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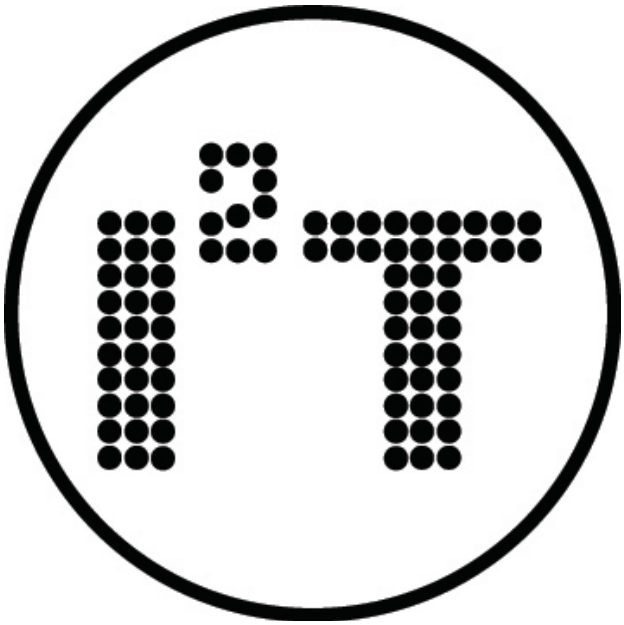

PART 3
INNOVATIVE INFORMATION TECHNOLOGIES IN INDUSTRY AND SOCIAL-ECONOMIC SPHERE

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The materials of The Third International Scientific – Practical Conference is presented below. The Conference reflects the modern state of innovation in education, science, industry and social-economic sphere, from the standpoint of introducing new information technologies.

Digest of Conference materials is presented in 3 parts. It is interesting for a wide range of researchers, teachers, graduate students and professionals in the field of innovation and information technologies.

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Section 4
INNOVATIVE INFORMATION TECHNOLOGY IN SOCIAL-ECONOMIC SPHERE

APPLICATION OF SELF-ORGANIZATION APPROACH FOR SOLVING THE PROBLEM OF FORECASTING IN AN INTELLIGENT MANAGEMENT SYSTEM OF INNOVATIVE DEVELOPMENT OF THE RUSSIAN MEDICAL-INDUSTRIAL COMPLEX IN THE INFORMATION SOCIETY

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The possibilities and prospects of applying self-organization approach for solving the problem of forecasting in an intelligent management system of innovative development of the Russian MIC in the information society are discussed. MIC information and analytical website could be the basis for the creation of the intelligent management system of innovative development of MIC. Members of a valeological Internet community forming around MIC website will act as experts in the intelligent management system of innovative development of MIC.

Keywords: health care modernization, innovative development, information society, Russian medical-industrial complex, information and communication medical-industrial space, MIC information and analytical website, intelligent management system, self-organization approach, self-organizing predictive model.

Prerequisite for improving medical and social assistance to the population of the Russian Federation, stable and progressive development of the Russian medical-industrial complex (MIC) [1] as a set of interrelated and interacting business entities pursuing in the process of their coordinated functioning one common goal – to ensure valeological and demographic security of the Russian Federation, is MIC focus on innovative development as a way of its existence through targeted changes in its quality as a result of innovation activity in the context of changing environmental factors and / or changing intrinsic properties. Innovative nature of contemporary organizational and economic processes in the medical-industrial sphere imposes special requirements on content, organization, forms and methods of development management of MIC, taking into account the increasing importance of immaterial forms and unconventional qualitative growth factors.

The key to a significant increase in the socio-economic efficiency of the Russian MIC in circumstances where the country is heading towards the information society is the use of possibilities provided to the producers and consumers of health services and medical supplies by modern information and communication technologies, the formation of an Internet-based unified and nation-wide information and communication medical-industrial space (ICMIS) as a form of existence of relations taking shape in the process of implementing health activities by MIC entities, using information and communication technologies [2].

