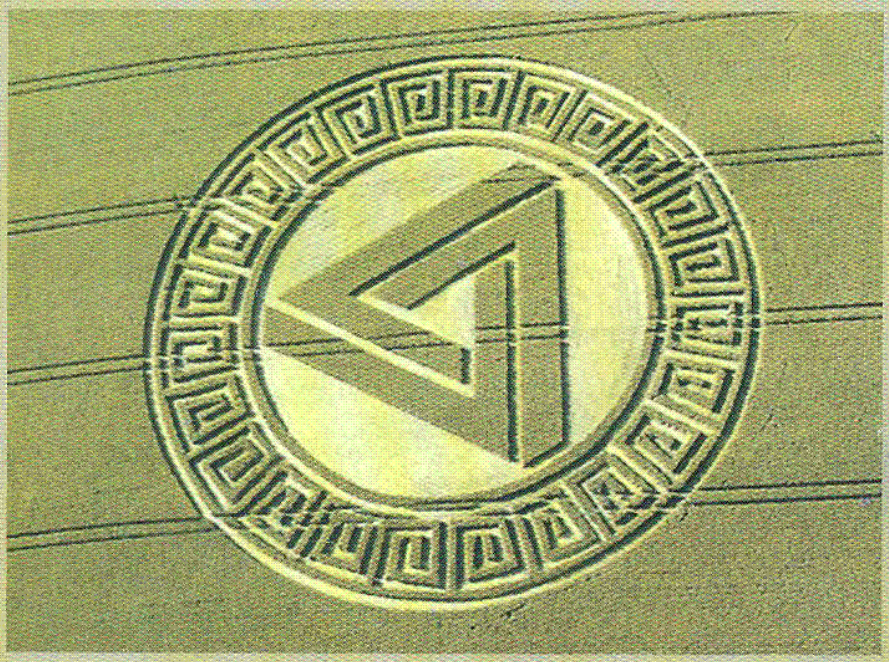

ГАРМОНИЧНОЕ РАЗВИТИЕ СИСТЕМ – ТРЕТИЙ ПУТЬ ЧЕЛОВЕЧЕСТВА

INTEGRITY APPROACH TO ANALYSING OF OPEN SYSTEMS

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Abstract:

Functioning efficiency improving of open systems (economic, financial, production systems, etc.) must be made, for instance, either due to the improvement of their integral structure or due to the improvement of the interaction between the system and the environment. The proposed approach to open systems analysis and synthesis is based on the substation and formalization of the integrity (wholeness) criterion.

It is known that the system effect is attained by skillful use of controlling actions that are performed through the channels of the positive and negative feedbacks with the environment.

Problems of providing the functioning efficiency of open flow-type systems as cybernetic ones thus reduce to finding the efficiency coefficient which optimum is achieved by the optimal flow distribution in the feed back channels.

The efficiency of interaction of such a system and the environment can be represented as an integral index which should reflect irreversibility, uncertainty, cooperative processes as well as the presence of contradict processes within the system. The main working hypothesis of the present work is that the best extent of their interaction or cooperation is reached when the life ratio systems is rigorously determined which is the main working hypothesis of the present work. Nonlinear models for estimating macroeconomic systems are used as a formal expression for evolution of the interaction efficiency of systems. If the criterion used by us for the open system takes a maximum value, then this system tends in the best manner to adapt to environment or another system and to provide it integrity of the interaction of open systems.

Key words: open system, interaction, efficiency, integrity criterion.

Реферат:

Предлагаемый подход к открытым системам основан на формализованном критери целостности, который позволяет повысить эффективность функционирования открытых систем. Известно, что системный эффект достигается за счет умелого использования управляющих воздействий, которые выполняются по каналам положительных и отрицательных обратных связей с окружающей средой.

Проблемы обеспечения эффективности функционирования открытых проточных систем кибернетического типа сводятся к нахождению коэффициента эффективности, который достигается за счет оптимального распределения потоков в каналах обратной связи.

