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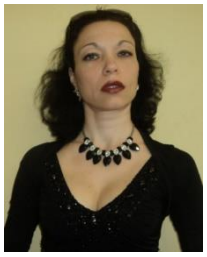

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SECTION 5. Innovative technologies in science.

METHODOLOGY OF ANALYSIS AND SYNTHESIS IN SCIENTIFIC ACTIVITY IN TERMS OF SUSTAINABLE DEVELOPMENT

Abstract: *The article deals with the foundations of analysis and synthesis as methods of scientific activity; methodological impartibility and unity of analyses and synthesis, as well as the requirements for application of these methods especially in modern conditions of global sustainable development implementation. A special attention is also paid to the concept 'quality' in association with analysis and synthesis.*

Key words: *analysis, synthesis, scientific activity, knowledge, thinking, system approach, quality, sustainable development.*

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The concept "sustainable development" is the result of the prolonged research of scientists on the problem of how to avoid the possibility of environmental shocks, the emergence and development of which was noticeable in the way of further expansion of the economy of market fundamentalism. The common feature of the approaches developed to understanding and putting into practice the concept of sustainable development in different countries is technotronic and operational orientation to the metaphysical project, concluding that all the pressing global problems can be solved within the framework of technotronic-manipulative approach in the field of economics, management, development of new technologies, including biological, et al [1].

The theory of scientific activity widely uses the methodology of analysis and synthesis, and its basic method becomes a system approach to the study of many phenomena of different nature in terms of sustainable development promotion.

The methodology of scientific activity has a long history. Thus, groundwork of Karl Popper "The Logic of Scientific Discovery", Michael Polanyi "Personal Knowledge", Ulric Neisser "Cognition and Reality", Thomas S. Kuhn "Logic of Discovery or Psychology of Research?", Russel L. Ackoff "Scientific Method. Optimistic Applied Decision" and other scientists are devoted to the study of this phenomenon.

So, let us study the foundations of analysis and synthesis as methods of scientific activity, and methodological impartibility and unity of these two opposite methods.

The main features of methodology are identified in the works of the founder of Russian methodology school – G.P. Shchedrovitsky. He considers methodology to be the work, which implies not only research, but also the creation of new activities and thinking, the latter, in turn, implies a critique, problems, research, elaboration, programming, regulation [2].

G.P.Shchedrovitsky [3] considers creation of new activities and thinking primarily as an *organization* and *regulation* of activity and thought. The basic function of methodology the scientist defines likewise: it caters to the entire universe of human activities, especially projects and regulations. In his opinion, the methodology began to emerge when multi-professional and multi-subject activity deployed, that needed comprehensive and systematic organization. The second feature of the methodology, on his opinion, is that it seeks to combine and connect knowledge of the activities and thinking with knowledge of the objects of this activity and thought. From these peculiarities it is concluded that in methodology binding and association of different

knowledge occurs primarily not according to the schema of the object of activities but according to the schemes of the activity itself.

Methodological schools relating to private methodologies has been developed in different disciplines and aim to maintain and manage the intellectual thinking in these disciplines, with no claim to the fundamental restructuring and integration of disciplines in new methodological Organon, as insisted Shchedrovitsky.

Scientific activity as a methodology is focused on development activity, which is understood in the technological sense as the methodological management of thinking in situations of rupture or disciplinary crisis.

Scientific activity is largely the activities aimed at the analysis and synthesis of certain data.

The deepest roots of analytical work should be sought in Prior Analytics of Aristotle [4], which dealt with the epistemic search (i.e. scientific research), evidencing the construction of a syllogism, the application of universal knowledge to particular cases. Posterior Analytics of Aristotle [5] is devoted to problems of proof and definition issues. This Analytics is also dedicated to the description of the epistemic search as a scientific method. In Analysts Aristotle is talking about finding universal knowledge, as well as about the application of universal knowledge to particular cases. So we can admit that in all these cases there are different kinds of analytical activities. In his Metaphysics [6] Aristotle writes down "As for the opinion that the ability is prior to operation, it is to some extend right, and to some is not; and that the activities is prior is recognized by Anaxagoras (for the mind is the activity)", and a few pages later "that the ability to make an object of thought and the essence is the mind; and it is active when it has an object of thought" [6].

Problems of association and co-organization of knowledge into a single system (i.e., what is commonly referred to as the synthesis of knowledge) are to some extant a key to the study of nature in general and theoretical knowledge in particular. And in this way they are understood and interpreted from the time E. de Condillac [7] and Kant [8]. But at the same time, as a rule, the problems of association and co-organization of knowledge were identified with the problems of constructing a unified theoretical system of knowledge – philosophical or scientific [9].

Dialectical thinking presupposes the unity of analysis and synthesis of the object or phenomenon under consideration. And this unity cannot be reduced to a simple following of analysis and synthesis, to a complement of one another, it would be wrong even to say that a deep inner connection exists between them, since they represent a single process that is reflected in different aspects. The need to combine analysis and synthesis, the following of one and the other, have been already known to metaphysics (e.g., materialists of 17-18 century), but the analysis and synthesis in their philosophy were separated. Really, standing up for scientific cognition of nature and arguing for the concepts establishing (knowledge synthesis), Kant [10] insisted on a rigorous analysis of the phenomena, that made possible the application of mathematics to the doctrine of bodies, which only thanks to it has been able to become a natural science, must be premised the principles of concepts establishing relating to the possibility of matter in general; in other words, the basis should be the exhaustive partition of concept of matter in general.

