Sakhno E.Y.
doctor of technical sciences, professor,
Chernihiv Polytechnic National University

THEORU OF EVOLUTIONARU INTERACTION OF NATURAL AND ARTIFICIAL SYSTEMS

Summary. The process of evolutionary interaction of natural and artificial systems is determined by a number of factors such as natural selection, timing, chance, and regularity of natural phenomena. At the same time, artificial systems allow to reduce the time of appearance of a useful sign in the habitat of a person by virtue of its nature.

In order to understand the process of interaction between the two systems, a mechanism for their transformation is proposed, which makes it possible to study the nature of their union and to find approaches to managing the process of creating and fixing useful traits in the human population and the environment of its habitat. The exchange between energy potentials and creation of an integrated, combined system based on the model of interaction between natural and artificial systems is considered. In turn, the combined system is a link in their transition to a new higher level of development. The peculiarity of the proposed model is the use of energy flow theory and apparatus of differential equations, which describe the stability of systems and changes in their parameters over time, and the solution of such equations is the phase trajectories that determine the motion of systems in space and therefore the vector of their development.

Аннотация. Процесс эволюционного взаимодействия естественных и искусственных систем определяется рядом факторов таких как естественный отбор, время, случайность и закономерность возникновения природных явлений. При этом искусственные системы в силу своей природы позволяют сократить время появления полезного признака в среде обитания человека.

Для того чтобы понять процесс взаимодействия двух систем предложен механизм их трансформации, который дает возможность изучить природу их объединения и найти подходы к управлению процессом создания и закрепления полезных признаков в человеческой популяции и окружающей среде его обитания. На основе модели взаимодействия естественных и искусственных систем рассмотрен обмен между ними энергетическими потенциалами и созданию интегрированной, комбинированной системы, которая является звеном при их переходе на новый более высокий уровень развития. Особенность предлагаемой модели заключается в использовании теории потока энергии и аппарата дифференциальных уравнений, которые описывают устойчивость систем и изменение их параметров в течении времени, а решением таких уравнений есть фазовые траектории, определяющие движения систем в пространстве и следовательно вектор их развития.

Keywords: evolution, natural systems, artificial systems, integration
Ключевые слова: эволюция, естественные системы, искусственные системы, интеграция

Target setting. The process of evolution of natural systems on the Earth is characterized by the development of human society in accordance with its needs and challenges to the environment. It is known that evolution through natural selection is random, with millions of mutations, of which units are useful, and as a result, the mechanism of evolution through natural selection is slow enough - dozens of generations must change before a useful trait becomes entrenched in a population. However, humanity requires a reduction in time to survive on the planet for the emergence of a useful sign of a natural phenomenon, and artificial systems must be the solution to such problems [1,2].

In this case, artificial systems are defined as systems that are created and developed directly by humans, or can be any material products and technologies created by humans. But if at least one element was purposefully altered or created by man, then the system can be considered as an artificial. And if we consider the environment surrounding modern man from the point of view of the stated approach, then mankind lives in the artificial world that he practically created.

A certain "cocoon" of artificial systems was created and developed in the course of the evolution of civilization, it covers every person, group of people, as well as the whole of humanity [3]. At the same time, evolutionary modeling is the basis of the modern theory of creating artificial systems, which can be defined as the reproduction of the process of natural evolution using special computer programs. Factors that determine the inevitability of evolution include:

- hereditary variability as a prerequisite for evolution, its material;
- the struggle for existence as a controlling and directing factor;
- natural selection as a transforming factor.

The modern theory of evolution is based on the theory of general and population genetics, micro evolutionary processes occur in populations that lead to a change in their gene pool and the transformation of the genetic composition of a population. The main directions of development of evolutionary modeling at the present stage include the following [4]:

• genetic algorithms (GA), designed to optimize the functions of discrete variables and using analogies of natural processes of recombination and selection;

• classification systems (CS) created on the basis of genetic algorithms that are used as trained control systems;

• genetic programming (GP), based on the use of evolutionary methods to optimize the generated computer programs;

• evolutionary programming (EP), focused on the optimization of continuous functions without the use of recombination;

• evolutionary strategies (ES), focused on the optimization of continuous functions using recombination.

