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PHILOSOPHICAL ASPECTS OF THE THEORY OF A FUNCTIONAL SYSTEM

Scientists in many fields are presently giving the closest attention to study of the potentials of the systems approach for understanding what cannot be comprehended with the analytical approach or, as V. A. Engel'gardt has put it, "an accumulation of material in reduced form." This approach is in some degree a gesture of despair. It is quite obvious that we now face the danger of drowning in the abundance of data accumulated in terms of "special" problems not tied into a system, and that this threatens loss of general direction.

Ellis, a major neurophysiologist recently awarded a Nobel Prize, expressed this notion as follows: one must stand in the middle of the battle over the problem of the brain to see that at least 95 percent of the published research is of no value to the building of a general theory. This applies not only to neurophysiology but to other spheres — biology and the like. Thus, the search for a key that would connect the level of integration and the analytical level at which details are learned is that cardinal problem that continues to face us not only in the sphere of world view but also in that of practice.

Naturally, there is also need for generalization of the special analytical materials that themselves are capable of being successfully utilized, both in practical activity and in major theoretical generalizations. At the present time, that quest for a system is being conducted as intensively as possible. Suffice

it to say that a whole list of societies, journals, and symposia are engaged in systems research; in a word, system has become the lighthouse directly illuminating the path to experimentation and all other types of scientific research. Although the tendency to tie the level of integration to the level of specialized studies, the level of the results of analytical investigation, has become considerably stronger, this phenomenon must be approached critically. It must be said that all this scientific motion does not yet have the rigorous logic that is essential if the two levels of research are to be combined. The absence of rigorous logic in posing the question of what is being sought and toward what end has brought a number of researchers and thinkers to a dead end, including L. Bertalanfi himself.

Therefore, it is necessary to decide first of all toward what end we seek to formulate a system that might be generally acceptable. This fundamental goal of the quest is of the utmost importance if the final result is to be truly productive.

The fact of the matter is that the task consists of filling that gap which still, in many sciences, separates the level of the whole from the level of the partial, analytically obtained finding. This chasm cannot be filled either by words or formulations. Effective principles of work in this direction must be found. In the second place, a system is useful only when it is an everyday instrument of research, i.e., an instrument helping a researcher to pose the task on a broader scale and to find explanation for data obtained by whatever analytical devices. Solution of these two tasks will make it possible to eliminate the gap and to develop concrete working principles.

Nevertheless, these questions have not yet been resolved. This means that the logic of development of the problem itself requires their solution first of all. If we do not settle them, we will be compelled to remain at the level of verbal formulations, and will not attain that concrete result for science which formulation of the notion of a system, in the true sense, can give.

The task which we posed in our practical and theoretical work consisted specifically of this. To close this gap means to formulate a principle of work that, on the one hand, is in the realm of

wholeness, i.e., has the characteristics of an integrated whole, and, on the other hand, falls into the analytical realm. When this condition is included, the principle can be viewed as a transmission belt between the whole and its parts.

The concept of a functional system provides us with precisely this principle. A functional system makes possible research in any given area of a whole, with the assistance of any techniques whatever (microelectronic, electrophoretic, etc.). But these researches are in intimate unity thanks to the functional system, which shows where and how the given researches are conducted.

This possibility arose as the result of the solution of two questions that had not been resolved in the systems approach, but without which no advance was possible. The first question, which we posed a long time ago and which found satisfactory solution at the given stage, consists of the following. All known formulations of systems essentially have a leitmotif, the principle of interaction (this means interaction of a set of components, interaction and relationship among components, etc.). If one were merely to count the number of cells and the number of synapses, i.e., of stimuli, that each individual cell is capable of receiving, the number of interactions possible in the brain would have to be expressed by a number of fantastic size — unity followed by so many zeroes that it would take a ribbon 9,500,000 kilometers long to write it. To call this an astronomical figure does not begin to describe it! And it is clear that nature has developed in the direction of increasing these degrees of freedom, these possible interactions. But unbelievable chaos would have resulted if all these interactions had been organized at once into a single system. This is why the word "ordering" is coming to penetrate more and more into systems formulations. However, if we introduce that term but do not discover the phases by which a set becomes ordered, we will not be far from the notion of entelechy, i.e., the assertion that there is someone who brings order, some power intervening in the system and straightening it out. Therefore, it is necessary to examine a concrete system and see what it is that orders this set of degrees of freedom.

Many studies carried out in our laboratory have shown that it is as a result of the working of the system that this factor bringing order is constituted. This alone is capable, by means of feedback (which is cybernetics' word for afferentation), of influencing the system, sorting through all the degrees of freedom and leaving only those that promote attainment of the given result. The result dominates the system, and the influence of the result pervades the entire system that has taken shape. The result has an imperative influence upon the system. If it is insufficient, that information about the insufficiency of the system soon reorganizes the entire system, sorts through all the degrees of freedom, and, in the final analysis, each element enters into the work with the degrees of its freedom that facilitate the obtaining of the result. Introduction of the result into the integrating factor made it possible to discover the path whereby order was brought in systems.

A second important problem that has not been resolved by the systems approach in Western countries, particularly the USA, consists of the following. As long as people continue to leap from the whole directly to analytical detail, it is difficult to anticipate positive results in the utilization of systems ideas as an instrument of everyday research. The functional system fills this gap, since it treats of a highly particular operational working architecture with a specific mechanism and specific properties, which admit of posing the question on the analytical plane. In a functional system, there is a stage of afferent synthesis, and it is at that stage that the question of the result to be attained is resolved.

