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**A contribution to questions of the philosophy of science**

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# A Contribution to Questions of the Philosophy of Science

In recent times, the need for a self-reflexive science has appeared as the result of a significant expansion of scientific knowledge and its subsequent technological applications and associated problems. This publication is a contribution to the discussion of these issues and will deal with questions of positivistic science and more recent ideas about science. It will also attempt to acquaint the reader with several more general problems which are associated with science.

## *Ernst Mach, Knowledge and Science*

In his work, Ernst Mach refused to consider himself a philosopher, but rather considered himself to be a scientist whose interest in philosophy was inspired by questions arising from his own scientific research. He believed that some terms, e.g. "substance," "matter," "subject," etc., created pseudo-problems in both philosophy and science and needed to be replaced with a new understanding of the world. He considered the materialistic philosophy which he perceived as dominating the natural sciences to be outdated.

Mach refused to distinguish between the material and spiritual. He did however recognize the existence of two forms of perception: external perception and self-perception. This led him to distinguish the physical from the psychic and yet to a certain extent he identified psychological research with physiology. This monistic world view did not allow him to distinguish between physical and physiological research. The focus of his research was on sensations-constituents and the relationship between them. According to him, the difference is not in substance but in the focus of research.

Although Mach was skeptical of philosophy as such, he regarded it as a type of scientific thought which was focused on general understanding. Although specialized sciences deal only with their narrow area of interest, the boundaries between these areas have been breached over the course of the evolution of science. According to Mach, all specialists must recognize in the end that knowledge acquired in other areas can help them in their own fields. In this way, a complete concept of the world where philosophy and science influence each other can come into existence.

Scientific knowledge rises out of a human biological need to preserve their own lives. Mach derives his belief in the credibility of knowledge precisely from this idea. Over the course of the evolution of science, a differentiated whole has been created in which the sciences influence each other.

In spite of the fact that Mach was a believer in the unified nature of science, he did not think that at that time there was a specialized science at such a

level as to allow it to become the basis for other sciences. Mach derives the need for economy of thought from the inexhaustibility of the world, which is contrary to ultimate human knowledge. Economy of thought often expresses itself in the process of abstraction and also in part in the principle of practicality. On the other hand, metaphysical thought is its direct opposite.

In considering the mechanism of knowledge, Mach analyzed the term abstraction and associated approaches in the construction of concepts or theories. Afraid of the hypostatization of concepts, Mach frequently stressed that concepts and theories are not identical to the objects which they represent. The ignoring of this fact can lead to serious errors, especially in the fields of cosmology and philosophy. Hypostatized concepts are then a most serious issue and idle reflection on them is a waste of energy which would be better spent on understanding the real world, a world which is only given to us through sensation. At the beginning of knowing the world there are psychic facts which are divided into sensations, when they are dependent on us, and into the characteristics of bodies when they are dependent on other physical conditions. Mach considered sensation to be fundamentally elementary.

Mach rejected the dualism of the psychic and the physical on the basis of his considerations of the economy of thought: such a dualism is useless. Sensations depend on circumstances both outside and inside our bodies. The psychic and the physical therefore contain common elements and are not absolute opposites as they are generally considered to be. This means that one can struggle against the concept of "self" as well as against the concept of "body." Mach found this statement to be fundamental. In his view, it is a statement which can help one to cope with "metaphysics" in both the narrower and wider senses of the word. In the wider sense, the metaphysical approach is that which is used in normal understanding and in the sciences and which is used to distinguish between the "material" and the "spiritual." For Mach, the first element is not the material, but rather the sensations-constituents. Therefore, the one scientific task which makes sense for mankind is the ascertaining of the relations between the constituents. This is why he rejects the concept of substance, which implies the ideas of constancy and permanence. Although Mach begins with the postulate of the external world's stability, his concept of the incompleteness and impermanence of knowledge makes him doubt the idea of substance. His reflections on the concept of causality (which he would like to replace with the concept functional dependence) and the concept of principle can be placed in this context.

Mach was convinced that his theories, primarily derived from scientific understanding (mainly from physics and physiology), could be applied to understanding society. He supports the idea that science is the one thing guaranteeing human advancement and future prosperity.