Analysis of recent research and publications. Scientists from many countries around the world are concerned with the development of natural and artificial systems. So the issues of the concept of "system", the principles of openness and closeness of natural and artificial systems, self-organization and adaptation to the environment are considered in works [1,2]. Natural and artificial evolutions, evolutionary analogues in artificial intelligent systems are described in works [3,4]. New technologies in the development of society, genetic-morphological selection with a material point conditionally called a mechanical gene are given in [5]. And finally, the main approaches to creating new methods and models for managing the process of integrating information systems, evaluating economic efficiency and building a unified enterprise information system and development projects are given in the monograph [6].

Highlighting previously unsolved parts of a common problem. It is advisable to use evolutionary methods in cases where the applied problem is difficult to formulate in a form that allows you to find an analytical solution, or when you need to quickly find an approximate result. In simple words, it is necessary to "tighten up" global economic growth for the successful development of artificial systems, especially for countries that aspire to leadership in a multipolar world, and at the same time it is necessary to create a product that will create demand for many years, make breakthroughs in those industries that can lead the whole world economy. In the coming years, a line of products that fundamentally change the market will be formed, and artificial intelligence systems that are being created or 3D systems, bio-, nano-, cryo-, robo-, eco-technologies that are already used now contribute to the transformation and development of artificial systems. All this will lead to the fact that countries which become carriers of these technologies will be among the world leaders, and those who delay in the development of artificial systems will be buyers of products and lag behind for many years.

The Aim of Research. This study is devoted to the study of the processes of interaction of natural and artificial systems, their development and exchange of energy potentials to discover the mechanism of their integration and the transition of systems to a higher level of development.

Also, the important issue of this study is the simulation of the processes of the interaction of artificial and natural systems using the theory of energy flow and the apartment of differential equations to determine the phase trajectories of systems motion in space and time.

The statement of basic materials. While studying the history of technology, we can assume the apparent randomness of the appearance of a particular invention, or the process of development of technology in total [5]. But in fact, there is a rigid connection between random and regular processes of development. Scientists from around the world are trying to erase the line between artificial and living organisms in order to ultimately create robots capable of independently producing their own kind. Moreover, the process of transition from natural to artificial systems can be conditionally divided into four stages (Fig. 1).

At the first stage, signs from natural systems are transferred to the field of artificial ones, where artificial ones are created on the basis of existing characteristics of natural systems. Until today, this evolutionary process seemed natural and logical. However, humanity is looking for opportunities to change the inartificial nature of things on the basis of the existing technological arsenal in connection with the development of scientific and technological progress. Technologies such as genetic engineering, management of natural phenomena, and creation of artificial intelligence gave impetus to a change in the very foundation of the human environment created by nature. In this case, we can distinguish the second stage (reintegration) of the interaction of natural and artificial systems, when a person directly violates natural laws by his actions, and in this instance, inartificial (natural) systems lose their original purpose (their original functions), turning essentially into artificial ones with separate elements of natural systems. Leading such a technological way of life in the environment, the line between the two systems is lost (obliterated). Mankind finds itself in a world created by him artificially depending on his desire (and to a greater extent on his selfish whims).