Here introduction of physiological determinist notions removed the semblance that the whole was teleological. The whole is something programmed in concrete afferent parameters of the result to be. We hold that once the entire process of approaches to the whole is evident from neurophysiological material (which has been well demonstrated by I. T. Frolov), this problem is one of expediency, and it is neither necessary nor possible to impose anything teleological upon it. At this point, we came up against the need to solve a philosophical problem,

or, to be more accurate, the need to draw a philosophical generalization, which would clarify the entire process occurring in the functional system until results are attained. The acceptor of the action is an apparatus that makes a decision upon receiving a result, and codes all the properties of this result before it is realized. And this circumstance compelled us to think. We could not but ask the question, how is this? The principal law of the reflex theory is the translational course of stimulation. The law of translationality is the fundamental principle of reflex theory. What is it that we see here?

At the moment the decision is adopted, a process is in progress that runs far ahead of events. It does not take shape translationally. It already has a result coded in its major parameters, the attainment of which may be a matter of minutes, of hours, or perhaps of years. How does the anticipation of events take shape? I think that many are familiar with the law of anticipatory reflection of reality. Anticipation of events is, above all, active maintenance of an established goal until it is realized.

Quite recently, a neurophysiological phenomenon has been recorded in our laboratory, on the basis of which it proved possible to "spy out" and discover the "cunning" that had created in nature the effect of long-term adherence to a goal. Thus, for example, suppose I have posed myself the goal to do something, to buy something. But no matter where I walked or traveled, no matter what I did, this goal remained. What forces maintain a goal until it is realized? It turns out to be the reflex apparatus. Our acts yield branchings of the stimulus that charge parts of the brain, and these impulses return to the brain, to the cerebral cortex, where they constantly yield energy to shape the goal. Thus, the physiological nature of active adherence to a goal over a long period of time has been discovered.

How does this anticipation proceed? It was inevitable that we would arrive at a formulation for space and time in the philosophical plane. And here we encountered an important circumstance that it proved necessary to think about. Both the physical and the philosophical formulation of space and time take into consideration the fact that the principal parameter here is

sequence. In an article by Lebedev and Stepin in Voprosy filosofii (1), we read that sequence is the principal parameter of time. We framed the question somewhat differently, and it is precisely this aspect that I should like to discuss here.

The physical theory of time proceeds from truly absolute time, i.e., from that which exists outside the organic world and which existed before the appearance of life on earth. But life did appear, and we know that it is inscribed by numerous mechanisms into all the laws of the world that existed before life existed. This is why the question we posed was legitimate: how was organism inscribed in the fundamental law of the world, in space? It turned out that the stimulating acceptor within a functional system is one of the indications of this inscription, existing during the millions of years of evolution of living beings.

May an organism which has but a single parameter — sequence — be written into time? No. There would be no life on our planet, and, of course, neither would there be the symposium at which I am speaking. What is sequence? It is the succession one after the other of events in the world without, which may not be repeated, for in such a case the possibility of stable life outside the organic world would then be ruled out entirely. However, other parameters of time, the repeatability and rhythmicity of events in the world without, proved to be the component of time that facilitated the development of life. Why is this so? The point is that if the space in which we are inscribed and which influences us every second comprises a continuum, and the brain is an organ of adaptation, this continuum cannot proceed for a single minute without the involvement of the brain. Otherwise, adaptation to the events of the world without would be impossible. The organism would not be able to survive, and the guarantee of natural selection would be ruled out.

We examined the brain precisely in the plane of how it might reflect the spatial continuum. Certain categories of nerve cells continue their reactions to external stimuli after cessation of the effect of the direct stimulus, which leaves a distinct "track." This "track" is expressed in discharges of nerve cells based upon chemical processes in the cell itself, upon ion and meta-

bolic processes. But the continuum of the external world is such that events occur in it considerably more rapidly and continuously than the individual cell can function. And therefore it is natural that every new event builds up on top of the preceding ones, as has been demonstrated by all the experiments conducted, examined from this point of view. Now, after what we know about the brain, we cannot conceive of any external impression that does not leave its own "track" in the form of chemical processes.

Here a new sphere of investigation, at first glance inexhaustible, opens before us. How can the world, with this uninterrupted flow of events, inducing an uninterrupted flow of chemical processes in the brain, be rationally perceived? We have resolved this problem on the theoretical plane. The entire question now is what path to take in further research. In inorganic objects, the physical sequence of external events is only a sequence in space and time. Not all the components of the space and time continuum are equally important. Therein lies the key to explaining why the organism has overcome this seeming chaos in reacting to all external events. That which distinguishes the brain's system of functioning is that it not only reflects the space-time continuum but, thanks to a special capacity of animate matter, is able, over and above all else, to accumulate past experience. This property of the human brain is expressed in the capacity to construct an anticipation of events through a continuum. And this capacity of animate matter was very widely employed in the entire course of evolution.

The problems that I have sketched out here are of decisive importance to us, and in some degree they are revolutionizing our process of research. At present, not only can and must many forms of that process be reexamined, but so must the entire research process. This is not just our task. A vast opportunity for interdisciplinary work has arisen, with philosophers first of all, but not with them alone.

This combining of efforts raises hopes. We will be able to produce generalizations and ideas without which advance is impossible. True, sometimes generalizations, ideas, and concepts collapse and new ones are built, but that is something that a

scholar must regard as inescapable from the very first steps of his work in research. Hypotheses become outdated, and if they are held onto, doubt is cast upon their tenability.

I should like to close with the words of Claude Bernard: "What happiness it is to destroy a theory, particularly one's own."

Note

1) See V. P. Lebedev and V. S. Stepin, "Gnoseologicheskii aspekt poniatiia vremeni," Voprosy filosofii, 1970, No. 10.