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NATURAL SCIENCE AND ENGINEERING METHODS IN THE INSTITUTIONAL ECONOMY

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ЕСТЕСТВЕННОНАУЧНЫЕ И ИНЖЕНЕРНЫЕ МЕТОДЫ В ИНСТИТУЦИОНАЛЬНОЙ ЭКОНОМИКЕ

The article gives an overview of modern trends of rooting scientific and engineering methods in economics and management. The article shows feasibility of their usage in solving problems of institutional economics – in particular, in order to prevent opportunism that takes place at the moment of conclusion of contracts for research and project works.

INSTITUTIONAL ECONOMICS. OPPORTUNISM. CONTRACTS. R&D ACTIVITIES. NATURAL SCIENCE METHODS. ENGINEERING METHODS. TECHNOLOGICAL MODE

Рассмотрены современные тенденции укоренения естественнонаучных и инженерных методов в экономике и менеджменте. Показана целесообразность их использования при решении задач институциональной экономике. В частности – для предотвращения оппортунизма при заключении контрактов на выполнение исследовательских и проектных работ.

ИНСТИТУЦИОНАЛЬНАЯ ЭКОНОМИКА. ОППОРТУНИЗМ. КОНТРАКТЫ. НИОКР. ЕСТЕСТВЕННОНАУЧНЫЕ МЕТОДЫ. ИНЖЕНЕРНЫЕ МЕТОДЫ. ТЕХНОЛОГИЧЕСКИЕ УКЛАДЫ.

Intensive development and application of methods of natural sciences and engineering methods in economics and management have begun about thirty years ago. There have been several reasons for that: first of all, there has been a dissatisfaction of traditional explanations of economic processes and phenomena; secondly, financial data mismatch with existed theoretical models, and thirdly, an imperfection of monetary valuation. A well-known academician L.I. Abalkin wrote about the construction of methodology of evolutionary economics: «... Dissatisfaction of science with its state is the first sign of exhaustion of the old paradigm and emergence of new needs. Its birth and further adoption is long and difficult process. At the first stage the system of analogs is used as a powerful incentive, addressing to the methods of other sciences with an established reputation. Such sciences are, for example, biology, genetics and thermodynamics, widely used ... in the analysis of cyclical dynamics of economic processes, or more generally – in constructing a theory of evolutionary economics...» [1]. Number of studies in recent years is devoted to the usage of natural science methods in economics and management [2, 3]. The position of the Russian Foundation of Fundamental Research seems to be interesting in part of establishing in 2013 the nomination of «natural science research methods in the humanities» [4].

Considering the ratio of monetary and natural indicators in economic systems, it is necessary to pay attention to the fact that it reflects an intense process of rapprochement between the natural and social sciences, which is a characteristic feature of modern scientific and technological revolution.

Use of scientific concepts in the economy of natural and technical sciences increases awareness of such features of economic (production, in particular) systems, as the absence of constant parameters in the processes, rapid changes of previously established trends, uncertainty of occurrence of specific events (e. g., crises), low predictability of dynamics in economic development.

The set of scientific and engineering methods, which have found its application in economics and management, is presented on Fig. 1.

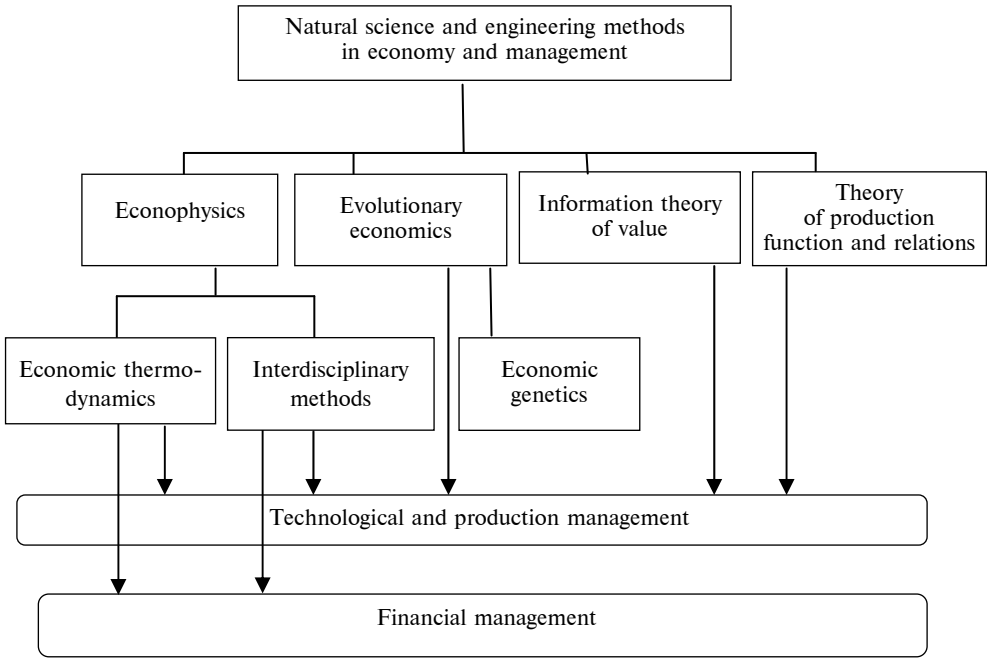

Fig. 1. Natural science and engineering methods in economy and managemen

The special place among them has econophysics, which appeared as the result of the researches in field of securities profitability dynamics, distribution of wealth and income in society using the methods of statistical physics, application of models of quantum mechanics to study the interaction of economic agents (similar to the interaction of elementary particles) .