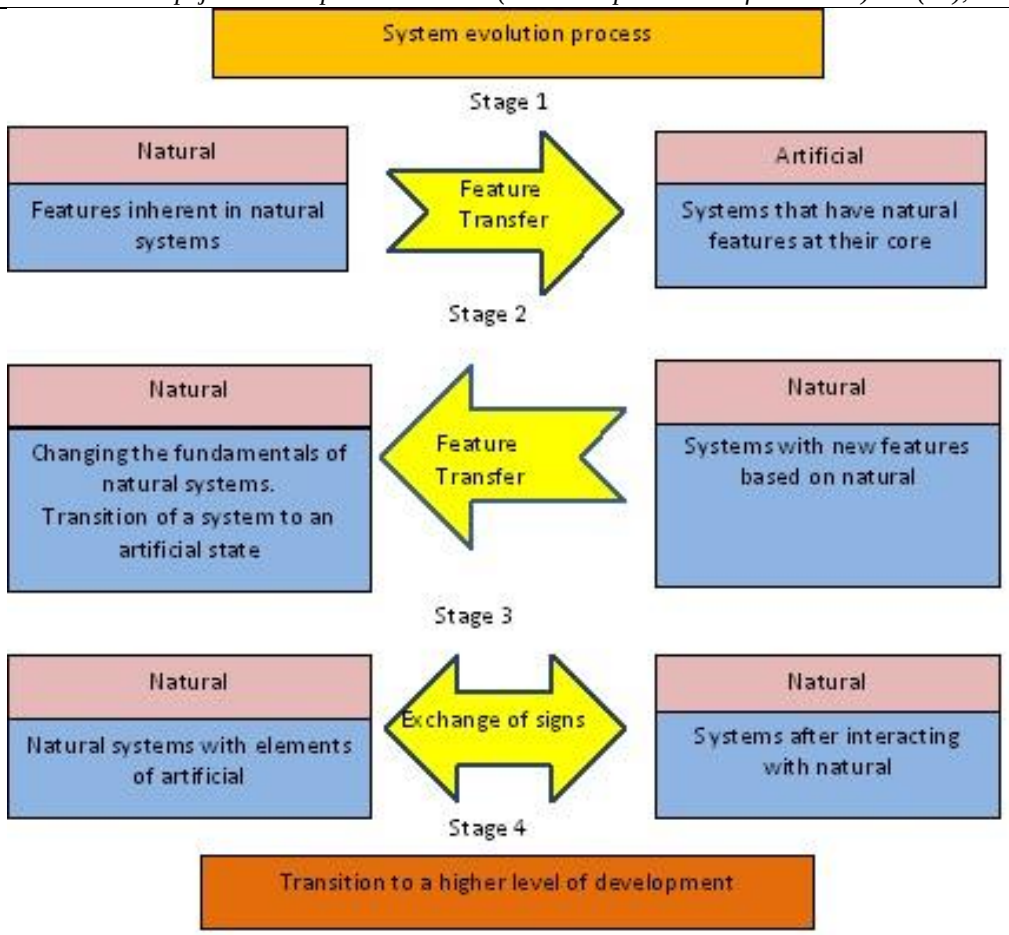


Fig. 1. The process of evolution of natural and artificial systems

Thus, we are approaching the third stage of the interaction of natural (man-modified with the remaining elements of inartificial and natural systems), but essentially artificial systems with newly created technological objects. In this case, the circle of movement closes and the integrated system reaches a new higher level of development where the movement repeats. Believe that this process will occur as long as the environment remains inartificial (natural) systems with the original characteristics that are created by nature. Over time, humanity will almost completely change its nature, and maybe even the form of existence, depending on the needs of society or its selfish ambitions. This process can occur contrary to human desire, as shown by the practice of spreading the planet coronavirus infection (COVID-19). That is, nature creates antagonists of human desires, although in essence this is an element of the evolution of human development.

It should also be noted that the described theory is quite simplified, and it does not take into account the enormous range of restrictions imposed on the evolutionary process. However, it is possible to learn how to control the process of evolution and interaction of natural and artificial systems by studying the mechanisms of movement of systems and their elements, and thereby maintain a rational balance in the development of mankind while moving to a new level of its development.

