CONCLUSION

Let us summarize the main results of our investigation.

1. Theoretical knowledge emerges as a result of the historical development of culture and civilization. Its primary forms were represented by philosophical knowledge which was the only form of the theoretical at the stage of prescience. The transition from prescience to science resulted in the emergence of scientific theoretical knowledge which in the further evolution of culture represents the theoretical as such.

2. Developed science as opposed to prescience does not confine itself to the modeling of only those thing-oriented (object) relations that are already integrated into the existing practice of production as well as everyday experience. It is capable of going beyond each historically concrete type of practice and of opening new worlds of things to mankind that may become the objects of mass practical assimilation only at future stages of the development of civilization. Leibniz used to characterize mathematics as a science of possible worlds. This characteristic may be in principle applied to any fundamental science.

3. Breakthroughs towards new object worlds become possible in developed science thanks to a new mode of generating knowledge. At the stage of prescience models for the transformation of objects included in practice were created through a schematization of practice. Objects of practical manipulation were replaced in cognition by ideal objects, abstractions belonging to thinking, whereas the relations of ideal objects, the operations involving them were also abstracted from practice, being a kind of scheme of practical actions. Though still applied in developed science, this mode loses its leading positions. A different mode of constructing knowledge comes to the force – one in which models of the object relations of reality are first created as if from above with respect to practice. Ideal objects, acting as elements of such models, are created not from the abstracted properties and relations of objects of actual practice, but on the basis of already existing ideal objects produced at an earlier time. Neither is the structure (network of relations) into which they submerge extracted directly from practice (by abstracting and schematizing the actual relations of objects), but is instead borrowed from earlier forms of knowledge. Models formed in this way serve as hypotheses which later, upon receiving justification, are turned into theoretical schemes of the field of objects under consideration.

It is precisely theoretical research based upon a relatively independent manipulation of idealized objects that can discover new fields of objects before they are assimilated by practice. The theorizing capacity is a kind of indication of developed science.

4. The theoretical mode of investigation and respectively the transition from prescience to science properly speaking was first fulfilled in mathematics, then in natural science and, finally, in technical and social sciences. Each of these stages in the development of science had its own social and cultural preconditions. The birth of mathematics as a theoretical science was linked to the culture of the ancient polis, to the values of public debate and the ideals of validation and proof distinguishing knowledge from opinion, all of them promoted by this culture.

The preconditions of natural science which brought together the mathematical description of nature and experimentation are to be found in the shaping of the fundamental worldview universals pertaining to the technogenic culture, they are: the conception of man as an active practice-oriented being engaged in transforming the world; the conception of activity as a creative process giving man power over objects; the conception of nature as a necessarily ordered field of objects set against man; the interpretation of the ends of knowledge as rational cognition of the laws of nature, etc. All these values and vital meanings that took shape in the age of Renaissance, Reformation and early Enlightenment were radically different from the understanding of man, nature, human activity and cognition which dominated traditional cultures.

The further development of the technogenic civilization, its industrial stage witnesses the emergence of the preconditions for technical and social sciences. The intensive development of industrial production generates the need in inventing and reproducing ever new engineering devices, which stimulates the appearance of technical sciences possessing a theoretical level of research. During the same historical period the relatively rapid transformations of social structures, the destruction of traditional communal bonds replaced by relations of "reified (thing-like) dependence", the emergence of new practices and types of discourse objectifying human qualities, create preconditions for the social sciences and humanities in general. There appear conditions and demands for finding ways of rationally regulating the standardized functions and actions performed by individuals entering one social group or another as well as of managing different social objects and processes. It is in the context of these demands that the first programs of constructing sciences of society and man come into being.

5. Scientific knowledge is a complex historically developing system which over time gives rise to ever new levels of organization. In their turn, they influence the levels of knowledge created earlier and lead to their transformation. This process marked by a changing strategy of scientific exploration witnesses the incessant birth of new devices and modes of theoretical research.

At its developed stages science appears as a form of knowledge organized into disciplines, in which its separate fields – the scientific disciplines (mathematics; natural sciences including physics, chemistry, biology, etc.; technical and social sciences) – function as relatively independent interacting subsystems.