Эффективность взаимодействия такой системы и окружающей среды может быть представлена в виде интегрального показателя, который должен отражать необратимость, неопределенность кооперативных процессов, а также наличие противодействующих процессов. Рабочая гипотеза состояла в том, что лучшая степень взаимодействия или сотрудничества достигается при определенном соотношении систем жизнеобеспечения. Были использованы нелинейные модели для оценки систем, которые характеризуются формальным выражением эволюции эффективности взаимодействия этих систем. Если критерий, используемый нами для открытой системы принимает максимальное значение, то эта система стремится наилучшим образом адаптироваться к окружающей среде или к другой системе и обеспечивает её целостность взаимодействия в открытых систем.

Ключевые слова: открытые системы, взаимодействие, эффективность, критерий целостности

1. THE SUBJECT UNDER INVESTIGATION

Open flow-type systems, e.g. economic, management, market (goods, services, finances), human-centered, information, biological, etc. are the subject for study in the present paper.

2. EFFICIENCY OF OPEN SYSTEMS

The integrity (wholeness) is the most important criterion for the efficiency of open systems [1–6]. For the integrity phenomenon to be studied account must first be taken of the mechanism of interacting the system elements with environment. For economic systems such elements can be represented by the processes and flows interacting in the system. These are flows of energy, researches, goods, services, finance, information, etc.

3. FEED BACKS IN OPEN SYSTEMS

On the basis of the system organization theory that has gained a rapid development for the last few years although it had been reported for the first time at the beginning of our century the special role of the phenomenon of system organization manifests itself through feed backs.

For organization (or an organized system) to be developed, not only the well-known negative feedback (NF) but also the positive feedback (PF) must be available. As experience shows any organized system realizes both types of feed backs. It can be asserted that the role of the NF and PF is the fundamental feature of organizing open systems, irrespective of their nature.

In open flow systems dynamic processes proceed and different flows appear. The flows are formed under the action of forces and gradients (in case, of goods, finances, information, services, energy, etc.).

As a rule, the flows much related to each other occur in such systems. The thermodynamic equations allow the informative nature of the processes of flow interaction to be studied.
Thus, the flow interaction can be described by using the integrity concept and the best efficiency of the processes and flows interacting in the system is also associated with the integrity concept.

In the present paper the integrity criterion will be justified theoretically. This very criterion permits the systematic effects to be investigated and synthesized in open systems regardless of their origin [3–6].

4. TASKS OF THE PAPER

The main tasks of the paper are:

- to substantiate the formal criterion of integrity and efficiency of the functioning of open flow systems (with regard to the principle of positive and negative feed backs);
- to use the given thermodynamic criterion for analyzing the integration efficiency of the above-mentioned systems.

5. MECHANISMS OF FLOW INTERACTIONS IN OPEN SYSTEMS

Let us use the concepts of "inlet" and "outlet" to describe an open flow-type system according to [1, 2]. The system inlet is characterized by the presence of the flow of any flows $I_{\mathbf{e}}$ and of the generalized force $X_{\mathbf{e}}$. The system outlet can be represented by some flow I_{i} appearing in the system and by the generalized force X_{i}. With Onsager's formalism in mind formulate the following equations for the systems flows.

$$\begin{cases} \boldsymbol{I_e = L_{ee} X_e + L_{ei} X_i} \\ \boldsymbol{I_i = L_{ie} X_e + L_{ii} X_i .} \end{cases} \tag{1}$$

The coefficient $\boldsymbol{L_{ie} = L_{ei}}$ characterizes the extend of interrelation between the incoming and outcoming flows, on the one hand, and the value of feed back between the incoming and outcoming flows, on the other hand.