Interaction in (inanimate, living and social) nature is associated with the transfer of resources and waste both within the system and between the system and the environment. The fusion of natural and artificial systems into a single integrated (complex) system occupies a particularly important place in their description. The process of integrating them can be considered on the basis of the theory of integration systems described by the author in [6]. It is known that new opportunities arise for a qualitative change in the trajectory of the system (changes in the principles of integration of systems in the process of evolution) during the evolution and introduction of new technologies, which are caused by the action of environmental factors and the ability of elements of the control system to accumulate information and independently generate innovations. Therefore, it is advisable to apply the principle of synergism in the development of the theory of the evolution of artificial systems, which is to obtain additional effects from the strengthening of the connection between the elements of the system, and to apply the synergistic concept along with the evolutionary approach to the development of civilization.

The process of interaction between natural and artificial systems is presented in Fig. 2. In order to reveal the process of interaction of research objects, it is necessary to: 1) investigate the mechanisms of interaction of systems depending on the characteristics of their energies; 2) to determine the peculiarities of

occurrence of common points of bifurcation and synergistic effect from the interaction of systems.

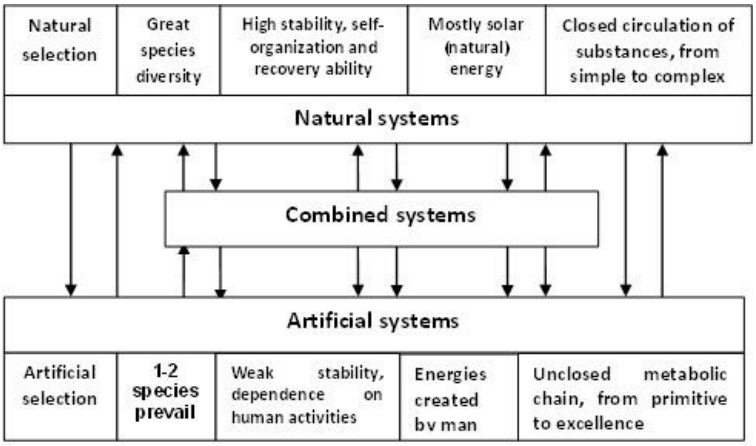
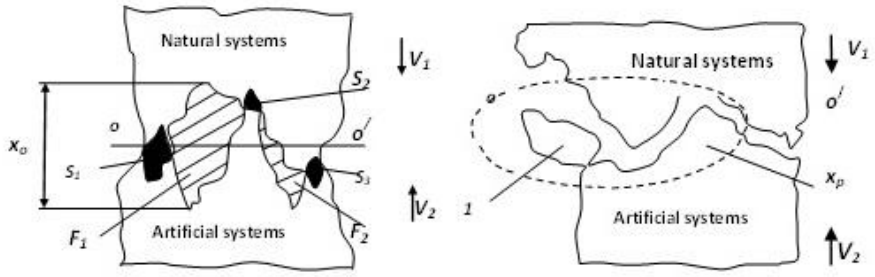


Fig. 2. Scheme of interaction of natural and artificial systems

Consider the issues of integration and exchange of features of artificial and natural systems in their development and formation of a single combined system based on the definition of the scheme of interaction (Fig. 3).Let's assume that the integration of systems will be incomplete, and in general systems will function individually, and will contact only at the points of their touch. Consider the case where the energy potential is distributed along the boundary that determines the parameters of the system, as a result of the systems moving towards each other with velocities V_1 and V_2, (Fig. 3a) their interpenetration occurs and an area is formed x_0, where they merge and combine with possible synergistic effects. Under real conditions, the energy of the systems is unevenly distributed along their boundaries, and in some cases - chaotic. Therefore, projections and depressions on the surface of the systems will be formed depending on the existing laws of energy distribution. In this case, different configurations of the region x_0 can be formed during the oncoming motion of two systems with velocities V_1 and V_2, by parameters of which it is possible to draw conclusions about integration processes and the end results of their joint activity.