The problem was and still is not to recognize the equal necessity of analysis and synthesis in the process of cognition, but to realize their methodological impartibility. Another current problem is to determine the logical structure of their unity.

The terms *analysis* and *synthesis* are used in a great variety of various meanings:

1) analysis and synthesis as proving phases in mathematics;
2) analysis and synthesis in the sense of distinguishing analytical and synthetic judgments (Kant). This difference is the method of gaining knowledge by purely logical processing of the experimental data (which is an analytical judgment) and the method of gaining knowledge by adding to the initial knowledge experimental data from some other source (that is a synthetic judgment).

In its broadest sense, '*analysis'* might be defined as a process of isolating or working back to what is more fundamental by means of which something, initially taken as given, can be explained or reconstructed. The explanation or reconstruction is often then exhibited in a corresponding process of synthesis [11]. In the *Concise Oxford Dictionary [12*], for example, *'analysis'* is defined as the "resolution into simpler elements by analysing (opp. *synthesis*)", the only other uses mentioned being the mathematical and the psychological. And in the *Oxford Dictionary of Philosophy* [13], *'analysis'* is defined as "the process of breaking a concept down into more simple parts, so that its logical structure is displayed".

In Encyclopaedia Britannica [14] *'synthesis'* is defined as the combination of parts, or elements, in order to form a more complete view or system. The coherent whole that results is considered to show the truthmore completely than would a mere collection of parts.

Within scientific activities the analysis and synthesis are the motion in space of knowledge and activities (situational space) not limited to gaining

new knowledge by deductive inference that is not limited by manifestation of deductive competence.

Especially often the term *analysis* in isolation from *synthesis* is used in the titles of scientific disciplines. For instance, *mathematical analysis*. However, this naming of theory formed by differential (analysis) and integral (synthesis) calculus is obviously single-sided. Introduction of infinitesimal is not an end in itself, but is made for the simultaneous (not later) synthesis in complex objects of differential and integral calculus, such as differentials function, derivatives, series, integrals, etc. Infinitesimals being a result of the analysis are valid only in conjunction with infinite processes, sequences or sums that are a result of the simultaneous synthesis.

Merab Mamardishvili [15] admits that "in a general sense thinking is the fragmentation of objects of consciousness, and their unification. While study some items we split them in a certain way, allocate in them certain parts, properties, ties, and consider them separately, that is analyze them. Thinking in general is reflection by abstractions. On the other hand every thought is the establishment of some relationships between objects fixed in the thought or their parts, that is the *synthesis*".

Dialectical philosophy emphasizes that the object abstraction and elaboration of some knowledge about it do not mean its analysis, if it does not consider those of its properties that distinguish it as a part of a collection of objects from other objects of the same set.

Thus, scientific activity is the identification of distinctive features, links of object by virtue of which it is a part of a system and that cause the relationship and interaction of objects in the system. Consequently, the system is synthesized while analyzing. Exactly so the joint consideration of objects (not yet the elements of the system), uniting them in a certain set does not mean their synthesis to the point where it will be installed some logic and interaction between them, which will create (synthesize) the system under consideration. Structural unity of analysis and synthesis means interdependence of knowledge (analytical and synthetic) or the research problem and characteristics of the method for performing each of them individually.

An example of the gap between analysis and synthesis could be the formation of the concept *quality* in its modern description. Before the standardization of the concept the word *'quality'* had been used in a wide variety of ways, mainly being reduced to a set of particular characteristics of industrial products. Coming from the British and international standards, the concept of quality has undergone exactly the gap on the stage of analysis and synthesis. In international standard ISO 8402:1986 the notion *'quality'* is defined as "the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implemented needs" [16]. 8 years later, in ISO 8402:1994, the definition of the notion *'quality'* has been transformed into "the totality of characteristics of an entity that bears on its ability to satisfy stated and implied needs" [17].

These examples emphasize that synthesis, as a component of scientific activity, is not picking up a set of elements or properties, but is a creation of a system of interacting elements and properties that differ for their role in a system that arises in the analysis, i.e. the creation of a full understanding of the object or phenomenon.

According to M. Mamardishvili [15] an elementary process already reflects the interaction of different elements of the system and is both analysis and synthesis in the sense of obtining knowledge through analytical synthesis and synthetic knowledge by analyzing.

Thus, we can conclude, that scientific activity is the practical or mental identification and connection of elements of the systems under research (objects, processes, events).

The analysis and synthesis have *mental* split and unification of items in the abovementioned sense. But it must be taken into account that the content of this logical activity historically is being formed for the first time in the real subject-human activity (i.e., not in contemplation) and only later is extended to items related as a 'part-whole' relation, regardless of the practice of a person. This relationship as well as the difference of the real and logical operations is also based on it [15].

The thing is that the process of analysis-synthesis occurs as a response to a problem with some real system. In the analytical work are either understood (modeled) components of existing real system, or are created some holistic system that does not exist in nature (the model of the system under consideration). Correlation and the set of elements itself is a result of practical human actions and is recorded as being necessary depending on the conditions of use of the object created in social practice.

So, to conclude we should admit that methodology may be defined as the most powerful form of human collective mental activity. And we can define scientific activity as the unity of analysis and synthesis in studying complex systems. The analysis and synthesis occur simultaneously, that is, analysis of the system into components is made simultaneously with synthesis of the system derived from the elements. Within scientific activities the analysis and synthesis are the motion in space of knowledge and activities not limited to gaining new knowledge and these aspects are extremely important in term of sustainable development implementation.

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