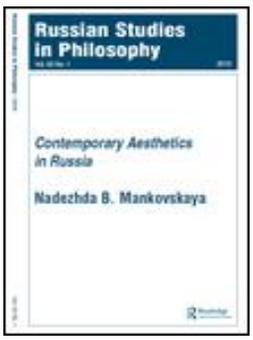

Routledge
Taylor & Francis Group

Russian Studies in Philosophy

ISSN: 1061-1967 (Print) 1558-0431 (Online) Journal homepage: http://www.tandfonline.com/loi/mrsp20

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To cite this article: Sergey N. Korsakov & Lidia F. Kuznetsova (2015) The Scholarly Career of Academician Vyacheslav S. Stepin, Russian Studies in Philosophy, 53:2, 115-150, DOI: 10.1080/10611967.2015.1096698

To link to this article: http://dx.doi.org/10.1080/10611967.2015.1096698

Russian Studies in Philosophy, vol. 53, no. 2, 2015, pp. 115–150.

ISSN: 1061-1967 (print)/ISSN 1558-0431 (online)
DOI: 10.1080/10611967.2015.1096698

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The Scholarly Career of Academician Vyacheslav S. Stepin

This essay serves as an intellectual biographical introduction to the special issue devoted to one of the leading Russian contemporary philosophers, Vyacheclav S. Stepin. The essay discusses Stepin's philosophical works and his chief contributions to such fields as philosophy and methodology of science, epistemology, and philosophical ontology among others. The authors also reflect on Stepin's academic leadership and his role as an organizer of research in philosophy in the contemporary Russia.

Academician Vyacheslav Semenovich Stepin's first scholarly publication appeared half a century ago. The ensuing fifty years witnessed a long scholalry career; moreover, during many stages of that career, Stepin represented one of the leaders of Russia's philosophy from the mid-twentieth to early twenty-first centuries.

An academic biography of Stepin would be valuable for the history of science and philosophy because the scholar's path of thought has a basically internal rather than external logic of circumstances. Stepin consistently advanced toward solving whatever problems he posed, and

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Translated by Brad Damaré.

each subsequent step was due to new possibilities that arose as a result of his having solved an earlier problem. This deepening along the path of knowledge was accompanied, as is usually the case among scholars who think ambitiously, by a broadening of the fields of applicability of his ideas. After solving the special methodological problems of physical knowledge, the philosopher moved on to fundamental questions about the emergence and functioning of scientific theories, and then to the general concept of the development of science, culture, and philosophy. In order to trace Stepin's scholarly career, it is necessary to draw conclusions about the nature and achievements of Russian philosophy of the past fifty years. This is even more important as we have not yet reflected sufficiently upon evaluations of the development of the most recent Russian philosophy, due to the lack of temporal distance.

Vyacheslav Semenovich Stepin belongs to the generation of the 1960s, not only in time but also in essence. He began his university studies in 1951 during the darkest period of Stalinism, and after graduating in 1956, he listened to Khrushchev's "secret" report on "Stalin's cult of personality" read at a Komsomol meeting. The changes taking place in the country could not help but influence the young philosopher. During his university years he was actively involved in self-education, filling in the gaps of the dogmatized academic programs; he studied the primary-source classics of philosophical thought. Stepin developed an interest in the problems of philosophy of science and began to study physics intensively; with the rector's permission, he studied in the university's physics department alongside his studies in the department of philosophy.

It is well known that the mid-1950s reversal of Stalinist dogmatism toward professional philosophizing took place primarily in areas like theory of knowledge and methodology of science. The standard explanation for this phenomenon was the desire of inquisitive minds to flee to the least ideological spheres of philosophizing, but such as explanation is too schematic. The issue was significantly deeper: the situation in Soviet philosophy was somewhat identical to that of the early modern period. Modern philosophy was primarily engaged with epistemological and methodological issues, and not only because of the needs of emerging sciences. Philosophy itself had its own needs: principal among them were justifying the sovereignty of the reason and overcoming the tradition of appeals to authority as decisive philosophical arguments. Descartes justified the sovereignty of reason with his *cogito*, and this means of justification implicitly valued the autonomous, sovereign individual. Without the second, the first would not occur. Therefore, a direct path lay from methodology and theory of consciousness to philosophical anthropology and humanism.

Something similar can be observed in the movement of all Russian philosophical thought during the second half of the twentieth century. Vyacheslav Stepin's creative search developed in a similar vein.

On entering graduate school, Stepin conducted research on positivism in the Vienna Circle (Karl Popper, Ludwig Wittgenstein, Hans Reichenbach). He studied the works of Moritz Schlick, Rudolf Carnap, Philipp Frank, Richard von Mises, and Viktor Kraft, as well as that of similar thinkers who ideas were in tune with and had an influence on the research of the Vienna Circle. But with his deepening study of the material, Stepin was faced with the necessity of revising the initial principles of analysis and evaluations of positivism that had been adopted by Soviet philosophy of that time. He was unsatisfied with the first written version of his thesis, though the text was approved at a meeting of a department as a whole. Stepin behaved unexpectedly for a young scientist who needed to define himself in life: he did not defend the thesis already recommended by his department, and at the end of his graduate studies he switched to teaching.

In Soviet philosophy during those years, the tradition of "critiquing" positivism was influenced by Lenin's book *Materializm i empiriokrititsizm* [Materialism and Empirio-Criticism]. Lenin, of course, regarded the second-wave positivism of Mach and Avenarius as a kind of subjective idealism. This kind of assessment is an enormous simplification, as the influence of Hume's phenomenology is more clearly visible in second-wave positivism, and in later neo-positivism, than Berkeley's subjective idealism. This Lenin-style assessment spread from second-wave positivism to positivism as a whole. Researchers did not have the right to use their own discretion in changing these established assessments. They were not allowed to demarcate between the historical features of positivism as a philosophical movement and the objective, enduring contributions that positivist philosophers brought to the creation of philosophy of science as a special philosophical discipline.

Returning to a revision of his thesis, Stepin managed to extricate himself from this difficult situation, as befits a true philosopher. He did not adapt himself to the official assessments, but neither did he polemicize against them. He analyzed the potential abilities and real results of the positivist program so deeply that he was able to provide a fundamentally new understanding of the issue as a whole in the master's thesis he defended in 1965.

Above all, Stepin separated the content of the positivist program, which corresponded to the methodological demands of science, from the "ideological" mindsets that positivism, like any other philosophical doctrine, did not avoid. The acceleration of development in science during

the age of industrialization and the emergence of new disciplines in the natural, technical, and social sciences required the development of a new methodology for scientific research. Positivism was the area of philosophical knowledge aimed at solving this problem. Each stage of its development from the first wave (Auguste Comte, Herbert Spenser, John Stuart Mill) to empirio-criticism and then to neo-positivism saw the propagation of mindsets both for the search for rules for forming new scientific knowledge, and for the development of principles of systematizing and synthesizing that knowledge that ensures that unity of science's disciplinary structure.[1]

These mindsets corresponded to the needs of science, and their formulation as priorities in the philosophy of science can be considered one of positivism's contributions. The issues were how to solve these problems and from what position to develop them.

Stepin showed that the positivist program of working through methodological problems in science derived from very narrow and generally inadequate notions about scientific knowledge. This program included three main clusters of ideas:

The first was the consideration of scientific knowledge as an absolutely autonomous structure, abstracted from the influence of social factors. Positivism believed that scientific knowledge needed to be analyzed outside its interactions with other forms of cognitive activity, like philosophy, art, and everyday knowledge. According to positivist doctrine, their influence on science only creates obstacles on the path to strictly scientific knowledge. The program of cleansing science of metaphysics emerged in line with this mindset. While rightly criticizing the formulations of natural philosophy that had no support in scientific facts, positivism extended this critique to philosophy in general. The elimination of metaphysics from science was seen as a condition of developing an effective research methodology.

The second set of ideas was the mindset on searching for methodological principles abstracted from their historical development. Positivism saw its task as constructing a strictly scientific and complete system of methods for ensuring effective research.

Finally, the third set of ideas was connected with the understanding of scientific research solely as a purely cognitive activity unconnected with the development of practices.

All these assumptions introduced a very limited idealization of science. As Stepin showed, the difficulties positivism faced were foreordained by the limitations of this idealization. Neo-positivism's idea of physicalism, in which the unification of sciences organized by discipline could be achieved

by reducing the diversity of discipline-specific languages to the language of physics, was untenable. As for the processes of developing new knowledge, neo-positivism initially set revealing the logic of scientific discovery as its goal, but it abandoned this program and limited itself to the development of a logical justification for knowledge. The process of advancing scientific hypotheses was assigned to the field of psychology of discovery, and only the process of justifying the hypotheses through experiment was included in the field of logical and methodological analysis.

In neo-positivism, justification itself was viewed through the concept of verification as the comparison of theoretical consequences with the protocol sentences that record the given observations. The well-known difficulties and contradictions of this concept testified to the need for new approaches toward the problem of justifying knowledge.

At the same time, Stepin also identified those substantive aspects that neo-positivism discovered in the analysis of scientific language (those aspects that positivism's idealization of knowledge permitted to be recorded). These aspects included the separation of the empirical and theoretical levels of scientific language; the statement of theoretical descriptions as those immediately related to the system of abstract objects (theoretical constructs) that form a network, some elements of which are connected with experiment, and the rest justified by virtue of intratheoretical connections; and the discovery, during the process of discussing protocol sentences, of the distinction between observational data and scientific fact, and the statement of the problem of transitioning from protocol sentences to fact-recording statements.