Eq. (1) governs the interrelation between the nonequilibrium processes in an open system which are determined both by inlet and outlet characteristics. This equation can serve as an integrity characteristic of an open flow-type system. Eq. (1) can be given in a dimensionless form as:

$$\boldsymbol{\eta = (1 - (ax)^2) / (1 + abx) - 1,} \tag{2}$$

where $x = X_i / X_e$ is the parameter of order that describes the relation between the variables X_e and X_i, i.e. the system inlet and outlet, respectively. The mechanism of the interaction between the system and

environment is determined by the efficiency coefficient ratio, i.e. by the system organization

$$\eta = \frac{L_{ii} X_i^2 + L_{ie} X_i X_e}{L_{ei} X_i X_e + L_{ee} X_e^2}. \qquad (3)$$

From this formula it follows that the efficiency of transforming the input to the output data depends on the fact of interaction, i.e. on the presence of feed backs. By reducing this formula by the cofactor $1 / \sqrt{L_{ii} L_{ee}}\, X_i X_e$ to the dimensionless form, we obtain

$$\eta = -\frac{ax + b}{\frac{1}{ax} + b}, \quad 0 \le \eta \ge 1, \qquad (4)$$

where
$x = X_i / X_e$ is the parameter of order,
a denotes the feedforwards,
b - the feed backs:

$$a = \pm\sqrt{\frac{L_{ii}}{L_{ee}}}, \quad 0 \le a \le 1,$$
$$b = \pm\sqrt{\frac{L_{ie}}{L_{ii} L_{ee}}}, \quad 0 \le b \le 1. \qquad (5)$$

If one flow cause the increase of the other flow then $b>0$ $L_{ie}>0$, thus pointing to the feedforward (see eq. (4)). The inversely proportional influence at $b<0$ and $L_{ie}<0$ reveals the presence of the feedback.

The system "output" is characterized by the presence of some flow I_e and of the generalized force X_e. The similar concepts of I_i and X_e are introduced for the system "output". The parameters L_{ei} and L_{ie} on the informative level characterize the integrity of the open system under study (see eq. (4) and (5)).

6. COOPERATIVE INTERACTION OF SYSTEMS

Let us consider the example of cooperative interaction of two companies A and B. Let the volumes of production assets be equal to X_a and X_b, respectively. Cooperative interaction of these companies promotes the

increase of production of goods, services, etc. and, hence, provides the rising of the effectiveness of the partner activities. The production of the compares are equal to:

$$\begin{cases} \boldsymbol{I_A = L_{AA} X_A + L_{AB} X_B} \\ \boldsymbol{I_B = L_{BA} X_A + L_{BB} X_B} \end{cases}, \tag{6}$$

where
L_{AA} and L_{BB} are the coefficients characterizing the capital productivity or the ratio of the change in the production volume of goods or services to that in production assets,
L_{AB} and L_{BA} are the coefficients characterizing the extent of the influence of the production assets of the company A on the results of the activities of the partner, say, the company B and vice versa.

Formal criterion allows to take the justified decisions in two directions (see eq. (6)):

1) the changes of production assets, resources, etc. X_A or X_B, e.g. when the latter is increased, the extensive development of the companies takes place;

2) increase in the production intensity due growing parameters L_{AA} or L_{BB}, i.e. the intensive development of the companies takes place.

Analysis of the combined parameters *a*, *b* or *x* allows the stability regions of the development of the companies or the development gaps of the companies to be found.

The usage of the criterion for evaluating of the efficiency of two (and more) companies interaction allows the following regularities to be revealed:

(1) The criterion serves as the controlled parameter and can be used in variational problems.

(2) Such a criterion permits the tendencies of this development of open systems to be established, e.g. the extensive development of the system.

(3) The invariability of the values of this criterion means that the stability of system's functioning is attained in the nonequilibrium environment.

(4) A maximum of the system efficiency is attained by using definite non-linear relationships between the coefficients (characterizing the

feedback) distributed according to a specific series of the numerical invariants that specify the integral properties of a system.

(5) If the criterion is used for the open flow-type system and gives a maximum value then this system tends in the best manner to adapt to the environment. In this case it is assured the integrity interaction between the system and its environment.

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