For management of innovative development of the Russian MIC in the information society, it is advisable to use intelligent management technology, including or based on the theory of functional systems by P.K. Anokhin [3]. MIC, like all other complex socio-economic systems, is a functional system. The effect, contributing to the goal of a functional system, is reached based on self-regulation. “What do we mean by self-regulation? It is the situation when the medical community is responsible for the quality of work of every doctor” [L. Roshal, 4]. The issue of ICMIS involvement in the process of forming a self-regulatory system of medical and social assistance to the population of the country is pressing.

Using the possibilities provided by the information society, it is possible to create an intelligent management system of innovative development of MIC, which is a set of technical and software tools, unified by a single information and communication process and operating in cooperation with man (group of people), able to, based on the information about the state of the environment and its own state, as well as the forecast of these states, given motivation and constantly updated knowledge regarding many different aspects of medical-industrial activities, generate a management goal, make decisions and find rational ways to achieve the goal [5]. Building an intelligent management system of innovative development of MIC assumes implementation of a mechanism of management goals generation, dynamic expert system, methods of self-organization, decision-making and forecasting, unified in the functional structure developed by P.K. Anokhin [6].

In the most general case, it is supposed to use the appropriate system economic-mathematical models for modeling and forecasting innovation activities in the medical-industrial sphere.

At the stage of Russia's transition to market economy, Hermeyer type models deserve special attention [7]. Hermeyer systems have no dependency relations: in market conditions, economic relations between entities are based on the principles of equality, autonomy of will and property of their participants.

In the medical-industrial sphere, in the class of Hermeyer type systems, models designed for the following tasks are the most relevant:

- optimization of the ratio of funds received by MIC from three sources: government, business entities and population (the main, global, purpose of the “government - MIC business entities - population” system is to ensure valeological and demographic security of the Russian Federation);
- reallocation of resources of state non-budgetary social funds: from the Social insurance fund and the Pension fund to the Fund of compulsory medical insurance (the global system goal is improving the socio-economic efficiency of preventive, diagnostic, therapeutic and other activities aimed at maintaining and improving the health of Russians);
- optimization of allocation of resources of compulsory medical insurance (CMI) between the Federal and regional CMI funds (the global system goal is improving the quality of health services in the regions);
- financing the modernization and development of MIC organizations from the budgets of all levels and funds allocated by business entities engaged in business activities in the market for medical services and medical supplies (the global system goal is improving the quality of medical care provided for Russians);
- strengthening the role of public associations of MIC organizations, medical and pharmaceutical associations and public organizations of physicians and patients in health management (the global system goal is improving the situation with socially significant diseases in Russia).

Where there are dependency relations, MIC and its subsystems can be considered as active systems [8]. In active systems, one or more controlled entities – active elements – can deliberately choose their state, guided by personal interests and preferences.

In terms of the theory of active systems the following tasks can be identified:

1. improving the management efficiency according to the scheme: territorial health management authority $\rightarrow$ accountable organizations;
2. improving the management efficiency according to the scheme: CMI regional funds and health insurance organizations $\rightarrow$ prevention and treatment facilities (PTF) tied by contractual relations;

3. improving the management efficiency according to the scheme: Chief physician of a prevention and treatment facility → medical personnel of PTF;
4. development of integral assessment methods for performance measurement of services, units and divisions of MIC;
5. improvement of the supply system organization, performance of works and services for the needs of state and municipal healthcare;
6. improving the efficiency of the drug supply system for state and municipal PTF;
7. improving procedures for licensing and accreditation of healthcare entities;
8. increasing the reliability of results of examination of medical aid quality;
9. development of methods for assessing the quality of healthcare services;
10. improving procedures for certification of medical and associated services;
11. improving the training quality of doctors and pharmacists;
12. improving management of the development of priority areas for medical science and technology;
13. improving the efficiency of health and social monitoring system.

For qualitative analysis of innovation processes in the medical-industrial sphere, it is advisable to use the methods and means of the self-organization theory, i.e. synergetics [9]. From the viewpoint of the self-organization theory, ICMIS is a kind of a virtual ground where there is a constant exchange of different value factors relevant to human health. With the development of exchange processes in ICMIS, social community of participants of medical-industrial processes is also developing, their value orientation is being identified, while the ways of their communication over the Internet are improving. In this context, models of the following major components of the MIC innovative development process in ICMIS are the most relevant [10]:

1. information development of ICMIS;
2. economic development of ICMIS;
3. entrepreneurial activity of MIC entities in ICMIS;
4. development of science in ICMIS;
5. professional training of health officials and managing medical officers;
6. elaboration of collective decisions aimed at improving the socio-economic efficiency of MIC.