All these results were necessary, but clearly insufficient for addressing the fundamental problems of scientific methodology and logic, which required overcoming the limitations of the neo-positivist program and introducing new, more productive notions of scientific knowledge.

The backbone of scientific philosophy, logic, and methodology lay in the study of changes in scientific mindsets and methods in their historical development, taking into account the impact of sociocultural influences on these processes. In Western philosophy of science before the early 1960s, there was no awareness of this basic circumstance. Imre Lakatos and Thomas Kuhn arrived at their new ideas only after the complete collapse of the neo-positivist paradigm. Stepin, as well as the whole current of Soviet science methodologists, was moving synchronously and in the same direction at the creators of positivism, but philosophers working in the Soviet Union were following their own path. What distinguished Soviet methodologists from those in the West was that they were initially spared the faith in positivism and the neo-positivist methodological program.

We have mentioned the historical reasons for this, in connection with the cultivation of Lenin-style judgments in the Soviet Union. In this case they did play a certain beneficial role. The fact that postpositivist science methodology is comparably better-known does not mean that the Soviet/Russian school of science methodology is somehow inferior to it; rather, the reasons lie in problems of translation, as well as, perhaps, in the fact that Western methodological schemes are constructed on analysis that is more popular and convenient for nonspecialists to master, though at the expense of greater depth.

The major feature of Soviet/Russian research during the 1960s and 1970s was the connection between notions of the sociocultural conditions of knowledge and Marx's ideas about the activity-related, practical nature of the cognitive process. The very problem of interpreting sensory experience and theoretical knowledge took on a different meaning when that experiment and theory were understood as being included in the historical development of practice, and when science was viewed in conjunction with other spheres of culture. Stepin was the leader of this movement in Soviet philosophy of science.

Along with recognition of the sociocultural conditions of knowledge and the impact on the sociology of science, a methodological interest in the history of science was common to both the postpositivist program and the Soviet school of philosophy of science. On this point Soviet/Russian research again had its own features. The idea of historicism was interpreted as an idea of the self-development of complex systems. This idea, a tradition running from Hegel to Marx, was connected with the development of a systemic approach, and later with the synergetic paradigm in which Stepin's research also played an important role.

We should note that Soviet philosophers of the 1970s and 1980s carefully studied the work of Western colleagues like Karl Popper, Imre Lakatos, Thomas Kuhn, Stephen Toulmin, and Paul Feyerabend. Soviet philosophers had to ability to assess the weak areas of postpositivist concepts and guide their creative efforts toward addressing those methodological problems that had not found solutions within the framework of those concepts.

Here Stepin followed his own path. His central focus was the question of emergence of new knowledge, both in science and in philosophy. He set as his goal the analysis of those complex processes through which the formation of a scientific theory takes place. These issues were a natural extension of his research, already laid out at the time he was writing and defending his thesis. A few years later he obtained new results in that area; they became the basis of his doctoral dissertation (1974) and later of his

monograph *Stanovlenie nauchnoi teorii* [How Scientific Theory Comes to Be] (1976), which had an enormous impact on Russian research in the philosophy of science and technology.

Stepin used the original texts by creators of scientific theories as an empirical basis for studying the structures and dynamics of scientific knowledge. "It is not possible to obtain a satisfactory answer to these questions *a priori*, without reference to the real history of science. This requires analysis of specific historical material."[2] Rather than using facts of scientific history chosen to verify certain methodological ideas, Stepin was interested in reconstructing the path of scientific thought that lead to the formation of new knowledge in light of science's historical development. Stepin's work, then, took place in the union of historical/scientific and logical/methodological analysis.

This kind of approach allowed the philosopher to perform constant examination of the various methodological ideas proposed, and at the same time, to give a historical and logical explanation for the transition from one stage in the development of natural science theory to another. Stepin's focus was particularly concentrated on the operations carried out with ideal objects during the emergence and development of scientific knowledge. To solve these problems, it was first necessary to analyze the structure of scientific knowledge in greater detail.

He proposed an idea of the multiple types of ideal objects in the system of scientific knowledge and set out to examine the rules of their formation and their translation from one system of knowledge to another, in connection with the generation of new theoretical content.

The widespread conception in philosophy of science from the late 1950s through early 1960s of a network of theoretical constructs whose connections and relationships were directly expressed by theoretical statements was only the first and very approximate description of the theoretical level of knowledge. Its organization was more complex and systemic.

Stepin showed that it was necessary to delineate two sublevels in the system of theoretical constructs, corresponding to theories of a narrowly specific nature and the development of generalizing theories. Each of those in turn could be distilled to a core: a small set of initial theoretical constructs whose connections and relationships are fixed in theoretical laws. This core represents the theoretical model of processes studied in the theory. Stepin suggested calling this a theoretical schema, as opposed to analog models that are used in statements of hypothesis but are excluded in theory. There are two levels of theoretical schemata in developed, basic theories: basic and specific, the latter shaped in terms of the basic. However, specific

theoretical schemata can also exist independently, either before the construction of a developed theory, or in solving problems that require the use of two or more theories (hybrid, specific theoretical schemata).

Stepin also delineated two sublevels in the empirical level of knowledge: real experiences and situations of observation and their empirical schemata. Accordingly, data of observation is shaped relative to the former, and empirical relations and facts relative to the latter. As a result, scientific knowledge is presented as a multilevel, hierarchical system where the different levels connect back and forth.

Stepin then showed that a specific subsystem of theoretical constructs, in relation to which the basic principles of science are formulated, performs an important function in the systemic organization of scientific knowledge. This subsystem is a special scientific picture of the world (disciplinary ontology). Its constructs are identified with reality, and they have an ontological status. As for theoretical schemata, the constituents of their theoretical constructs represent an idealization, logical reconstructions of the reality under study (in physics, for example: a particle, a perfectly rigid body, and so forth), but by virtue of their correlation to a picture of the world, they are objectified, and they appear as a statement of essential connections of the real objects being studied.

The case with knowledge at the empirical level is similar. Experience, situations of observation, and empirical schemata are all products of human activity, but the empirical knowledge obtained through these processes is perceived and evaluated as expressions of objectively existing phenomena. This view ensures their correlation with a special scientific picture of the world (disciplinary ontology).

A picture of the world is not reducible to either theoretical or empirical knowledge. It is a special theoretical model that introduces a whole systemic and structural view of the subject of scientific research in relation to the individual sciences (physics, chemistry, biology). It acts as a system-generating factor for the whole developing system of knowledge in a scientific discipline.

We should note that the classics of twentieth-century natural science (Max Planck, Albert Einstein, Max Born, Erwin Schrödinger, and others) determined the picture of the world a special form of scientific knowledge and used a corresponding term when describing those changes in our understanding of nature that brought about discoveries in the twentieth-century natural sciences. However this form of knowledge was not a subject for special analysis in logic, methodology, or philosophy of science in the first half of the twentieth century. The positivist tradition identified the scientific picture of the world with theory. Only in the mid-1970s did works

appear in Western philosophy of science that highlighted some specific features of the scientific picture of the world. By this time, Russian research was already far ahead in working through this set of problems. The structure of a scientific picture of the world had already been analyzed, its relationship to theories and experiments were clarified, and a typology of pictures of the world and their function in scientific research were defined. The work of Stepin and his students played a defining role in solving these problems.

Work on the problems of systematizing knowledge identified three basic forms of scientific pictures of the world: (1) a specialized scientific picture of the world (disciplinary ontology); (2) a natural sciences and social sciences picture (a picture of social reality), the first of which represents a form of synthesis of natural sciences disciplines, and the second, a synthesis of social sciences and humanities; and finally, (3) a general sciences picture of the world.

Stepin's work showed that the path to solving these problems of unifying scientific knowledge was not in reducing the languages of all these disciplines to some universal language of science, as neo-positivism suggested, but in the content-based analysis of development of a general science picture of the world that includes the most significant achievements of the different sciences and builds a total system of ideas about the evolution of the universe.

Scientific knowledge develops as a complex, multilevel system, including both intradisciplinary and interdisciplinary interactions.

According to Stepin, theory in any scientific discipline is formulated in several types of linguistic expressions connected with each other, rather than in a uniform language. If a theory were expressed mathematically, it would include (1) equations (mathematical expressions of laws), (2) a theoretical schema for whose objects the equations are valid, (3) complex and mediated projections of the theoretical schema's abstract objects onto empirical material, and (4) their projection onto the picture of the world.[3] All these connections are included in the definition of scientific knowledge, and they form the theory's conceptual framework.

Guided by his analysis of the systemic organization of scientific knowledge, Stepin introduced a number of significant innovations in our understanding of the processes of their genesis. He defined the process of forming a theory's substantive core (the theoretical schema and its corresponding theoretical laws) as the primary aspect of constructing a theory.

The standard approach describes the genesis of theory as the advancing of hypotheses and their subsequent substantiation through experiment.

According to the neo-positivist tradition, which was also assimilated by postpositivism, the advancing of hypotheses was viewed as the subject of psychological discovery (but not of the logic of discovery).