(a) *(b)*

Fig. 3. Scheme of integration systems: (a)-interpenetration of two systems; (b)- filling of energy spaces

Consider some typical cases (Fig. 3,a), where, as a result of the interpenetration (diffusion) of energy flows, the projections of systems with areas S_1, S_2, S_3 (Fig. 3,a) are combined, where energy flows complement each other and form bifurcation points based on the principles of synergism. There are also regions with areas $F_1$and F_2 where clearly expressed energy potentials are absent. In this case, there are local energy cavities that adversely affect the total allowable area x_0 and as a result, its area decreases. An alternative case is when the projections and depressions of the two systems coincide (Fig. 3,b). In this case, the energy space is completely filled. Interesting is the case where the energy potentials are unipolar, then a projection with a higher potential can destroy the projection with a lower potential and a local energy potential arise 1, and energy will be dissipated in some region xp, supplementing adjacent energy zones. As a result of the collision of a large number of microscopic elements, the movement of the elements of the system contributes to an organized redistribution of energy flows, which is based on fundamental system principles inherent in complex objects of any nature. The mathematical model of flow theory can be represented by equations of balance for state variables. The integral balance equation for any studied time interval (t_a, t_y) will be:

for statistical systems:

$$U = UA + Y,$$

for dynamic systems:

$$X(t_N) = X(t_0) + U(t_0, t_N) - Y(t_0, t_N) \pm K(t_0, t_N),$$

where U - is the energy entering the system; Y - energy exiting the system; A - is the coefficient matrix; t_0, t - are the studied intervals; X - is the variable state of the system; U - input parameters; K - is the coefficient that appeared as a result of system activity.

The apparatus of differential equations is most appropriate for the study of systems theory, which describes changes in the system over time in the form of:

$$\frac{dY}{dt} = f(X, B, t), \quad (1)$$

where $X = \{X_1, X_2, \ldots, X_n\}$ is the vector of dependent variables that describe the state of the system; $\frac{dY}{dt}$ - is the speed of change of system factors; $f(X, B, t)$ - is the nonlinear vector function; $B = \{b_0, b_1, b_2, \ldots, b_n\}$ – is the vector of system parameters, generally time dependent. The solutions of the equations of the form (1) are usually represented by phase trajectories in the state space of the system (Fig. 4).