These models of innovative processes, characteristic of MIC, representing equations with a fixed structure, in ever-changing operating conditions and state of MIC often become inadequate. In this regard, building predictive models, including dominant (key) parameters of MIC, is proposed to be done using a self-organization technique [11]. Self-organization avoids unnecessary and casual relationships and connections between the system elements. It is also essential that the self-organizing models can be built while MIC is functioning.

The adequacy of self-organizing models is determined by the minimum number of selection criteria for the models – a set of complementary criteria. By cleverly selecting these criteria, we can eliminate irrelevant state variables to determine their relationship most accurately.

The intelligent management system of innovative development of MIC operates as follows. The first stage consists of selection (culling) of all scenarios, which are inacceptable according to selection criteria. The remaining scenarios undergo further selection and arranging; the best one is executed. In each subsequent step, using updated information on operating conditions and own state of MIC, the scenario selection procedure is repeated, while maintaining some old scenarios.

In intelligent management systems of innovative development of MIC, a method for building predictive models based on a combination of statistical and expert information can be implemented. When forming the action acceptors of intelligent management systems, based on

the theory of functional systems by P.K. Anokhin, a method for building predictive models, based on a combination of statistical and expert information, should be combined with the self-organization approach.

Self-organization is the most effective approach given the minimum amount of a priori information, as well as in cases where, for various reasons, some important factors are not considered or when interference is several times bigger than the desired signal. The principal possibility of prediction with a lack of information about some of the key factors relies on the fact, that in complex systems all factors are intercorrelated; each measured factor will provide information on other related factors.

Methodological prerequisite for the use of the self-organization approach when building predictive models is the assumption that all necessary data that characterize the dynamics of the research object are contained in the information on its operating conditions and its state, as well as in the set of selection criteria. Applying the approach of self-organization, it is possible to build a mathematical model of the research object without a priori statement of its behavior. The developer just needs to specify the set of selection criteria; a model of optimal complexity will be chosen automatically.

Within the approach of self-organization, a self-organization method, which is based on the following principles, is implemented:

2. Principle of the model self-organization.

It is based on the fact that in the process of selection of predictive models according to the set of criteria, the complexity of the model structure grows, while the criteria values decrease. Achieving minimum criteria values indicates a model of optimal complexity. Further criteria values remain constant or increase.

1. Principle of external addition (S. Beer).

Prerequisite of solving the problem of choosing the model of optimal complexity is the introduction of an external selection criterion, calculated based on the information, that is not used in the assessment of the model parameters, performed with the help of a learning sequence.

1. Selection hypothesis.

According to the selection hypothesis in deterministic formulation, all impacts, which did not overcome a self-selection threshold in the previous row, will not participate in the formation of the best result in the next row. For most heuristic selection criteria, the selection hypothesis can be proved only in the probability meaning.

1. Principle of freedom of choice – inconclusiveness of an intermediate solution (D. Gabor).

In order to ensure freedom of choice in the selection process, several models are transferred for each next step from the previous one.

The adequacy of the chosen model is confirmed by achieving the minimum selection criteria. The correct choice of selection criteria allows excluding from consideration all irrelevant, random and uninformative states.

The most famous selection criteria for models include regularity criteria (mean-squared prediction error of the test sequence), minimum model displacement (normalized sum of squared differences of the output values of two models, obtained for two different subsets of the original data set), balance (projected value in any remote reference point). The criteria of argument diversity, model simplicity, information etc. are less common. They all have their specific drawbacks. Thus, in particular, the application of the balance criterion, choosing the model with easily traceable general patterns, revealed in the process of observation, can lead to multiple model selection, because, as a rule, at each time interval there are many models which correspond to a common pattern formed earlier.

