \qquad (2)$$

Here the first component is the gravitation force, the second – centrifugal force. It is clear, that in order to achieve this condition, *g(t), m(t)* and $R(t) \rightarrow const$. The following equation describes the transition of spiral trajectories of planets into circular ones:

$$dR/dt = F(R,t) - F_c(g,m), \qquad (3)$$

Where *F(R)* – gravitation force created by the Sun, $F_c(g,m)$ – centrifugal force of the forming planet. Obviously, the limit cycle of planets, their transfer into a circular orbit, was possible only there was a sufficient distance from the place of their origin to the Sun. Otherwise, the cosmic bodies would fall onto the Sun.

In a similar manner worked the formation processes of planets' satellites – the centers of accretion of the third order.

4.2. Dynamics of erosion relief forms. The dynamics of relief forms is determined by the changes in their volume V and surface area S, induced by water streams and occurring at some known physical properties of substance, which determine the morphometric parameters. Because the growth rate of the relief forms sizes is determined by the amount P and Q of sediments, in the corresponding F- and D-litho-flows (F – flow of sediments, building the relief forms, D – flow of sediments, created as a result of their destruction), the dynamics of geomorphosystems is described by the following equation:

$$dV/dt = P(S,t) - Q(S(t)). \qquad (4)$$

If, as a system size, we will take the volume *V* of sediments accumulated in the relief forms, we will receive the following equations (Pozdnyakov, Chervanev, 1990; Lyalin, Pozdnyakov, 2001):

$$\begin{cases} \dfrac{dV(t)}{dt} = P - Q(t) \\ \dfrac{dQ(t)}{dt} = kS^m(V(t)) \end{cases} \qquad (5)$$

where *k* – coefficient of denudation, *m* – fractional indicator of the fractal growth of relief surface.

This system is nonlinear, because of nonlinear changes of the surface area S depending on the forms volume.

4.3. Floodplain dynamics. The height of floodplain $\Delta h(t)$ is changed only at simultaneous horizontal and vertical displacement of the river channel, $h(t) = f(x, y)$, where *x, y* - horizontal and vertical coordinates. If $dy/dt = 0$ (the channel bottom is not lowered) the river, changing its position in a horizontal plane, leaves behind a low surface, which flooding level during high waters is changed from the maximum value at the

initial time t_0 down to zero at the time t_n. Precisely so, for understandable reasons, changed is the total amount of sediments accumulated on the floodplain. Thus, the floodplain height H (t) grows proportionally to the difference of the material amount Q (t) precipitating as sediments (amount of warp on a unit of area) during the period of flooding, and the amount q (t) of the material removed from the area during the time between high waters. In this case, with approaching the floodplain height $h(t)$ to the limit value h_{np}, equal to the maximal height of high waters, $\Delta Q(t) \rightarrow 0$, and $\Delta q(t) \rightarrow max$. Equation of floodplain height dynamic as a function of time is shown below (Pozdnyakov, 1994; Pozdnyakov, Mahinov, Ushakov, 1986):

$$dh/dt = Q(h,t) - q(h,t) \qquad (6)$$

This model, without essential variations, allows to take into account the river incision, accumulation of sediments onto the floodplain from the slopes and denudation from the floodplain surface, as well as the dynamics of mobile inundated islands and vegetative communities on them. For example, their age is determined by the equation (6) and the period T of the island movement.

4.4. Formation of sea and lake coasts. An indicative example proving the action of this law is the development of sea coasts, lakes and artificial water basins (Pozdnyakov, 1994). Due to the sea transgressions (or creation of artificial water basins), coastal abrasion and accumulation of detrital sediments in lagoons and gulfs is growing. Thus a series of storm banks is formed, with the distance between them naturally decreasing down to zero. In any case the coastal line dynamics and of shoal connected with it depend on the ratio of detrital sediments volume in two flows and can be described by the equation:

$$dL/dt = Q(L,t) - q(L,t), \qquad (7)$$

where L – a unit of coastal shoal area.