It is possible to define two directions of econophysics development: based on the use of thermodynamics [5] and «interdisciplinary» direction, based on the integrated use of physical models and methods [6].

In our opinion, use of natural science methods in combination with methods of institutional economics seems to be promising – for example, in solving problems of preventing opportunistic behavior of market participants.

Let us take an example of contracts concluded in the field of engineering projects, research and development, engineering services. In fact, in this case we can talk about the activities of certain organizations related to the transfer of information and proprietary rights of creators of intellectual goods (manufacturers) to other subjects – consumers – under certain conditions.

In this case, there is a possibility of opportunistic behavior of developers interested in getting orders and information asymmetry, in which the customer of the project doesn't have full information about its parameters, and the developer does not know about real intentions of the buyer regarding the use of this project. The possibility of opportunistic behavior (from the side of sellers (developers) and from the side of customers (investors) reduces significantly in case a good tool is used for evaluation, that allows to quantify the qualitative characteristics of a product. Here integrated assessment is very important, because it allows to compare development of different sub-parameters. In the conditions of R&D that can be done by referring the analyzed project to a specific technological way.

In this case, to solve the problem of choosing the optimal technological options it is inevitable to use methods and tools borrowed from the natural sciences and engineering. Talking about it, it is necessary to note the attention that was paid to this question by various researchers, who considered ways of improving of economic development, its methodology and tools. During an integrated assessment of trust qualities of developments undertaken under engineering services, as noted above, it is perspective to assign the analyzed development to a particular technological system.

Table 1

Technological relations and the production functions [7]

Technological relations type	Function number	Function name
Pragmatic	1	Goal-setting, choosing the product to manufacture
	2	Grounding the product characteristics
	3	Developing the action program for the industrial engineering
Syntactic	4	Choosing the possible technologies
	5	Choosing the technological relations
	6	Grounding the production relations system
Semantic	7	Developing the technological processes system
	8	Fine-tuning of the technological processes
	9	Combination of the manual labor and machinery work
Cognitive and Emotional	10	Developing the system of the instrumental regulators
	11	Means of the instrumental operations' regulating
	12	Regulating of the instrumental process
Material	13	Investment goods reproduction
	14	Product reproduction
	15	Instrumental operating a subject of labor

In role of quantitative characteristic of technological structure can be a degree of materialization of information in production systems, deepening during transition from the previous mode to the next. As the most interesting approach in this field, we can mark out O.M. Yunya approach [7], who considered some technological relationships and functions implemented in any production system (Tab. 1). This approach can be used in the analysis of changes in information relationships within different technological structures.

The evolution of production systems brings changes to the information content of the labor process and the nature of media relevant information that determines the shape of the production system inherent in this or that technological way.

According to the mentioned above, the information processes which are materializing at cannon, machine and information stages of production development are shown in Tab. 2, made on the basis of [8]. The second quantitative characteristic of technological way is the dimensional scale of shaping processes, which is characteristic for the dominating technology causing economic results of production (Tab. 2).

The dimensional scale of shaping processes during the transition from previous to the subsequent technological way decreased. Within 1–4 ways it was connected with increase of dimensional accuracy of products of the mechanical engineering, causing their operational parameters, the fifth way was connected with emergence and development of the microelectronics operating with dimensional parameters of few microns.

Consideration of changes of materialization degree of information and dimensional scale of shaping processes corresponds to conceptual situation when each condition of a trajectory of economic development is defined by whole previous evolution of production systems [9, 12].

It is obvious that the sixth technological stage is marked by the next reduction of dimensional scales of shaping processes. It fully corresponds to results of researches successfully conducted now of the natural and live systems operated by behavior of nuclear and molecular objects from 0.1 nanometer to 100 nanometers in size.

Table 2

Timeframes and the basic characteristics of the technological orders

Time frame	Dominant techno-logical order	Characteristics of the technological order				
		Production development step	Basic economic resource	Dominant management concept	Level of the information's materialization	Dimension scale of the forming processes
1	2	3	4	5	6	7
1830	1	Instrumental	Materials (natural stuff)	Basic production management	15–11	1–0.2 mm
1880	2	Machine	Energy		11–10	100–50 micron
1920	3			Production management		50–10 micron
1950	4			Management of the enterprise	9	
1980	5	Informational	Information	Business management	8–6	10–0.5 micron
1995				Cost management		
2015	6			Managing the technological efficiency	5–2	100–0.1 nanometer

Transfer of shaping processes carried out within the sixth technological way on a nanolevel can lead to conceptual changes in the economic tools used in management of production systems in general and in rendering engineering services, in particular. It is obviously important that in this case the concept of extremely effective technologies offered in the mid-eighties of the last century [10] and gaining development nowadays [11, 13] can be almost realized. In this case as the extremely effective the technology providing the greatest possible exit of a target product (100% selectivity of the process) is understood. Degree of approach of real technology to extremely effective, which leads, first of all, to decrease in specific expenses for production, can be considered as an indicator of production efficiency.

The aforesaid represents a private example of successful use of natural-science methodology in the solution of tasks of the research and development and engineering activity – the most important transactional institute of intellectual mediation.

The assessment of projects by their reference to a certain technological way is used now in the engineering company «Polytech» and at the Southern Russian State Polytechnical University.

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