The emergence and development of scientific disciplines is quite uneven. They give birth to various types of knowledge, and while certain sciences have already gone a long way in the direction of theorizing and have demonstrated examples of elaborate mathematized theories, others are only embarking on this path.

The specificity of the subject of each science may result in the fact that certain types of knowledge prevailing in one science may be of a second order in another. They may also become transformed in it.

The primary unit of a methodological analysis of the structure of theoretical knowledge should be associated not with a separate theory in its relation to practice (as was argued by the so-called standard conception), but with a scientific discipline. The cognitive structure of a scientific discipline is determined by the levels of theories of a varying degree of generality, both fundamental and local, by their relations to each other as well as to the complex level of empirical research (of facts and observations), and, last but not least, by their links with the foundations of science. The foundations of science serve as a system-building factor for a scientific discipline. They include: 1) a special scientific picture of the world (a disciplinary ontology) which introduces a generalized image of the subject of a given scientific discipline in its major systemic and structural characteristics; 2) the ideals and norms of research (the ideal and norms of description and explication, of proof and justification as well as the ideals of a structure and organization of knowledge) which determine the generalized scheme of the method of scientific cognition; 3) the philosophical foundations of science that justify the accepted picture of the world as well as the ideals and norms of science, ensuring that the conceptions of reality and of the methods of its cognition devised by science enter the flow of cultural transmission.

The foundations of science, besides a disciplinary component, possess an interdisciplinary one. It is formed by the general scientific picture of the world as a unique form of systematizing scientific knowledge, contributing to a wholesome image of the Universe, of life, society and man (disciplinary ontologies are aspects or fragments with respect to such a general scientific picture of the world), and also by a special layer related to the contents of the ideals and norms of cognition, of the philosophical foundations of science, which places in relief the invariant characteristics of the scientific as such accepted in this or that epoch (these characteristics are specified in accordance with the subject and methods of each scientific discipline). The interdisciplinary component of the foundations of science provides for the interaction between different sciences, the transfer of methods and ideas from one science to another. Theoretical knowledge functions and develops as a complex system of intradisciplinary and interdisciplinary relations.

6. The content structure of scientific theories is defined by the systemic organization of idealized (abstract) objects (i.e., theoretical constructs). The statements of theoretical language are directly formulated regarding theoretical constructs, and only indirectly, due to their relation to an extralinguistic reality, do they describe (this) reality.

In the network of the abstract objects (constructs) of a scientific theory one may single out specific subsystems created from a limited set of basic constructs. By means of their interrelations they form theoretical models of the reality under consideration. These models are integrated into a theory and play the role of its “inner carcass”. Theoretical laws are formulated with respect to them. Such models, being the nucleus of a theory, can be named theoretical schemes. They should be distinguished from models-analogues which are employed to build a theory and serve as its “scaffolding” without forming part of its structure.

In a developed theory one may discover a fundamental theoretical scheme in respect to which the basic laws of theory are formulated, as well as local theoretical schemes in respect to which laws of a lesser degree of generality are formulated, being inferred from the first. These schemes and corresponding laws create a hierarchy of levels. Within the framework of the theoretical knowledge of a scientific discipline certain local theoretical schemes and laws may enjoy an independent status. Historically they precede developed theories. Theoretical schemes are projected onto the scientific picture of the world (disciplinary ontology) and the empirical data accounted for by theory. Both of these projections are captured by means of special statements which characterize the abstract objects of theory in terms of the picture of the world as well as of idealized experiments grounded on actual experience. The latter statements are operational definitions. They have a complex structure and are not reduced to the description of actual measuring situations, though such descriptions are incorporated into their very essence.

The relation of a mathematical apparatus to a theoretical scheme projected onto the scientific picture of the world ensures its semantic interpretation, while the relation of the theoretical scheme to experience provides for its empirical interpretation.