In this equation, $Q(S,t)$ characterizes the change of the coastal line position due to the accumulation of detrital sediments in the lagoon; the coast attacks the sea, due to growing abrasive processes and increased material discharge $q(L,t) \rightarrow max$. That's why coastal system objectively proceeds to the stable, dynamically equilibrium mode of development. Based on this regularity, it is possible to obtain an exact enough forecast for the coastal abrasion of artificial water basins. Using this method, our laboratory has made the prognosis of abrasion transformation of Zeyskoye and Bureyskoye water basins on the Far East (Pozdnyakov, 1994).

Similar equation describes the processes of soils formation, due to rocks weathering and denudation, formation of accumulative plains when tectonic valleys are filled, and formation of other geosystems, dynamics of aeolian formations – dunes, barkhans, etc.

5. Dynamic equilibrium in biological systems. Apparently, one of the first models that used the equation describing the dynamics of complex self-regulated systems with nonlinear feedback for the analysis of population dynamics, were the Lotka-Volter equations, offered in the 1930s of 20th century (Gilderman, 1974)**,** as well as the models developed by I. Poletayev (Poletayev, 1966). Those were the models describing the competition of populations in conditions of limited resources, widely known as "*predator - victim*" models:

$$dN_1/dt = k_1N_1 - k_1 N_1N_2$$
$$dN_2/dt = k_2N_2 - k_2 N_1N_2 \qquad (8)$$

where N_1 - the population of some kind of animals acting as food for the population N_2 of predators; k_1 and k_2 - the factors describing the growth and decrease speeds of populations N_1 and N_2 accordingly.

The equations (8) describe the dynamics of "*victim*" and "*predator*" populations in their interaction. This model allows to consider variants in the relations of different biosystems, for example, intraspecific competition in both "*victim*" and "*predator*" populations. Using these equations, more complex models of biocenoses dynamics can be built, allowing to take into account not only food, but also energy.

6. Civilization development models. Lately, we observe a growing interest to the models of global civilization development. Actively discussed were the models developed at the Massachusetts Institute of Technology, under the direction of G. Forrester (Forrester, 1978) and other models. Most popular are the works of the Rome Club.

System-dynamic approach of Forrester to the description of global socio-economic system represents the society as a set of communicating reservoirs, through which different types of liquids flow, imitating matter, energy and information. Amount of matter M(t) in any of reservoirs (analogs of separate socio-economic systems) at each moment of time t is determined by the difference between the amount of matter that: P_i – is added to the system from other reservoirs (sociosystems) and q_i – is discharged into the environment and other reservoirs (sociosystems) (Egorov, Kallistov, and other 1980).

Hence, general equation for different indicators of the civilization development looks like:

$$dM/dt = P_i - q_i, \qquad (9)$$

where $i = 1, 2 \ldots n$. For example, equation for capital K (equally, for agricultural production, pollution and so on) is

$$dK/dt=K_2-K_1, \quad (10)$$

where K_2 – increase of assets (capital, any other production), proportional to the population; K_1 – decrease of capital, due to amortization and ageing. A similar equation describes the demographic process.

7. Function models of artificial (technical) systems. We can say without exaggeration that progressive development of civilization (technical inventions, including modern cybernetic systems, atomic power stations, man-made satellites, etc.) is determined by the objectively working regularity. Man, being a product of Nature, in his intellectual and practical activity also obeys genetically inherited general patterns of development and uses them, often unconsciously, as a function base for artificial technical systems.

In a generalized form, the equation describing the dynamics of regulated technical systems is given below (Krutov, Sporysh, Younoshev, 1969; Shinsky, 1974):

$$Bdy/dt=E_1-E_2, \quad (11)$$

where Bdy/dt - energy accumulated by the system; B - the system constant; y - regulated parameter; E_1 and E_2 - input and output energy.

By similar equations are described:

$Jdw/dt=M_d-M_c$ - dynamics of technical systems with torgue;

$dG/dt=Q_n-Q_p$ - receiver of a certain volume with gas input/output communications;

$FgdH/dt=Q_n-Q_p$ - technical systems with regulated liquid levels in reservoirs, etc.