Stepin offered a new understanding of this stage in formulating theory. He showed that the core of a future theory is created through special mental operations whose essence consists of the translation of abstract objects (theoretical constructs) and their combinations into a new network of connections borrowed from a different area of theoretical knowledge. The basis for this operation is a method of analog modeling. Theoretical schemata that were already constructed in a science are used as analog models for the new domain of knowledge. A specialized scientific picture of the world "suggests" which of these constructed theoretical schemata can be applied in this way. In this case it performs the role of a research program, defining the formulation of research goals and the choice of mechanisms for solving them.

Analog models represent an array of connections between theoretical constructs and a structure in which these constructs translated from a different area of knowledge should be immersed. The replacement of preceding constructs of an analog model with new ones leads to the formation of a hypothetical version of the theoretical schema, a version that requires its own substantiation through experimentation.

At this point in analyzing the process of empirical substantiation of hypotheses, Stepin again discovers operations that had not yet been analyzed in logic, philosophy, or methodology of science. He shows that, when the translation of abstract objects from one area of knowledge to another and their immersion in a new array of connections as expressed by an analog model occur during the process of advancing a hypothesis, the abstract objects (theoretical constructs) acquire new features within the new connections and relationships. These features can complement those already substantiated by experiment, but they can also contradict them. Therefore, the first step in substantiating a hypothesis is checking it for consistency, for the compatibility of the theoretical constructs' previous and new features. This procedure is necessary, though still not sufficient for substantiating the hypothesis.

The second step is the drawing up of new (hypothetical) features for the abstract objects as idealizations, based on that new area of experience the hypothetical model is intended to describe. Stepin designated this whole complex of operations as the constructive substantiation of theoretical schemata. By virtue of this constructive substantiation, laws formulated in relation to the abstract objects constituting a theoretical schema are connected to experience. If the law is formulated mathematically, as it is,

for example, in physics, then constructive substantiation creates, as a theory, formulas that connect physical quantities with experience.

Theoretical objects recognized as nonconstructive are eliminated in the course of building a theory; "the identification of nonconstructive elements in a preliminary theoretical model discloses its weakest links and creates the necessary foundation for its reconstruction."[4] Nonconstructive features lead to paradoxes that result in possible paths for rebuilding the theoretical model.[5] Nonconstructive objects that enter the new theoretical schema need to be constructively redefined and adapted to the new experience and to the corresponding view of reality.

In that sense, theoretical schemata are the result of the inductive generalization of experience. They come "from above" in relation to experience, but by virtue of the procedures of constructive substantiation, they can appear as a theoretical generalization of experience. A theoretical scheme, constructively generalized and applied to experience, "is able to explain the existing accumulation of experiential facts and to predict the results of future experiment."[6]

A theoretical schema created during the process of constructive substantiation is again compared to the scientific picture of the world, and it brings corresponding corrections and specifications to that picture.

In that sense, the generation of new theoretical knowledge occurs by virtue of multiple repetitions of a cognitive cycle based, in Stepin's words, on "a shuttle's movements" from the specialized scientific picture of the world to the hypothetical versions of a theoretical schemata, to its constructive substantiation by experiment and then back again to the picture of the world.[7] Thus does the formation of new theories take place within the framework of a corresponding scientific discipline.

Stepin substantiated the universality of the operations involved in constructing a theory, operations he himself discovered, by analyzing extensive material on the history of physics and mathematics. He showed that these operations provide for the construction of both specific theoretical schemata and developed scientific theories. Taking into account the historical factor of changes to methods in scientific research, Stepin analyzed the kinds of changes to these operations (while maintaining their invariant content) that occurred during the transition from the classical to the nonclassical (quantum and relativistic physics). He accomplished this by carrying out historical reconstructions of classical electromagnetic field theory and quantum electrodynamics (the former he reconstructed together with Lev Tomil'chik, the latter independently).

During the process of these reconstructions, he identified both the general, enduring core of operations in constructing the theory, and also

the features that distinguished the classical and nonclassical stages in the development of physics.

Stepin also reconsidered the functioning of existing theories and their application in explaining and predicting new experimental facts. He showed that the widely held, standard notion of the hypothesis and deduction method's decisive role in the construction and subsequent functioning of theory does not express the most important and essential features of that process.

According to Stepin, the hypothesis and deduction method in a developed theory is subordinate to the genetic and constructive method. Only one aspect of logical deduction is included in the processes of explanation and prediction, but, in thought experiments verified by experience, the particular operations of constructing specific theoretical schemata based on a fundamental one play a major role here. This design represents a solution to the theoretical problems. A theory unfurls its hidden content during the process of solving theoretical problems. Some forms of problem-solving are included as part of the theory. They appear as models for the researcher to orient himself when seeking solutions to a new problem.

In Western philosophy of science, Thomas Kuhn was the first to draw attention to this feature of theory. He specifically noted that there are paradigmatic models for problem-solving as part of theory. This raises two questions: what kind of structure do these models have, and how do they emerge as part of theory? Kuhn did not provide answers to either question. He believed that the search for solutions to these problems lay not in the plane of logic and methodology, but in the plane of psychological analysis.

Stepin found answers to these questions in the conceptions of structure and genesis of scientific theory that he developed. Models for problem-solving are a demonstration of the methods for forming specific theoretical schemata included as part of theory, founded on the basic theoretical schema. They occur as a natural product of a developed theory's construction, by synthesizing all the specific theoretical schemata and their corresponding laws that describe particular aspects of a domain of knowledge of a prospective developed theory. A decisive role in this process is played by the procedure of constructively substantiating the generalizing theoretical scheme.

By reconstructing the formation of Maxwell's theory of electromagnetic fields, Stepin demonstrated the complex of research operations that generate the inclusion of paradigmatic models for problem-solving as part of theory. He showed that, in accordance with the features of complex,

evolving systems, theory reproduces, in compressed form, the main features of its own genesis as it functions.[8]

The further functioning of a new theory and its application to an expanding field of experience can include new models for problem-solving in the theory. In this process a theory is able to modify itself while preserving its basic content. This modification of a theory can be expressed in a new theoretical language. For example, in the development of mechanics, its original Newtonian formulation was modified and refined by Euler, and then, during the process of historical development, Lagrange and Hamilton-Jacobi formulations emerged.

Stepin showed that this kind of development of theory creates new tools for future theoretical discoveries.

In Stepin's conception, the genesis and functioning of a theory are viewed as aspects of the total development of a scientific discipline's theoretical knowledge. In his research, the process of creating a theory represents a unity of the logic of discovery and the logic of substantiation. Their opposition to each other, which comes from the neo-positivist tradition, proved unproductive. If we include in the logic of substantiation the procedure of constructive substantiation that Stepin discovered, then that logic represents the most important aspect of the logic of discovery. This is the very approach that solved the problem of the genesis of paradigmatic models included within theory, a problem that arose from Kuhn's ideas, though he himself did not solve it.

This raises questions: what were the objective premises of Stepin's discoveries, and what were the obstacles preventing Western philosophy of science from solving their corresponding problems? Apparently the issue was that, for the basically phenomenalist philosophical tradition that dominated Western philosophy of science, they tended not to consider theoretical models included within the theory in its two interrelated aspects: both as ontological schemata that reflect the characteristics of the reality being studied and "as a singular 'coil' of the substantial and practical procedures"[9] of human activity, during which these characteristics can also be identified. Conversely, this train of thought was natural for the Marxist tradition.

The notion of knowledge as a complex, historically developing, multilevel system played a no less important role in Stepin's ideas. This notion also had its sources in the tradition from Hegel to Marx. Finally, the third initial component was the idea of the sociocultural conditioning of cognition. Science research often reduces this idea to the problems of sociology of knowledge, but without losing sight of those aspects, Stepin focused on epistemology, examining sociocultural factors as factors

integrated in the process of generating new knowledge and its inclusion in the flow of cultural transmission.

All three of these ideas were organically fused together in the total concept of the structure and dynamics of scientific knowledge that Stepin developed, and that, in assimilating the main achievements of that field, introduced much new and constructive material to its development.

Already at the first stage of his work on the problems of structure and genesis of scientific knowledge, Stepin applied a technique of methodological analysis that was fundamentally new in comparison to the traditional program of philosophy of science.

The basic unit of analysis in the traditional approach was the theory, taken separately, and its relationship to experience. Stepin's approach showed clearly that the unit of analysis is the scientific discipline itself as a complex, historically developing system of theoretical and empirical knowledge in interaction with other disciplines and the sociocultural context. Somewhat later Stepin formulated this position explicitly.[10] It is gradually beginning to occupy a position of priority in Western research on philosophy of science, but Stepin's conception was one of the first to demonstrate the effectiveness of this methodology and its realization in the organic unity of various aspects: activity-based, systemic and historical, and sociocultural.

American professor Tom Rockmore called Stepin's innovative concept "historical constructivism."[11]

The comparison between modern epistemological constructivism and Stepin's "historical constructivism" is an obvious one. For constructivists, objective reality is nothing more than our own construct, and along with the denial of objective reality they deny the objectivity of scientific truth. Enough has been said in the literature about the fact that constructivist ideas disagree with the practice of science.[12] As far as Stepin's ideas concern, the objectivity of the reality under study and the ideal of scientific knowledge's objectivity represent basic principles of scientific research.