In the first phase of systemogenesis, the set of selection criteria consists mainly of general criteria – regularity, minimum displacement, balance, etc. In the second phase, the set

of selection criteria will consist of one general criterion (e.g., regularity) and several special ones.

Using the set of selection criteria, it is possible to make a choice of the predictive model clear. The criteria, each of which exercises multiple options, are collectively applied to the models, already selected with the help of auxiliary criteria, which in every particular problem formulation are selected usually from physical considerations.

The predicted state of the studied system will be used in the quality functionality, which is minimized when searching for optimal management. Management generation with forecast optimization is conducted periodically, taking into account new data.

The process of building a model based on self-organization is performed in three stages:

1. Building a generator of applying models.
2. Assessment of the generated applying models according to selection criteria and selection of the best of them.
3. Use of the selected predictive model for extrapolation.

The self-organization method is applicable in cases where measurements provide enough information about the dynamics of processes, occurring during the operation of the studied system, i.e. when the effect of measurements aging does not strongly affect the accuracy of the predictive model. When measurements aging critically affects the accuracy of the predictive model, an algorithm based on time series is used. The accuracy of the predictive model can be improved by means of expert information used in its building. The error ratio in the action acceptor of the intelligent management system can be regarded as an indicator of the transition from self-organizing predictive models to predictive time series.

The self-organization method is used in heuristic self-organization systems. The central element of a heuristic self-organization system is a generator of hypotheses, which is a program generating random combinations of input signals – arguments and their functions. In addition to the generator of hypotheses, the system includes a unit of self-selection thresholds for useful information based on heuristic criteria and a unit of thresholds optimization. Although in general the number of possible combinations of input and intermediate signals can be very big, self-selection thresholds for useful information allow reducing the scope of the problem, and thanks to the thresholds optimization procedures it is possible to achieve maximum accuracy of its solution.

Building the intelligent management system of innovative development of the Russian MIC is associated with a number of significant problems. Serious difficulties arise primarily out of implementation of mechanisms for the generation of management goals, as well as formation and functioning of the action acceptor. Goal generation and formation of the action acceptor in the management system of innovative development of MIC are performed by industry executives in the context of legal, economic and other limitations. In such a situation different human errors are inevitable which can have serious consequences for both MIC and specific social groups, rights and interests of which will be violated, and Russian society as a whole.

In the information society, the intelligent management system of innovative development of MIC can be built based on MIC information and analytical website [12].

In the intelligent management system of innovative development of MIC, MIC website performs the following functions (Fig.1):

1. collection, accumulation and storage of information about the state of MIC and the state of its environment;
2. generation of management goals based on active assessment of information about the state of MIC and the state of its environment, as well as the forecast of these states given motivation and expertise;

1. formation and development of the knowledge database on many different aspects of medical-industrial activities;
2. development of assessment required for decision-making, as well as the forecast for the action acceptor;
3. decision-making;
4. verification by the action acceptor of compliance of the action result (in case of implementation of the selected management) with the forecast.

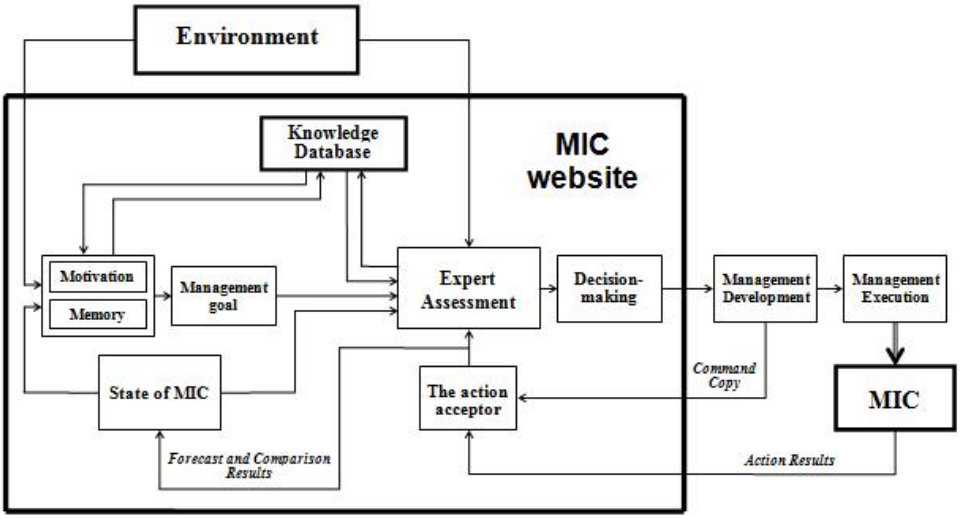

Fig.1. The structure of the intelligent management system of innovative development of MIC, built on the basis of MIC website