Taken just by themselves, these technical systems cannot be referred to self-organizing systems. Nevertheless, as they are a part of unique symbiosis of technical and intellectual anthropogenic system, they must be considered as complex anthopo-technogenic self-organizing systems, possessing spontaneous, genetically inherited by Man desire to increase the quality of order and decrease entropy.

8. Particularities of self-regulating global system "civilization-ecosystem". The above system dynamics equations are the equations of self-organizing complete binary systems. But naturally formed systems have no special regulating organs to determine the size of mismatch between the target and current states of the system. Regulating functions in them are performed by their own sizes M, V, etc., connected in a negative and positive feedback cycle with the processes of receiving matter and energy in such a manner that with the increase of M, the amount of energy brought into the system decreases.

Similar principles work in the development of socio-economic systems. They also use their own dimensions as a regulator of development. In other words, socio-economic systems are growing in accordance with existing ordered negentropic flow of resources from the environment – both natural and created by the global set of sociosystems.

A system is self-organizing if its development is accompanied by growing of the system structural orderliness, at $dH \rightarrow min$. Evidently, only such system can be considered truly progressive. But, according to the laws of thermodynamics, within the closed system, like the Earth, non-limited development of sociosystems, with growing consumption of matter, energy and information, growing in sizes and variety, results in the growth of entropy in ecosystems. As if paradoxical conclusion follows from here: civilization in the whole is not a self-organizing system.

In reality, naturally developing self-organizing natural systems do not raise the entropy of the Earth's ecosystem. There are enough evidences, that they reduce it, raising the opportunities for sustainable development. Each time when the development of natural systems was interrupted by global catastrophes, the Earth's ecosystem was not only recovered, but also developed in the direction of teleologic functional orderliness. This process is possible only in one case: if the system receives from the environment energy, matter and *negentropy* – which contains and brings order. Whereas human civilization, acting according to the principles of self-organization and functioning that are inherited from nature and suppose the movement to sustainable, dynamically equilibrium condition obviously increases its own entropy and the entropy of geoecosystems.

This contradiction is not insoluble or inexplicable. Today's dynamic state of the civilization is temporary, conditioned by some lagging of the civilization reaction on developing and working negative feedbacks: this is a noticeable decrease of ecologic capacity.

9. Spontaneous tendency to equilibrium as a driving force of development. Bifurcations and chaotic behavior are considered (Prigogine, 1985; Prigogine, Stengers 1994; Khazen, 1998) to be determining factors in the development of complex systems, with the objective tendency to equilibrium showing the

increasing degradation of systems. There exists a tendency among scientists to understand bifurcations as "turning points of evolution", when the choice of the further way of development is made under the influence of the slightest random impacts. Bifurcations are also connected with sensitivity to the initial conditions and with the creation of so-called "strange attractors", described by Lorentz in 1963. But it is a major mistake to exaggerate the role of bifurcation and initial conditions in the evolution of complex self-organizing systems.

All complex self-regulating and self-organizing systems are developing expediently, which is their immanent quality. Man creates different technical systems: planes, rockets, satellites, etc., that is moving to a certain goal and in order to achieve that goal. Absolutely all of them are sensitive to initial conditions, and from the very beginning their target and actual trajectories become different, but this difference is removed by continuously working regulator, which is adjusting the system trajectory. If there were no such regulator, Man wouldn't achieve such grandiose results that are achieved. Migrant birds would never reach their destinations places, if they didn't possess abilities to adjust their direction according to target condition.

For systems with highly developed negative feedback cycle, chaotic behavior is not the characteristic feature, and this is generally proved by the presence of stable fractal patterns revealing themselves both in the form (in fractal geometry) and in content (in fractal dynamics), for example, as a self-similar mode of the system behavior (Pozdnyakov, 1994).