7. Theoretical schemes play a most important role in the deployment of a theory which is carried out not only by means of a deductive inference accompanied with formal

operations (the deduction of corollaries from equations), but also in a genetically constructive way by means of intellectual experiments with theoretical schemes. The conception of a theory and its functioning as a hypothetico-deductive system requires serious reconsideration. In theories which do not belong to the class of formalized systems (and theories of this kind constitute an overwhelming majority in natural sciences, in technical and social sciences) the inference, from basic laws of their theoretical consequences presupposes a complicated transformation of the theoretical schemes, a reduction of the fundamental theoretical scheme to a local one. Such reduction combines deductive and inductive modes of investigation and serves as a ground for solving theoretical problems. The unfolding of a theory takes place as the solution of theoretical problems some of which are integrated into theory in the form of "paradigmatic models (patterns)" (T.Kuhn). The conception of the structure of theoretical schemes as well as of the genetically constructive ways of building theories allows to considerably specify Kuhn's problematic of models as an obligatory element in the structure of a theory of experimental sciences.

8. The construction of a theory and its conceptual apparatus regarded as a problem presents itself first of all as the problem of the genesis of theoretical schemes. Such schemes are first created as hypotheses and then are justified experimentally. The construction of theoretical schemes as hypotheses is performed by way of borrowing abstract objects from other fields of theoretical knowledge and of combining these objects in a new "network of relations". This mode of creating hypothetical models can be fulfilled in two ways: by means of a substantive manipulation with concepts and by means of putting forward mathematical hypotheses (in the last instance hypothetical equations implicitly introduce a hypothetical model providing for a preliminary interpretation of those equations).

It is hard to overestimate the role of the foundations of science in articulating the hypothetical variant of a theoretical scheme. They determine the formulation of the problem along with the choice of technical devices indispensable for putting forward a hypothesis. The foundations of science function as a global research program guiding scientific exploration.

9. In the process of constructing hypothetical models abstract objects are endowed with new characteristics since they are introduced within a novel system of relations. An experimental justification of hypothetical models implies that the new characteristics of abstract objects should be acquired as idealizations based on new experiments and measurements – those that were to be accounted for by the hypothetical model. We suggest that this procedure be designated as the method of a constructive justification of a theoretical scheme. Schemes that have undergone this procedure usually acquire a new content in comparison with their initial hypothetical version. Being reflected upon the picture of the world they induce changes in it. Due to all these operations the development of scientific concepts takes place. Not only the formulation, but also the justification of a hypothesis plays a decisive role in shaping a theory's conceptual apparatus. In their turn, the justification of hypotheses and their transformation into theory create means for future theoretical inquiry.

10. The method of constructive justification allows revealing the "weak points" in a theory and thus ensures an effective reconstruction of scientific knowledge. It opens up possibilities for an effective verification of the consistency of theoretical knowledge, allowing to discover a theory's hidden paradoxes before they are unveiled by the chaotic

flow of developing cognition. The method of constructiveness should be regarded as a further elaboration of the rational elements of the principle of observation.

11. The discovery of the procedure of "constructive justification" offers a solution to the problem of the genesis of the "paradigmatic models" of theoretical tasks. The elaboration of a developed theory is carried out through a successive synthesis and generalization of the local theoretical schemes and laws. At each new step of this generalization the intactness of the previous constructive content is verified, which automatically introduces the models of reduction of a generalized theoretical scheme to local ones. At the final stage of the theoretical synthesis when a fundamental theoretical scheme is created and the basic laws of a theory proclaimed, the verification of their constructive meaning is performed by way of an elaboration, on the basis of the newly formulated fundamental theoretical scheme, of all the local theoretical schemes that it encompasses. This results in the emergence of paradigmatic models for the solution of theoretical tasks. The further evolution of a theory and the extension of the field of its application introduce new models into its core. But only those that appeared while a theory was still in the making remain basic with respect to it. A theory preserves the traces of its past history reproducing the main stages of its evolution in the form of paradigmatic tasks and models.

12. The strategies of theoretical investigation are subject to change in the historical development of science. Such changes presuppose a reconstruction of the very foundations of science and are characterized as scientific revolutions. One may sort out two types of these revolutions. The first of them, described by Kuhn, is linked to the appearance of anomalies and crises produced by the expansion of science into new fields. Their mechanisms may be specified on the basis of the foundations of science structure as well as the procedures of an ongoing correlation with the foundations of emerging theories. The second type, rather poorly examined in methodological literature, can emerge without anomalies and crises, springing from interdisciplinary connections. In this case various elements of disciplinary ontologies, ideals and norms and also philosophical foundations are transferred from one science to another. Such "paradigmatic grafting" leads to the reformulation of a scientific discipline's former tasks, to the posing of new problems and the emergence of novel means for their solution. The first type of scientific revolutions is exemplified by the making of the theory of relativity and quantum mechanics. The second – by the coming into being, in the end of the 18th – first half of the 19th century, of a science organized into disciplines as well as by the contemporary "exchange" between cybernetics, biology and linguistics.