Constructivist paradoxes only appear new at first glance. Essentially, they reproduce problem situations that are well known in the history of philosophy and often reoccur, especially during periods of civilizational crisis. Relativization has always been a reaction to the difficulties of knowledge, whenever an existing model has stopped working. Thus we have seen ancient cynics and skeptics, medieval nominalists, subjective idealists, and the phenomenalists of modern times. On the other hand, we know of brilliant examples in the history of philosophy of positive development in the constructive activity of cognition. We can recall Plato's world of ideas, Descartes's innate ideas, and finally, Kant and his active role of cognition's categorical structures.

For Stepin, constructivist paradoxes did not represent something fundamentally new. For him the criterion of truth, that is, what determines the relevance of knowledge of reality, is the practices that transform activity. "Activity," Stepin writes, "is that very process in which a person repeatedly relates and compares an idea with an objectively existing object, and juxtaposes the image of the object with the object itself. Activity presupposes and always includes setting some goal. That goal is the ideal image of the future result of activity, that is, of that final state of the transformed object that represents the product of that activity. The conversion of the object into a product is not arbitrary. It depends on the object's objective characteristics that determine the possibility of achieving an O-2 state (the product as an objectified goal) from an O-1 state (the initial material). If the goal is objectified in the product, if we get the expected and desired result each time we repeat the activity, that means our images of the object as a goal correspond to the object itself; but if our activity does not achieve the objectified object/goal, its concurrence with the result of the activity, that means the object is not submitting to our actions. It means the object has its own nature independent of our will and desire, and in our images of its transition from one state to another (from the initial material of activity to its product) we have not adequately taken that nature into account. At that point we need to adjust our image of the object."[13] The multiple, mutual correlation of the object's properties, the person's properties, and the characteristics of those resources and operations of activity that the person applies to the object provide objective knowledge and the ability to reveal patterns in reality. In this perspective, Stepin's "historical constructivism" appears more like constructive realism.

Stepin's complex application of activity-based, systemic, historical, and sociocultural approaches in the course of analysis posed new challenges: to clarify the mechanisms of interaction between science and culture, the impact of sociocultural factors on the processes of generating new scientific knowledge, the inclusion of that knowledge in the processes of cultural translation, and their effect in turn on different cultural spheres.

Solving those problems required a new, even deeper analysis of the structure of scientific knowledge, which led to issues about the foundations of science. Stepin carried out this cycle of his work in the second half of the 1970s and early 1980s. He identified three clusters of foundations upon which all specific theories and empirical knowledge of science rest: (1) a scientific picture of the world, (2) ideals and norms of scientific research, and (3) philosophical foundations of science.

The basic features and typology of the scientific picture of the world had already been described in his 1976 book, *Stanovlenie nauchnoi teorii* [How

Scientific Theory Comes to Be]. His newer works (*Priroda nauchnogo poznaniia* [The Nature of Scientific Cognition. Minsk, 1979], *Idealy i normy nauchnogo issledovaniia* [Ideals and Norms of Scientific Research. Minsk, 1981], and *Nauchnye revoliutsii v dinamike kul'tury* [Scientific Revolutions in the Cultural Dynamic. Minsk, 1987]) specified the functions of the scientific picture of the world: the picture of the world as a form of systematizing knowledge, as a research program, and as scientific ontology that provides an ontological status for all the empirical and theoretical knowledge that corresponds to it, as well as its understanding and inclusion in the culture.

The interaction between picture of the world, theory, and experience that Stepin had previously analyzed was supplemented by an analysis of the empirical pursuit, during which discoveries emerge that are inexplicable within the framework of already existing, specific theories. In a case like this, the picture of the word interacts directly with experience, without the mediation of theoretical schemata. The picture of the world serves as the research program in relation to empirical research, and new facts, in turn, refine and develop the picture of the world. Stepin analyzed these situations of unmediated interaction between the picture of the world and experience based on extensive material not only in the history of the natural sciences, but also in the social sciences and humanities (sociology and social anthropology).[14]

The scientific picture of the world introduces, in a sense, an extremely generalizing schema of the object of scientific research, its integral image in its main systemic and structural aspects. This image of the object of research is introduced to a correlatively generalizing schema of the method of research, which is represented as a system of ideals and norms of science. The ideals and norms of science form the second cluster of foundations of science.

Here we are referring to the criteria of "scienceness": which argument, method, or procedure we consider scientific, and which regulative principles express the goals and values of the scientific mindset.

In their system, Stepin delineated ideals and norms (1) of evidence and substantiation of knowledge, (2) of explanation and description, and (3) of construction and organization of knowledge. Stepin traced our understanding of the features and norms of science during different historical stages in the development of science and its correspondence with our attitude toward the object of study, as expressed in the picture of the world. Through their content, the ideals and norms of science represent a multileveled system, in which we can delineate (a) a deep layer of meanings, or a skeleton of sorts, that expresses the requirements and commonalities for

each type of scientific knowledge; (b) specifications of its requirements with regard to the mentality of a particular historical epoch, and (c) specifications tailored to the features of a particular scientific discipline's domain of knowledge.

All three layers of meanings are historically mutable, but in that mutability is also the continuity of content.

The philosophical foundations of science constitute the third cluster of norms and ideals of research. They are represented by a system of philosophical ideas and principles, providing a justification for the scientific picture of the world, and also for the ideals and norms of science, adapting them to the features of the culture that corresponds to the historical era. The need for this kind of justification consists in the fact that, in its basic areas of research, developed science deals with objects that have not yet been assimilated, neither in production nor in everyday experience (sometimes, practical assimilation of these objects is not even accomplished in the historical era in which they are discovered). These objects may be unfamiliar and confusing to everyday common sense. Knowledge about them and methods for obtaining such knowledge may differ significantly from the norms and notions about the world in the corresponding historical era's everyday consciousness. Therefore, scientific pictures of the world (the object's schema) as well as the ideals and normative structures of science (the method's schema), both during the period of their formation and also during subsequent periods of development, are needed as a kind of interface with the dominant mindset about the world during a particular historical era. This task is performed by the philosophical foundations of science.

Also included here are the philosophical ideas and principles that provide a heuristic for the pursuit. These principles first set goals for restructuring normative structures of science and pictures of reality, and they are then used to substantiate the results obtained: the new ontologies and new notions about method.[15]

The philosophical foundations of science should not be confused with the general corpus of philosophical knowledge. To justify its structures, science uses only some of the ideas and principles from the larger field of philosophical problems and the varieties of solutions that emerge in the culture of each historical era.[16]

These three identified clusters of foundations of science are correlated with each other and form a special, integrated subsystem of scientific knowledge in development. According to Stepin, they perform a kind of mediating link through which different sociocultural factors influence the intrascience processes of generating new knowledge, process which, in

turn, define the impact of that knowledge on different cultural phenomena.[17]

The analysis of the foundations of science opened up new possibilities for researching those critical stages of science's development that have been labeled scientific revolutions. In Western philosophy of science Thomas Kuhn's work was the best-known research on these issues. Stepin not only knew this work well, he also discussed emergent problems in private discussions with Kuhn during meetings in Boston and Moscow.

The idea of a scientific revolution as a paradigm shift, a distinction between extensive (in Kuhn's words, normal science) and intensive stages in the growth of knowledge (a scientific revolution) allows us to define scientific revolutions as qualitative transformations in strategies of scientific research.

Further analysis of the mechanisms of scientific revolutions depended on a deeper analysis of the structure of scientific knowledge and a clarification of our understanding of the word "paradigm."

The best-known criticisms directed at Kuhn's ideas were primarily due to the uncertainty of this key concept. Due to criticism, Kuhn introduced the notion of paradigm structure, outlining its components as "symbolic generalizations" (mathematical formulation of rules), models for problem-solving, "metaphysical parts of paradigm," and values.[18] However, this version of paradigm structure was also unclear, because the links between its disparate elements were never established. Furthermore, certain aspects contradicted each other.

Stepin noted that a change in symbolic generalizations and in models for problem-solving is constantly taking place during the process of a developed theory's functioning at the "normal science" stage (in Kuhn's terminology.) According to Kuhn, this should all be interpreted as a change of paradigm, that is, as a scientific revolution, but this results in an erasure of the difference between "normal science" and "scientific revolution." If we associate scientific revolutions with a paradigmatic break, then we should define the structure of paradigm in a different way. Its main components must be found in that area that Kuhn, at best, only outlined in approximation: the metaphysical parts of paradigm and values.