The entire set of events, accompanying the development of chaos and order, testifies of one thing: in the condition of chaos the coherence of particles and the coordination of their movement are impossible. Their synergism appears due to the action of a higher rank order and asymptotically grows with saturation, approaching the condition of dynamic equilibrium. And upon achieving this condition, all elements of the system "see" each other. Moreover, in the condition of dynamic equilibrium, correlation and coordination of the system elements' behavior are in the most perfect form, compared with the initial stage of the development, the period of chaos removing of chaos and order formation. Quite another point is that starting from the moment when order starts to be formed (structure invariant) and to the moment when the limiting development cycle is reached, most significant changes of the forming system occur. With approach to the dynamic equilibrium, the greatest possible coordination under the set conditions, these changes decrease, and in the condition of dynamic equilibrium they are negligibly small. Nevertheless, in this condition the system also exchanges matter, energy and information with the environment, at a level, sufficient to maintain the given condition stable. Probably, the disagreement about these phenomena comes from the fact, that in the conditions of equilibrium, it is very difficult or even impossible to reveal the dynamics of the transitive mode of development from chaos to order and from order to chaos. However, it should be recognized, that the condition of equilibrium is the attractive goal for all self-organizing systems.

The described self-organization mechanism of complex binary structures operates on a global scale. It determines both the formation of natural systems and the development and functioning of biosystems, civilizations, including human activity on the creation of artificial structures of different complexity, which management principles do not differ much from those working in nature. Man has achieved fantastic heights in his constructive activity, due to the creation of systems with a mistake-tracing regulator, which is able to correct the way when the system is moving to its goal and is working by the negative feedback principle.

Thus, based on all described above, we cannot agree with the widespread statement that self-organization can appear only in the conditions of high entropy, where, ostensibly, the development of heterogeneity starts "in the initially lifeless equilibrium". We state, that the original cause of self-organization is the existence of an organized flow of energy, matter and information, and this flow is immanently inherent to all kinds of matter. Self-organization is directed not against lifeless static equilibrium existing in abstraction, but towards a real-life condition of dynamic equilibrium characterizing the established mode in the evolution of self-organizing systems. A pendulum, not supplied with energy, being in the condition of equilibrium and, actually, not being a pendulum at this moment; a ball, occupying a point of equilibrium in a spherically symmetric vessel and being in the quiescent state; liquid in a vessel without a supply of thermal energy to it, and so on – are not of much interest for synergetics. Strictly speaking, they, from the point of view of synergetics, are not self-organizing systems at all. However, a pendulum with the ordered flow of the energy brought to it and corrected by Man forms (together with Man) a self-organizing in time self-oscillatory system - chronometer. All technical devices produced by Man – are parts of self-organizing binary systems of the type "man-machine". The history of these self-organizing systems can be tracked on self-developing processes of creation of any modern technical systems. We will see that in all cases self-organization is initiated not by entropy, but by the action of higher laws – initial orders, inseparable from matter, energy and, thus, information.

Entropy in binary structures cannot tend to maximum. Rather, the process is directed to the equilibrium with the environment, which is understood in physics as equilibrium where movement is absent. But

equilibrium with environment does not mean that there is no movement. What does equilibrium with environment mean? If to admit that there is no energy coming from the environment (E=0), then there is no environment, in other words, the environment is vacuum. In this case, any system which consists of functional assembly of different forms of matter and energy, and which somehow was placed inside this vacuum environment, would transform itself to vacuum – equilibrium condition with the environment. But the environment is a combination of self-organizing systems, and each of them, producing new forms of matter and energy, influences the environment and, in the result such non-additive summation, new systems are formed.

10. Conclusions. The notion of *geosystem* comprises all self-organising and self-developing structures on the Earth: various geologic-geomorphologic structures; biogeocenosis (ecosystems); socio-economic structures; geosystems "man-machine", etc. Any integral structure, including technical ones, if considered together with its creator, i.e. man, forms a paired, binary structure.

All self-organising systems are paired formations, since if there is an *X* system formed, alongside with it a *Y* system (*X, t*) – its satellite – is formed too. The dynamics of the system as a binary structure is realised by means of the intake of matter and energy from the environment and the subsequent exchange of them among the subsystems. We have named the flows of energy, matter, and information consumed by the *X* system from the environment *F-flows*, whereas those given to the *Y* system – *D-flows*. Thus, any system can be considered on the basis of self-regulating balance relations in the system "resource-consumer".

The *Y* system always tends in value to *X*, and, actually, its value stands for a negative feedback slowing down and stabilizing the growth of matter, energy, and information in the system $X \leftrightarrow Y$.

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