13. The reconstruction of the foundations of science at the time of scientific revolutions is performed, on the one hand, under the pressure of new empirical and theoretical data accumulating within scientific disciplines and, on the other, under the influence of socio-cultural factors. Scientific revolutions are specific "points of bifurcation" in the evolution of knowledge when different possible guidelines (scenarios) of scientific development become apparent. However, those guidelines (research programs) are implemented that not only bring about a positive empirical and theoretical shift (I. Lakatos), but that also fit into the culture of the epoch, being in accord with the possible modifications of the meaning of its worldview universals. If the historical development of culture and civilization had taken a different turn, other possible histories of science could actually have happened. In times of scientific revolutions it is as if, from the multiplicity of scenarios of a future history of science, culture sorts out those that best of all correspond to its basic values.

14. In epochs of global scientific revolutions when all the components of the foundations of science are being reconstructed a change in scientific rationality takes place. One can single out three basic historical types of rationality, i.e., classical, non-classical and post-non-classical science. Classical science assumes that true knowledge of an object is conditioned by the elimination, in the process of theoretical explication and description, of all that which has to do with the subject, its goals and values as well as the means and procedures of its activity. Non-classical science (its example being a relativist quantum physics) takes into account the relation between the knowledge of an object and the nature of the means and procedures of the activity in which the object is discovered and cognized. Nevertheless, relations between intrascientific and social goals and values are still outside scientific reflection, though defining implicitly the nature of knowledge (defining what it is that we isolate and conceive in the world as well as the way we do it). The post-non-classical type of scientific rationality extends the field of reflection on activity. It is aware of the relation not only between the knowledge of an object and the specific nature of the means and procedures of activity, but between this very knowledge and the structure of the goals and values of such activity as well. At the same time the relation between intrascientific and extrascientific goals is brought to light. In overall investigations of complex self-developing systems more frequently than ever becoming dominating objects in natural science and technology (including the objects of ecology, genetics and genetic engineering, "man – machine – environment" technical complexes, modern information systems, etc.) the elucidation of the ties between intrascientific and social values is performed through social expertise of respective investigation programs.

The historicism of the objects of contemporary natural science along with reflection on the value-related foundations of research remove the opposition between natural and social sciences. True with respect to 19th century science, at present it considerably loses its significance.

The emergence of a new type of rationality does not eliminate those that preceded it historically, instead it limits their field of application. Every subsequent type of scientific rationality introduces a new system of the ideals and norms of cognition, which provides for the mastering of a respective type of systemic objects, i.e., simple, complex, historically evolving (self-organizing) systems. This brings about a change in the categorical framework of the philosophical foundations of science – in the concepts of thing, process, space, time, causality, etc. (the ontological component), and in the concepts of knowledge, theory, fact, method, etc. (the epistemological component). Finally, a new type of rationality accounts for the alteration in the worldview applications of science. At the classical and non-classical stages of its evolution science was justified only on the values of the technogenic civilization rejecting the values of traditional cultures as contradictory to it. Post-non-classical science markedly extends the field of possible worldview meanings with which its achievements accord. It forms part of the contemporary processes of solving global problems and choosing mankind's vital strategies. Post-non-classical science embodies the ideals of an "open rationality" and actively participates in the search for new worldview guidelines determining the strategies of contemporary civilizational development. It uncovers the proportionality of its own achievements not only to the values and priorities of the technogenic culture, but also to a series of philosophical and worldview ideas elaborated in other cultural traditions (to the worldview ideas of the traditional Oriental cultures and the ideas articulated in the philosophy of Russian cosmism). Post-non-classical science organically enters the contemporary processes of shaping a planetary thinking, of a dialogue of cultures, becoming one of the most important factors of a cross-cultural interaction between the West and the East.