Stepin's analysis differentiated and clarified the meanings of these very general concepts, and eventually developed the notion of a systemic and structural organization to the foundations of science. Examining the structure of scientific revolutions from this position, Stepin achieved a number of new and important results. We can distinguish the most important of these as follows:

1. Stepin analyzed, in significantly more detail than Kuhn's version, the mechanisms of scientific revolutions, when the foundations of a scientific discipline are being reconstructed due to internal factors in its development. Stepin's work demonstrated the general laws of this process by reconstructing the process of building a special theory of relationships.[19]
2. In addition to the intradisciplinary version, Stepin isolated and analyzed another, interdisciplinary version of scientific revolutions, associated with "paradigmatic translations" from one science to another. Here the change in a scientific discipline's foundations takes place without any preliminary appearance of anomalies or crises within the discipline. Stepin demonstrated the features of this process through the example of changes in biology and sociology in the mid-twentieth century due to the "cybernetic paradigm" (a reconstruction of discoveries by Ivan Schmalhausen[20] and Talcott Parsons[21]).
3. He showed that new research strategies that emerge during a scientific revolution represent the realization of only one possible trajectory of the historical development of knowledge. This development process is non-linear and includes the field of both realized and unrealized possibilities. From this angle, scientific revolutions appear as bifurcation points, opening up new possible paths for the development of science. The realization of one path is determined not only by intrascientific factors, but also by coordination of science's new foundations with the worldviews and the type of rationality predominant in the culture of a given historical era.[22]
4. Stepin distinguished between local scientific revolutions, which do not change an already established type of scientific rationality, and global scientific revolutions, which lead to changes in the type of rationality. In this context he raised the problem of historical types of scientific rationalities and the criteria for distinguishing them.
5. He established that, in the course of a radical transformation of the foundations of science, the researcher is always faced with the problem of new categorical meanings that provide both an understanding of the new types of objects in the system and also a justification for the corresponding changes in the ideals and norms of research. These kinds of new categorical meanings are lacking in science during the previous stage of development, and they cannot be gleaned from everyday experience, because science, in its basic areas of research, provides breakthroughs to a new world of objects not yet widely assimilated in that historical era's practices. Science selectively draws new categorical meanings necessary for generating its new basic principles and ideas

from philosophy, as evidenced by extensive historical and scientific materials, primarily those related to the creative work of prominent naturalists. This raises a new question: how is it possible for philosophical research to develop ideas, principles, or categorical meanings that go beyond not just the everyday, but also beyond the scientific experience of its historical era in anticipating future experience?

Stepin solved both of these problems (the historical types of scientific rationality and the prognostic functions of philosophy) by extending the scope of his research.

Since the mid-1980s, his scope of subject matter has included philosophy of culture, sociology, and philosophical anthropology. The most important point here is Stepin's holistic picture of social reality. He laid out the first sketches of his ideas in separate articles in the mid-1980s, and then gathered them in relatively complete form in his book,*Filosofskaia antropologiia i filosofiia nauki* [Philosophical Anthropology and Philosophy of Science] (Moscow, 1992).

Stepin outlined the general content in different approaches to analysis of social dynamics, as they were presented both in Russian research and abroad. He observed that the majority of these researchers introduced the notion of society as an integrated system and examined the economy (whose core was material production), social relationships, and culture as subsystems. From the standpoint of philosophical anthropology, these subsystems correspond to the three main relations between the person and the world: (1) the relationship to nature and to the world of man-made objects (the second nature) in which the activity of human living takes place; (2) the relationship to other people, or the social collective; and (3) the relationship to the spiritual world, in which both a person's individual experience and general, historical experience accumulate. Each of the designated subsystems has only relative independence, and in their historical development, they are always mutually dependent on one another.

In analyzing each of these subsystems, Stepin paid special attention to their philosophical and anthropological aspects.

The core of society's economic life is the reproduction and development of the world of man-made objects in the process of material production. The different objects and object-oriented complexes in human activity are fragments of that world, and they function as a complement and enhancement of the human body's natural organs. Karl Marx, the German philosopher Ernst Kapp, and the Russian philosopher, mathematician, engineer, and priest Pavel Florensky all showed that the presence of some

"object-oriented component" of human corporeality appears to be the human being's most important characteristic. Marx called this component the person's "inorganic body." It is inherited, socially transmitted from one generation to another, and represents one indicator of the level of civilization. Stepin designated it the "inorganic body of civilization" and used increases in the system's complexity as criteria for characterizing the stages of its development. Each increase in the systemic complexity of civilization's inorganic body leads to a change in the human being's function in production and, more broadly, in social life.

In accordance with each new level of systemic complexity in civilization's inorganic body, the connections and relationships of people in both large and small social groups changes, as well. The most labile groups in this social subsystem are small groups, and their changes may ultimately call for shifts in the macro-structure of society, which is represented by large social groups (classes, castes, nations, and so forth.)

Social processes, including both the reproduction of social life's established structures and their transformations, take place through human activity (actions, behavior, and social relationships). Stepin shows that an analysis of these processes necessarily leads to a particular understanding of culture, and culture's place and role in people's social life. Many specialists in this area who are well-known in Russia consider Stepin's concept of culture an important milestone in the work addressing this set of problems.[23]

The basic ideas sketched here and the logic of their conception can be summarized as follows. Initially, Stepin shows that activity, behavior, and social relationships, those things that allow society to be reproduced and developed as a total organism, are directed by corresponding programs. Any kind of activity suggests the presence of the subject's values, goals, knowledge, and skills. All of these components form a program of activity. A person who has not assimilated this kind of program does not understand how to act, what the results of his actions should be, and in general what this form of his activities are needed for. This kind of person is not the subject of activity.

The programs of social behavior and relationships are analogous to the programs of activity. None of these programs are innate. There are only a few biological conditions for them, but they are essentially suprabiological, irreducible to biological or genetic programs. People assimilate them in the course of living, in the process of education, upbringing, and socialization.

Programs of activity, behavior, and social relationships are transmitted from person to person, from generation to generation. The transmission of these programs involves implementing them in symbolic form. They exist

as a social code that is constructed on top of the biological code. A change in the programs of human activity, that is, the emergence of their new forms, is accompanied by a change in the social code. Stepin built this part of his analysis on the ideas of Marshall McLuhan, as well as those of Russian philosophers and culturologists Mikhail Petrov and Yuri Lotman.

The analogy between the programs of social activity and the functions of genetic code in principle was an already well-known idea (Dawkins's theory of memes), but Stepin did not limit himself to notions of a network of transmissions of sociogenetic codes. The primary issue for him was the understanding of programs of activity, behavior, and social relationships as a complex, hierarchical, and historically developing system. The idea of a network is only one aspect of this understanding.

In sum, Stepin defined culture as a historically developing system of suprabiological programs of basic human activity (activity, behavior, and social relationships) that preserve and transfer already established programs (tradition) in the form of social codes, as well as generate new programs until the point that they create new, corresponding conditions for social life (creativity).

Stepin identified three levels of historically developing programs that constitute the "body" of culture.

Every culture may have, simultaneously, (1) reliclike programs that have formally retained some features of earlier historical eras, but have in fact lost their meaning; (2) contemporary programs that are based on the existing forms of activity and on regulating them; (3) programs aimed at the future that can give rise to new forms of activity and, moreover, that can become the foundation for a new type of civilizational development during periods of crisis in values.

Despite the variety and constant renewal of programs of human activity, behavior, and social relationships at each stage of its development, these programs, which have been generated and transmitted in the culture, act collectively as a systemic whole. This wholeness is defined by the features of the culture's foundations, which are represented by the culture's system of "worldview universals" (the latter are also known as the ideas, concepts, and categories of culture).

This profound analytical research into the nature and function of worldview universals was one of Stepin's most significant achievements. In accordance with his understanding of activity as the connection of its two aspects of subject–object and subject–subject relationships, he proposed a way of classifying worldview universals. Subject-object relationships are represented by the categories of "nature," "part and whole," "thing," "process," "causality," "necessity," "randomness," "space and time," and

so forth. These categorical meanings can also be applied to analysis of the subject of activity and his social connections, which, in science for example, can be viewed as a special object of knowledge.

As for subject–subject relationships of activity, the classification of worldview universals corresponds to the categories of "person," "I," "others," "good," "evil," "life and death," "faith," "hope," "love," "truth," "justice," "freedom," "conscience," "fear," and so forth. There is a strong degree of coherence between these two aspects of the system of worldview universals. For example, the understanding of nature, causality, necessity, and randomness correlates in culture with the categories of "freedom," "justice," "I," "others," and vice-versa.

Worldview universals determine not only interpretation and understanding, but also the person's experience of the world. This kind of experience is connected to our emotional evaluations of phenomena, events, human actions, and conduct; therefore worldview universals (the categories of culture) in their primary sense express the fundamental values of one culture or another.

As complex and evolving entities, worldview universals contain several levels of meaning: (1) a level that is universal and general to humankind; (2) a level of particularity, expressing the specific qualities of one historical era or another, as well as the national and ethnic features of a culture in one type of society or another; and finally (3) a level of meanings that give concrete shape to these historical features, meanings corresponding to a person's individual experience or to the experience of the social group to which he belongs.

The system of worldview universals provides a selection of artifacts from everything created in human activity for further cultural transmission, forms a categorical array of human knowledge for the corresponding era, and creates a total image of the era's living world.

People can become only partially aware of the meanings of universal culture. Culture is more than just the conditions of social and individual knowledge associated with acts of self-awareness, but it also includes elements of the socially unconscious.

Worldview universals change along with the historical development of society, which can change not only their content, but also their composition. The initial universals of culture can splinter and form new categories on their basis (a splitting of the old meanings of the "love-friendship" categories into two independent categories; or the sprouting of a capital-T "Truth" [*istina*] from the basic category "truth" [*pravda*] in nineteenth-century Russian culture.)

With the development of culture and the emergence of relatively autonomous spheres within it (everyday cognition and language, art, religion, political and legal consciousness, philosophy, science), universals permeate each of these spheres through their connections. Therefore, the changes in basic meanings of universals in one area will resonate with others sooner or later.

In these connections, worldview universals form a sort of genome of social life. Changing society as a total organism is impossible without transforming this genome.

Stepin's work on the ideas of society's structure and dynamics opened up new prospects for solving not only the problems of philosophy of science, but also problems in other areas of philosophical thought, and even more broadly, of the social sciences and humanities.