The action acceptor operates on the basis of self-organizing predictive models of innovative processes in the medical-industrial sphere. Report on compliance of the action result with the forecast is transferred to the expert system and the system of goal generation. If the action result corresponds to the forecast, the management goal is considered achieved, and the selected management is deemed correct. In case of discrepancy between the action result and the forecast, a new expert assessment is performed, a new solution is adopted and new management is implemented. If the compliance cannot be reached even theoretically, there is a change in management goals – a new goal is generated.

Members of a valeological Internet community forming around MIC website, focused on solving urgent problems of public health and healthcare, will act as experts in the intelligent management system of innovative development of MIC

In the management system of innovation processes in ICMIS, the following self-organizing model can be used for prediction:

$$\varphi(x) = \sum_{i=1}^{n} a_i \mu_i (f_i x) \ .$$

Where n is the number of basic functions in the model, μ_i is basic functions of a parameterized set $F_p = \left\{ a_j \mu_j (f_j x) \middle| j = \overline{1,m} \right\}$ (each basic function is associated with a two-dimensional parameter vector $(a_i, f_i)^{\mathrm{T}}$, where a is amplitude, f is frequency).

Thus, the following general conclusions can be drawn from the above:

1. For management of innovative development of the Russian medical-industrial complex in the information society, it is advisable to use intelligent management technology, including or based on the theory of functional systems by P.K. Anokhin.

2. When forming the action acceptor of the intelligent management system of innovative development of MIC, a method of building predictive models, involving a combination of statistical and expert information, shall be combined with the self-organization approach.

3. MIC information and analytical website can be the basis for the creation of the intelligent management system of innovative development of MIC.

4. In the intelligent management system of innovative development of MIC, MIC website will perform the following functions:

3. collection, accumulation and storage of information about the state of MIC and the state of its environment;

4. generation of management goals based on active assessment of information about the state of MIC and the state of its environment, as well as the forecast of these states given motivation and expertise;

5. formation and development of the knowledge database on many different aspects of medical-industrial activities;

6. development of assessment required for decision-making, as well as the forecast for the action acceptor;

7. decision-making;

- verification by the action acceptor of compliance of the action result with the forecast.

5. Members of a valeological Internet community forming around MIC website will act as experts in the intelligent management system of innovative development of MIC.

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DESIGN OF THE INFORMATION TECHNOLOGIES FOR VARIABLE RATE APPLICATION OF FERTILIZERS

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The foundations of the design of information technology for the differential impact on soil and plants in the system for precision farming are presented.

Keywords: precision agriculture, information, decision-making

Agriculture in Russia, despite the existing difficulties is in need of innovative approaches that use information technology. For developed countries, precision farming is no longer an innovative technology, but in Russia it is still novel and has not been applied broadly.

The Russian agricultural sector, particularly in the area of arable farming and plant cultivation experiences an acute shortage of modern technologies and facilities equipped with computers and modern means of communication. The application of innovative information technologies in this area will improve crop production, reduce costs, the usage of resources and the negative impact on the environment.

The most widely used information technology in agriculture is precision farming, which allows an efficient management of crop production. Precision agriculture uses global positioning systems (GPS and GLONASS), geographic information system (GIS), special sensors, aerial photography and satellite imagery.

The basis of precision agriculture is to characterize soil heterogeneity within the same field. The main purpose of precision farming is to increase the effectiveness of technological operations, the quality of agricultural products and to reduce losses due to variable soil fertility. This naturally implies a differentiated approach to the problem of fertilization, crop protection and seed application rates.

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