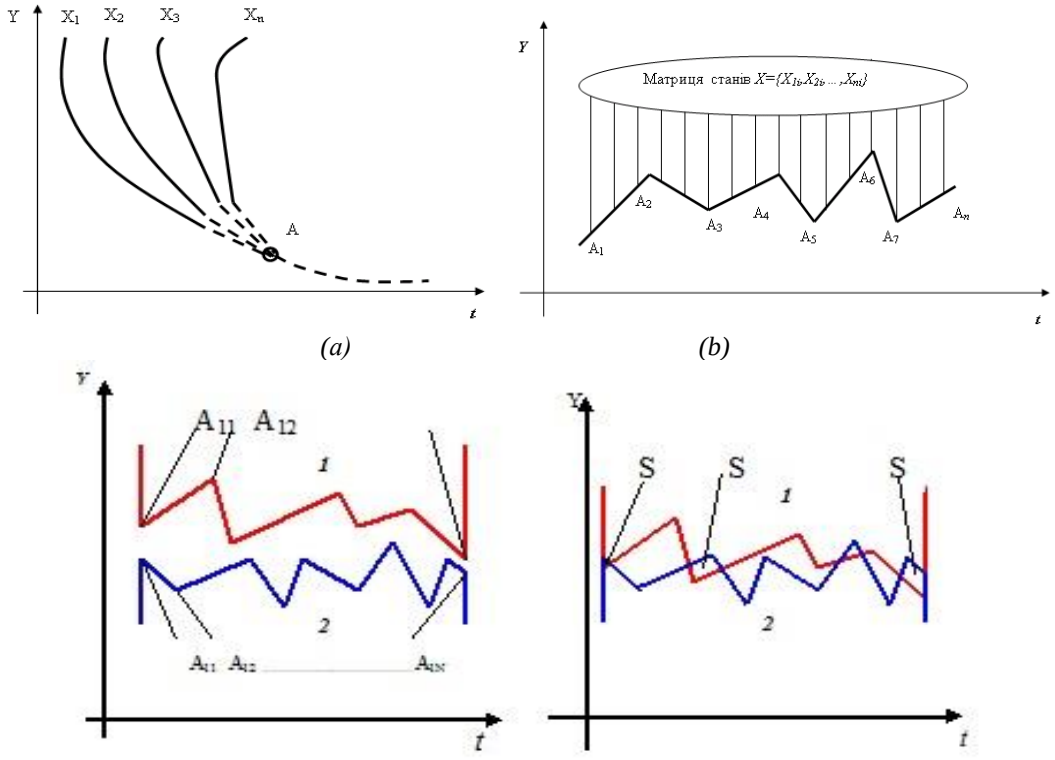


Fig. 4. Phase trajectories in the state space (A - is a center attractor): (a)phase trajectories; (b)dynamic distribution of stability of states; (c) to interaction; (d) after interaction

The analysis of phase trajectories allows us to draw conclusions about the development of systems in time, to determine the areas of deterministic behavior and the area of bifurcations (areas of uncertainty and region of unstable states of the system), as well as attractors of the system (areas of stable states, for example, type "center").As a rule, the transition from steady state to unstable (and vice versa) occurs when changing the b_i parameter of system (1), which can be called "order parameters". The problem of state analysis can be formulated as follows: determination of such parameters by which the behavior of the system and its states or order parameters that determine resistance to external influences is possible. It is possible to speak about the presence of a set of bifurcation points $A = \{A_1, A_2, \ldots, A_n\}$considering the behavior of the system in the set of states. This means that the system behavior function (Fig. 4,c,d) is described in the state space as a general trajectory with bifurcation points distributed over time or attractors and intersection areas of $S_1 \ldots S_N$ (Fig. 4) [6].

The control parameters or "order parameters" defined at such points form a matrix $B = \{B_1 \ldots, B_n\}$, by which it is possible to evaluate the stability (instability) of the system.

And at the end of the article I want to say about the structure of human civilization, its basis, its chemical composition and elemental base. Famous fiction writer Isaac Azimov described the waning culture of civilization as C/Fe in his novel, Steel Caves, 1953 [7]. Where carbon is the basis of man (about 21%), and iron isan element of the robot. Therefore, the C/Fe ratio symbolizes the connection between wild and inanimate nature, artificial and natural systems, a culture that combines the best qualities of both on an equal but parallel basis. Adapting this theory to the conditions of development of society, I want to recognize its rational basis for the existence of human civilization. However, considering this theory at the current stage of evolution,

I think it is right to add to it a class of polymeric easily formed materials from which rigid, durable, corrosion-resistant products can be made. These substances consist mainly of carbon C, hydrogen H, oxygen O, and nitrogen N. It is safe to say that high molecular weight compounds have conquered mankind, so modern human culture can be described by the following basic chemical elements (Fig. 5).

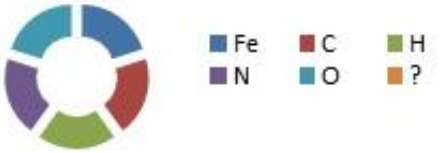


Fig. 5.The chemical structure of human civilization

In this diagram, the question mark is specifically placed in the empty sector as a symbol of future chemical elements (already existing or newly created) and which will complement or replace the existing culture of civilization. Thus, the theory of the relationship between natural and artificial systems, living and inanimate nature will continue its evolution and movement towards the development of human society.

Conclusions and perspectives.

The researches made it possible to substantiate the theory of evolutionary and interaction of natural and artificial systems, in which four main stages due to a number of factors, such as natural selection, time random and regular processes of the development of civilization, were identified. The presented model of interaction of the two systems allows to reveal the mechanism of their interaction in the transition to a higher level of functioning. The mathematical description of the proposed model is based on the principles of energy flow theory and the system of differential equations, which allow us to describe the stability of systems under the influence of external factors and when their phase trajectories change over time. Also the chemical structure of human civilization is presented, and it proposes to add high molecular weight compounds to its basic elements - iron and carbon, which have confidently conquered human culture.

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