His research allowed a new approach to the problem of the function of philosophical consciousness in social life. Stepin connected these functions with the eras of fundamental changes that periodically emerge during the development of society, changes that involve the transformation of cultural universals and the production of their new meanings. Philosophy, in reflecting on the culture's fundamental worldviews in the contemporary era and reinterpreting those foundations, plays a role in solving these problems.

Stepin succeeded in uncovering the mechanisms of this process by identifying the two levels of philosophical reflection on a culture's worldview universals. At the first level, philosophy reveals the general meanings of universals in various cultural spheres: in everyday consciousness and language, in art and religion, in the sphere of morality, in science, and in political and legal consciousness. What regulates human actions and behavior in a largely unconscious way is identified and brought before the court of reason. At this stage philosophy captures the universals of culture not only in strict terms, but also in sense-images [*smysloobrazy*], without losing emphasis on the understanding and emotional experience of the world.

The second level of reflection transforms these sense-images into rather strict notions. Philosophy sets their definitions, focusing primarily on their rational component. As a result, the worldview universals are transformed into philosophical categories, whose connections form a special network of relationships and particular categorical clusters. Each of these categories serves as part of the networked cluster, and changes to the meaning of one leads to changes in the meaning of others. They acquire new features and new definitions. At this level philosophy solves theoretical problems by handling these categories as special, ideal objects and by revealing their features. In many respects this work is similar to research in mathematics,

which considers numbers, functions, and space as special entities, discloses their new properties, and creates new structures which may not have applications in that era, but often find them in future eras.

In an analogous way, the new categories of meaning constructed and substantiated by philosophy can seem redundant for their time, but at a future stage of civilization's development they may crystallize into new worldviews, mindsets, and basic values for a new type of social life. Leibniz's definition of mathematics as a science of possible worlds is well known. According to Stepin, this can be extended to philosophy, as well, in that it offers humanity theoretical sketches of the possible worlds of future living activity.

Stepin puts special emphasis on the fact that philosophy performs these functions only when uniting both levels of reflection on cultural universals. This includes two types of philosophizing, the first of which is closer to literature and art, and the second to science. To use Stepin's figurative expression, these are the two wings on which the Owl of Minerva flies; injury to either of them halts her flight.

When philosophy, working through the new meanings of worldview universals, presents them as the basis for a way of life, it is performing a specific ideological function. However, this function is only on aspect of philosophizing. Philosophical criticism and its focus on the ceaseless work of generating new categorical meanings prevent us from reducing philosophy to pure ideology. The scientific component of philosophical consciousness constantly leads to a rethinking of values, identifying their universal core and its changing interpretations.

Stepin convincingly reveals this complex dialectic in philosophizing, due both to stable conditions of social life as well as to conditions that change in the course of development. If society did not develop, philosophy would be unnecessary. To reproduce a particular type of society without making any changes, reflection on the "genome" of a society's culture is unneeded. However, the primary rational and critical understanding of a culture's worldview universals poses a problem for possible modifications of it, "hence for the possibilities of a different image of the world and different way of life, that is, the movement out of a culture's existing state and into another one."[24]

Stepin's position differs in its restrained, reasoned, and reserved relationship to philosophical fashion (postmodernism, constructivism, transhumanism), which calls truth, logic, historicism, and sometimes even the human subject into question. Stepin the philosopher is fully aware that philosophical reason "is not unpreconditioned reason, and it does have sociocultural conditionality. Therefore, it is impossible to construct an

absolutely pure philosophical system, since every such system is determined, even in its prognostic components, by the specific features of that era's culture, and it is limited for that reason. While renouncing the construction of final and complete systems, nonclassical philosophy did not at all renounce systemic thinking or the establishment of connections between categories. Unlike classical philosophy, it allowed for the appearance of new meanings in cultural universals, even those not yet analyzed or discovered by philosophy. Therefore, for the nonclassical approach, philosophy does not end as long as the development of society and its history continue."[25]

Stepin's analysis of philosophy's functions in culture and social life led logically to solving the problem of how categorical schemata necessary for science, schemata that go beyond already well-known scientific experience and that anticipate future experience, are created in philosophy. These schemata are formed as philosophy generates the new meanings of worldview universals.

Stepin analyzed the main features of the selection and subsequent adaptation of philosophical ideas to the needs of a given scientific discipline, as well as the path of specifying and clarifying these ideas, and the impact in turn of this process on the new categorical meanings being generated by philosophy.

The whole complex of these operations includes multiple transitions from concrete scientific analysis to philosophical analysis, then back again to concrete scientific research. In the historical development of the natural sciences and mathematics, this kind of activity was usually carried out by great researchers who opened up new directions in science and authored prominent scientific discoveries: Galileo Galilei, René Descartes, Gottfried Leibniz, Albert Einstein, Niels Bohr, Norbert Wiener, and others. They were, therefore, great natural scientists and mathematicians, not only specialists in their areas of knowledge, but to a certain extent philosophers. As for Descartes and Leibniz, they were philosophers in the first place, creators of well-known philosophical systems, and their discoveries in mathematics were closely related to their philosophical research.

The picture of social reality that Stepin developed provided not only a solution to problems related to philosophy's prognosticating function, but also opened up new possibilities on the whole for the analysis of processes involved in the social determination of science. In the early stages of his research Stepin had already distinguished prescience, which forms knowledge about objects that are transformed into a given historical era's practices, and science in the modern sense, where a theoretical level of knowledge is shaped, providing an outlet beyond the era's dominant forms

and methods of practical assimilation of objects. Often, the possibilities for practical application of this kind of knowledge emerge only in the future, at some future stage of civilization's historical development.

In a new series of studies, Stepin traced the kinds of changes to a culture's "genome" that were necessary for the formation of science in the proper sense of the word. He analyzed the features of culture in the ancient polis, features that were the condition for establishing the theoretical level of mathematics and for constructing the first model of a developed scientific theory, Euclidean geometry. He showed how the radical transformation of medieval culture's genome that took place during the Renaissance, Reformation, and early Enlightenment ensured the conversion of experiment into a method of scientific research and the combination of experiment with a mathematical description of nature, and thus led to the creation of the natural sciences. He clarified how social changes during the first industrial revolution and subsequent industrializations gave rise to the necessities and prerequisites for forming the system of technical sciences, including both basic and applied research. Finally, he explained the sociocultural foundations of the emergence of the social sciences and humanities.

Stepin's whole series of studies are impressive in their depth of analysis and broad coverage of sociocultural phenomena whose systemic interactions lead to qualitative transformations in science. He identified the cooperative effects between different spheres of culture during the transformations of worldview universals, and he traced how the foundations of science were created and reshaped during these eras.

This essay is too short to dwell on these most interesting pages of Stepin's philosophical work and their nontrivial, logical movements based on extensive historical material, newly interpreted. Instead, we would refer the reader to the relevant section of Stepin's book-length summary, *Teoreticheskoe znanie* [Theoretical Knowledge].[26] We should note here that the in-depth analysis of the impact of sociocultural factors on scientific research demonstrated that the foundations play a special role in these processes. They appear as that substructure of science where the meeting of intrascientific and extrascientific factors for generating new knowledge takes place. This meeting not only changes the specific content of scientific knowledge, creating new facts and new specific theories, but it also serves as a source of change for scientific rationality itself.

Stepin's work on the problems of historical types of scientific rationality is one of his greatest achievements in philosophy of science and philosophy of culture. Rationality is among the key worldview universals of modern culture. The meanings of this universal include an understanding of

scientific rationality, but they are not confined this understanding alone. Rationality is included as a specific component in other forms of cognition, as well; in everyday cognition, philosophy, art, and religion. The development of scientific rationality takes place among and in conjunction with these other forms.

Stepin identified a stable core in scientific rationality that is preserved during the historical development of science and that connects with different manifestations of its interpretations. The latter appear as characteristics of different types of rationality, and the stable core ensures their continuity. Features that define the stable core of scientific rationality are what distinguishes science from other forms of cognition; to formulate these features clearly is a singular problem that had also emerged in the Vienna Circle's neopositivism and in the work of Karl Popper.

Stepin solved this problem by analyzing the different types of cognition as cultural phenomena. This approach required an understanding of knowledge as a program of activity, then a search for features of science in the way that science programs activity. Science delineates only that aspect (the substructure) of activity that consists in the transformation of objects. Science seeks out the laws for that kind of transformation, and this is its main feature. According to Stepin, science is like the legendary King Midas, for whom everything he touched turned to gold. Everything science touches is an object directed by a certain set of laws. Science can study any phenomenon—natural, social, mental—but only ask objects. All other means of seeing the world fall to art, religion, morality, and philosophy. Science plays an enormous role in the activity of human living, but it cannot replace all of culture. The scientific mindset on obtaining object-oriented, objectively true knowledge about the world is the first and most important of its system-generating features.

The second of these fundamental features is the mindset on the increase of objective knowledge, on the discovery of new objects and their laws, whose assimilation can extend beyond the possibilities of today's practices, and can be addressed toward the future.

As Stepin showed, all other features of scientific knowledge—the specific qualities of its resources and methods, the features of the product of scientific activity (knowledge), which need to be systematically organized, substantiated, and proved—derive from these two primary characteristics. The main characteristics of science also correlate with the two basic principles of scientific ethics, which tries to understand the subject of scientific cognition. These ethical principles establish the values of truth and novelty and introduce two corresponding prohibitions: on the deliberate distortion of truth for a particular nonscientific interest, and on plagiarism

(as a requirement for clearly establishing what science has already discovered and what claims the status of new knowledge.)

This whole systemic collection of science's general characteristics that differentiate it from other forms of cognition, like cultural phenomena, represents the core of scientific rationality.[27] Stepin further showed that this core is part of the foundations of science in each historical era, but it is interpreted and established in a particular way. This kind of establishment can be reproduced over the course of long historical eras as a type of scientific rationality. Its transformations take place during global scientific revolutions.[28]

According to Stepin, we can identify three types of rationality in the history of science, beginning with the era when the natural sciences emerge: classical, non-classical, and post-nonclassical. The first two had already been established in philosophical literature. Their characteristics had been introduced through phenomenological description of the individual features that distinguish classical and non-classical approaches. Stepin suggested a different set of systemic and structural characteristics for types of rationality, separating their features into the three main clusters of scientific foundations. In his approach, the types of rationality differ not only in the nature and level of philosophical reflection, and not only in their specific features for explaining and substantiating scientific knowledge; they differ primarily in way the objects studied by science are organized systemically. The specific features of each type is represented in the notion of the scientific picture of the world and described in the form of ontological principles of science.

This approach allowed, first, for a deeper understanding of classical and nonclassical rationality, and second, for the delineation of a new, post-nonclassical type of scientific rationality that is gradually beginning to play a major role in research at the vanguard of contemporary science.

At the stage of classical rationality, notions about the objects of science as simple (mechanistic) systems dominated; nonclassical rationality included complex, self-regulating systems into the orbit of scientific research; post-nonclassical rationality examines the objects of its research as complex, self-developing systems. Stepin shows that understanding and making sense of each type of system involves a particular categorical matrix, particular meanings of the categories of part and whole, thing and process, causality, space, and time. He explains these meanings and traces how they defined the scientific picture of the world for each type of scientific rationality.[29] Accordingly, he fully analyzed changes in the ideals and norms of science that occurred during these transitions to a new systemic view of the objects of research.

Finally, Stepin established that the features of the philosophical foundations of science that express the level of philosophical reflection on the scientist's cognitive activity are one of the most important criteria for distinguishing the types of scientific rationality. He showed that this reflection, in the classical era, represents cognition in the simplified schema of the cognitive subject's relationship to the object. The subject of cognition is understood here as the bearer of sovereign, unpreconditioned reason, who has the ability to pin down a phenomenon and examine its essence. This level of reflection was sufficient for assimilating simple systems.

In the nonclassical approach we can trace a deeper philosophical reflection on cognitive activity. It turns out that the selection of one object of research or another is defined by historically developing resources and operations of activity, and therefore the awareness of their features is a condition for obtaining objective and true knowledge about the object being researched. This type of reflection creates necessary prerequisites for assimilating complex, self-regulating systems.

Finally, an even deeper level of reflection on cognitive activity is characteristic of post-nonclassical rationality: an understanding of the fact that it is socially determined, depends on the culture's basic values that program activity, and affects the formation of its value- and goal-oriented mindsets.

Stepin shows that the need for this type of reflection is correlated with the specific features of those objects of study which are complex, self-developing systems. The majority of these systems are human-dimensional; that is, they include the human being as one of its components, therefore one cannot freely experiment with them. The principles of a scientific ethos that express values of objectively true knowledge and of new discoveries that provide for the growth of that knowledge are still necessary, but already insufficient. They are adjusted on a case-by-case basis through their correlation to humanist ideals. As Stepin notes, these adjustments take place in the form of social and ethical reviews of scientific programs and projects. These new situations of social and ethical regulation of knowledge, beginning with the choice of research strategies, are especially important in the newest areas of research, like global studies, biotechnology, including genetic engineering, computer technology, and cognitive science, as well as in sociological and psychological research.

We should note that, in general, Stepin's work on research methodology for the complex, self-developing systems and ideas of post-nonclassical rationality is extremely relevant and in demand today. Significantly, according to the Russian Science Citation Index (RSCI), Stepin occupies first place by number of citations among scholars in humanities; the bulk of

references to his work are made not so much by philosophers, but by specialists in related fields of knowledge, like the technical sciences, natural sciences, and social sciences and humanities disciplines (psychology, sociology, history and theory of culture, linguistics, and political science.)

In Stepin's work we can identify a great many ideas that are, over time, beginning to take on great relevance. His conception of the types of civilizational development undoubtedly belongs to this cluster of ideas.

Based on the programming role of a culture's worldview universals in living activity, he introduced the idea of a type of civilizational development. He based the demarcation of these types on the difference in meanings of a culture's universals that constitute the genome of social life. Mutations in this "genome," the appearance of new worldview meanings, are the necessary prerequisite for the transition from one type of civilizational development to another. From these theoretical positions Stepin analyzed the systems of cultural universals inherent to traditionalist and technogenic types of civilizational development, as well as their values and priorities (like the relation to traditions and innovations; the understanding of the human being and his activity; the relationship to nature; the understanding of development, space, and time; and the understanding of rationality, individuality, and power.)[30]

In the depths of traditionalist societies, he traced the main stages of formation of new meanings of worldview universals and new types of cultural transmission that come to an end with the formation of a technogenic type of development.

Stepin identified the historically emergent forms of interaction between technogenic and traditionalist societies, as well as the features of changes in the latter during periods of "catch-up" modernization, which transform traditionalist societies on the path of technogenic development. He traced the way that "catch-up" modernizations evolved into the processes of contemporary globalization.[31]

In analyzing the dialectic of success and growing danger that the technogenic civilization has generated, Stepin highlighted the inevitable worsening of global crises within the dominant strategies of contemporary development. In this connection he proposed the idea of a new, third type of civilizational development, designed to solve the problem of worsening global crises and to fulfill the prospects for the sustainable development of humanity. The transition to new strategies of development involves the transformation of the existing "genome" of technogenic culture, and the search for new values and orientations toward the meaning of life.

These values will not arrive, ready-made, out of nowhere. Their preconditions must emerge in the depths of contemporary civilization.

Therefore, according to Stepin, it is important to reveal growth points for new values in different areas of contemporary culture: in science, philosophy, religion, art, ethics, and political and legal consciousness.

He showed that the formation of post-nonclassical rationality in the scientific and technical sphere is one of those growth points. This type of rationality opens the path for approaches to the biosphere as a total organism in which the human being is only part, asserts the priority of non-violent actions in relation to self-developing systems, and leads to new forms of integration for cognitive and value-oriented measurements in activity with complex, human-oriented systems (humanist review and so forth).

In Stepin's opinion the contemporary era needs, like never before, new worldview ideas and a new strategy for civilizations development responsible toward future generations. He has consistently emphasized that identifying the prerequisites for these ideas and their development is today the main purpose of philosophy and of the whole complex of social sciences and humanities.

Stepin's philosophical conception of the fundamental nature of working through problems, of the degrees of coverage in spheres of cognition, and of its own internal structuredness and integrity, a systematic view of the world and the human being in their interactions, is undoubtedly a significant phenomenon of contemporary Russian philosophy. It is a genuine philosophical system, albeit not in the old metaphysical sense of the world. Perhaps this type of conceptualization should be called a philosophical and methodological system. In any case, you cannot claim to understand contemporary Russian or global philosophy without familiarizing yourself with this system.

In this essay dedicated to the academician's path as a scholar, we must at least briefly discuss the results he obtained in his role as an organizer of research in philosophical discipline in general. In 1988 Stepin become director of the Institute of Philosophy at the Soviet Academy of Sciences (since 1991, the Russian Academy of Sciences). The Institute of Philosophy is a unique research institution in which Russia can take pride. The Institute's scholars rightly occupy leading positions in many fields of philosophical knowledge.

Stepin began his work under conditions of party control over the Institute's activities, but the times changed rapidly, and the early 1990s saw an era of creative freedom of which the Institute's philosophers, led by Stepin, succeeded in taking full advantage.

An effective creative collective developed, and its scholarly production greatly increased. During the Soviet period the Institute produced around 30

books a year. By the early 1990s that number grew to 100, and then to 120 books a year. The Institute achieved a certain publishing independence; on Stepin's initiative, the Institute created its own publishing house, and of the 120 or so books a year that the Institute's scholars published, 30 to 35 were from the Institute's own publishing house.

The changes that had occurred in the country necessitated the mass retraining of philosophy teachers. In 1992 the Institute established a Russian Center for Humanitarian Education on Stepin's initiative and active participation, and in conjunction with the leadership of the Russian Federation. In connection with the transition to new educations standards and curricula, it retrained the heads of departments of human sciences at Russian institutes of higher education. With this task performed, RCHE was converted into the State Academic University of Human Sciences in 1994.

During Stepin's directorship, the strength of the Institute's international contacts greatly increased. A number of major scientific research projects were carried out in conjunction with U.S. scholars. Stepin served as the Russian co-director of "The Fate of Democracy in the Twenty-First Century" project. Along with Boston University, he took part in "Paideia" project, dedicated to the philosophical problems of education. *Boston Studies in the Philosophy of Science* published materials from a series of conferences on the history and philosophy of science that were conducted by members of the Institute alongside colleagues from the United States, England, Greece, and others. On Stepin's initiative, an agreement with the Universities of Paris-10 and Paris-8 was reached over the "Fate of Civilization and Analysis of Social Changes at the Turn of the Century" project. Through a joint project with the University of Madrid, a number of discussions on the questions of philosophy of science were published, with the participation of Stepin and other philosophers from the Institute. They reached agreements on cooperation with academic institutions in China and India. The agreement on cooperation with India in the area of philosophical research was included as a special point in the intergovernmental agreement of cooperation between India and Russia.

In 2006 Stepin was elected as the head of the section on philosophy, sociology, psychology, and law in the Division of Social Sciences at the Russian Academy of Sciences. The section coordinates the work of six academic institutes. With this transition to his new work, he left his position as director of the Institute of Philosophy and recommended as his replacement Abdusalam K. Guseinov, who worked as his deputy for nearly fifteen years and then successfully continued his strategy for developing the Institute. The Institute's Academic Senate recognized Stepin's service by

electing him honorary director of the Institute of Philosophy at the Russian Academy of Sciences.

Stepin's activities as a teacher and instructor deserve at least a brief mention. He has spent his entire life teaching in higher education. "Brilliant instructor" is a cliché one often uses in biographical sketches, sometimes with no regard to the facts, but this assessment applies to Stepin to the maximum degree. He presents the most complex problems in ways that are both accessible and absorbing. Both philosophers and nonspecialists find it interesting to listen to him. The listener feels a sense of initiation into the depths of knowledge of nature and of the human being, because he understands, which one cannot say about the lectures of many other philosophers, even if they are presenting well-known issues. Stepin talks about the latest results of philosophical knowledge, including his own results! As a lecturer, he systemizes his material into educational goals in an exceptionally talented way. Stepin's lectures have had a profound, long-term impact on the representatives of very different areas of knowledge. Even if Stepin had not been such a formidable scholar and innovator, we would have considered him a suberb instructor.

Stepin's creative career can be considered a typical example of a successful career for a scholar and philosopher. The characteristics of his success involve defending his own opinion as a matter of course and fighting against the restrictions on freedom of creativity and the unfortunately necessary circumstances that accompany the path of a creative person. His success is measured here by the fact that this thinker was able to pose the most complicated, innovative problems and find consistently innovative solutions. His success also means that the ideas he put forward during his lifetime and without any administrative support have come into use in science and teaching for the simple reason that they accurately and systematically explained the whole complex of problems of philosophy, science, and culture.

Stepin was not a typical philosopher for the era of Stagnation. He distinguished himself in his dissimilarity to many other Soviet philosophers, many of whom considered him a marginal figure. When his time arrived, the era of perestroika, he immediately stepped forward as an intellectual leader ideally suitable for his time, and as a scholar, and as an instructor, and as an organizer of scholarly work in philosophy.

In life, it often happens that opponents describe a person with feature that do not correspond to their real activity. Throughout his creative career Stepin was criticized for the weaknesses of positivist philosophy, even though he was never a positivist. "Party philosophers" nevertheless branded him a "secret positivist" for decades. For many years he was not allowed to travel abroad due to his insufficient political loyalty, even when he was personally

invited to make a keynote speech at an international conference on philosophy. Against the background of ideologically engaged texts by many Soviet philosophers, Stepin's articles and books involuntarily attracted attention due to their style. They contained no dutiful references to the classics of Marxism or to the materials of party congresses as ideological ritual. In their presentation, Stepin's texts reminded one of natural science textbooks, where each statement stands on previously prepared, fundamental work on the production of true knowledge, and where each position is logically substantiated and bears some new, significant thought.

The secret is not simply in Stepin's creative longevity, but in his ability to move forward with each new major work in terms of deepening his conceptual view of the development of philosophy, science, and culture, and in terms of reaching newer and newer spheres of cognition; in that case the secret is apparently simple. "The important thing was to keep working," Stepin has said.[32] He has not allowed himself to rest and does not consider his work complete. He continues to work on problems that interest him, and thus to work on himself, as well. This kind of secret for living success has long been known to us through the words of the classics of science. Newton, when asked how he achieved his results, said that it happened after long and constant meditation. Descartes noted that one of the most important obstacles on the path to understanding was "the difficult and tedium of intellectual effort aimed at a single object." Stepin belongs to that number of creative people who consider the kind of stress that leads to new results pleasurable and necessary.

Notes

1. V.S. Stepin, "Obshchemetodologicheskie problemy nauchnogo poznaniia i sovremenny positivism." [General Methodological Problems of the Scientific Cognition and the contemporary Positivism]. Candidate's thesis abstract (Minsk, 1965), pp. 7–8.

2. V.S. Stepin, "Problema struktury i genezisa fizicheskoi teorii." [The Problem of the Structure and Genesis of the Physical Theory]. Doctoral thesis abstract (Minsk, 1975), p. 35.

3. Ibid., p. 25.

4. Ibid., p. 38.

5. V.S. Stepin, "Struktura teoreticheskogo znaniia i istoriko-nauchnye rekonstruktsii," in *Metodologicheskie problem istoriko-nauchnykh issledovanii* [The Methodological Problems of the Studies in History of Science]. (Moscow, 1982), pp. 154–55.

6. Stepin, "Problema," p. 4.

7. V.S. Stepin, *Stanovlenie nauchnoi teorii. Soderzhatel'nye aspekty stroeniia i genezisa teoreticheskikh znanii fiziki* [Establishing of the Scientific Theory. The

Conceptual Aspects of the Construction and Genesis of the Theoretical Knowledge of Physics]. (Minsk: Izd. VGU, 1976), p. 275.

8. Ibid., pp. 143–69. These results were also included in Stepin's more general book, *Teoreticheskoe znanie* (Moscow, 2000). English translation: V.S. Stepin, *Theoretical Knowledge* (Springer, 2005, pp. 186–205; 268–71.

9. Stepin, *Teoreticheskoe znanie*, p. 508.

10. Stepin, *Theoretical Knowledge*. Preface, pp. xiii–xiv.

11. T. Rokmor [Tom Rockmore], "Postneklassicheskaia kontseptsiia nauki V.S. Stepina i epistemologicheskii konstruktivizm," in *Chelovek. Nauka. Tsivilizatsiia* [Man. Culture. Civilization]. (Moscow: Konon +, 2004), pp. 258–60.

12. V.A. Lektorsky. "Epistemologiia, filosofiia, sovremennaia kul'tura," in *Rossisskaia filosofiia prodolzhaetsia: iz XX veka VXXI* [The Russia's Philosophy is Continuing: From the 20th Century into the 21st Century]. (Moscow, 2010), p. 385.

13. V.S. Stepin, *Chelovecheskoe poznanie i kul'tura* [The Human Cognition and Culture] (St. Petersburg, 2013), p. 110.

14. See, for example: V.S. Stepin, *Istoriia i filosofiia nauki* [History and Philosophy of Science] (Moscow: Akademicheskii proekt: Triesta, 2011).

15. V.S. Stepin, "Nauchnye revoliutsii kak 'tochki bifurkatsii' v razvitii znaniia," in *Nauchnye revoliutsii v dinamike kul'tury* [The Scientific Revolutions in the Dynamics of Culture] (Minsk, 1987), pp. 52–53.

16. V.S. Stepin, "Nauchnye revoliutsii kak 'tochki bifurkatsii' v razvitii znaniia," in *Nauchnye revoliutsii v dinamike kul'tury* (Minsk, 1987), p. 55.

17. *Nauchnye*, p. 375.

18. T. Kuhn, "Postskriptum-1969," *Structure of Scientific Revolution*, 2nd ed. (Chicago, 1970).

19. V.S. Stepin, *Idealy i normy nauchnogo issledovaniia* [The Ideals and Norms of the Scientific Study] (Minsk: BGU, 1981), pp. 28–65; idem, *Theoretical Knowledge*, pp. 283–306.

20. Stepin, *Theoretical Knowledge*, pp. 319–20.

21. *Postneklassika: filosofiia, nauka, kul'tura* [Post-neoclassic: Philosophy, Science, Culture]; ed. by L. Kiiaschenko and V. Stepin (St. Petersburg: Mir, 2009), pp. 258–61.

22. V. Stepin, "Social Environment, Foundations of Science, and the Possible Histories of Science," *BSPS*, vol. 151, pp. 129–37.

23. See, for example: A.S. Zapesotskii, "Teoriia kul'tury akademika V.S. Stepina." Lecture delivered to students at SPbGUP (St. Petersburg, 2010).

24. Stepin, *Teoreticheskoe znanie*, p. 282; *Theoretical Knowledge*, p. 145.

25. Stepin, *Istoriia*, p. 269.

26. Stepin, *Teoretichesko znanie*, pp. 36–99; *Theoretical Knowledge*, pp. 10–45.

27. Stepin, *Teoretichesko znanie*, pp. 36–99; *Theoretical Knowledge*, pp. 36–54; pp. 10–20.

28. Stepin, *Teoretichesko znanie*, pp. 36–99; *Theoretical Knowledge*, pp. 619–36; pp. 328–37.

29. V.S. Stepin, *Tsivilizatsiia i kul'tura* (St. Petersburg, 2011), pp. 163–207.

30. Stepin, *Teoreticheskoe znanie*, pp. 29–36; *Theoretical Knowledge*, pp. 1–10.

31. Stepin, *Tsivilizatsiia*, pp. 261–75.

32. *Voprosy filosofii* [The Questions of Philosophy]. 2004, no. 9, p. 16.