### *Henri Poincaré and the Concept of Science*

Poincaré was not a conventionalist in that sense that he would claim that every theory, and with it all science, is mere convention. He denied neither the existence of objective reality nor its relative knowability. What he did deny is

its absolute knowability. He stressed that there are many paths to understanding reality and we may choose from among them. Before the criteria of simplicity (parsimony) can be applied, the theories which we select must meet many other conditions, among the most important of which are congruity (logic and consistency) on the one hand and the robustness of its predictability, on the other. It is the latter condition which demonstrates that Poincaré's conventionalism cannot function without an acceptance of the existence of an external reality. All in all, this also corresponds to his explanation of our primal scientific concepts as being based on sensory experience with objects in the external world.

Poincaré also believed that some aspects of reality are truly unknowable. According to him, science recognizes relations between objects and not the objects themselves. He considered the objects to be unknowable and that they are replaced by concepts, terms which we use in specific theories. Although Poincaré did not relinquish the idea of a concordance between theory and reality, he believed (in slightly different words than his) that theory is a model of reality, that there can be more of these models and that we can choose from among them. Our choice is primarily influenced by our experience, which in turn is conditioned by reality if for no other reason than that our understanding should help us to orient ourselves in the world. The relativity of understanding which Poincaré accepted does not necessarily lead him to relativism. On the contrary, Poincaré criticized relativism. This is in accordance with the fact that the problem of incommensurability was not a part of his thinking. This is why the specific instrumentalism of Poincaré could not result in a basic conflict with questions of truthfulness, even though these questions retreated into the background and were modified by Poincaré semi-agnosticism, i.e. his unbelief in the knowability of reality's essence: objects which he evidently imagined as something similar to Kant's the reality of the thing.

### *One "small" Textbook*

This "small" textbook is the work of Richard von Mises entitled *Kleines Lehrbuch des Positivismus (Einführung in die empirische Wissenschaftsauffassung)*, which was published in 1939 in The Hague. Today, the book is interesting primarily from a historical point of view as it provides an overview of what were considered to be the fundamental ideas on positivism. Not all of the individual chapters of this book will be discussed here. Following a brief general description, the focus will be on the opinions of the mathematician Richard von Mises, on what he calls the "non-physical" sciences.

Richard von Mises' resistance to any form of dogmatism is a mark of positivism and his own version of this philosophy. He claimed that he did not intend to offer any sort of final teaching. For him, understanding or knowing is only provisional regardless of whether one is speaking of philosophy or the hard sciences. It is primarily necessary to analyze individual expressions in both philosophy and the sciences if the point is to determine whether they are non-contradictory and whether they accommodate previous experiences. Yet

all of this, even the measure, which determines the degree of non-contradiction, remains open to modifications as a result of further research.

Richard von Mises asserted his rejection of any type of dogmatism, including both the "empirical" (All knowledge is derived from experience) and the "positivistic" (The sensory world is the only reality). He believed that his task was only to describe science.

This does not make him a relativist. Richard von Mises was a believer in science and scientific progress, which he would like to link with the ideal of an improving human destiny on the Earth. Even in this, however, he was not extremely "dogmatic". He was aware of the relativity of values expressed by various cultures and in contrast with earlier positivists or confirmed Eurocentrics, he was not prepared to accept the idea that only European values are the "correct" values. For this reason, he was not able to define "progress" in a worldwide context. He therefore defines it rather negatively as life with less unpleasantness.

Richard von Mises' theory of the relationship between the physical and "non-physical" sciences can be understood within the context of two specific issues which appear in his writings, i.e. within the context of considerations of "negativism" and in considerations of the unity of science. These two contexts are derived from a common issue, i.e. the question of whether or not there are fundamentally different approaches to knowledge for different fields of knowledge.

Richard von Mises defines negativism as an opinion which claims that for certain fields of reality, which are considered to be especially important by "schooled" philosophers, there are also specific methods of understanding which are different than those normally used in the natural sciences. In connection with this idea of negativism, von Mises is primarily arguing with Heinrich Rickert. While von Mises did not deny the existence of different methods of understanding among the various sciences, he believed that Rickert made these differences absolute as far as the natural and historical sciences were concerned. In this polemic against Rickert, von Mises consciously used the extremes, e.g. theoretical physics, on the one hand and purely descriptive history on the other, and tried to prove that here Rickert's absolutism was also invalid. While physics does have a tendency to formulate laws, it also focuses on description of individual processes. The field of history also offers up generalizations. What is more, the selection of what the historian says about a particular event is controlled by the author's subjective opinions and is used to mediate these ideas to the reader, although perhaps only implicitly.

As the previous paragraph shows, von Mises' argument is not terribly persuasive. The difference between the formulation of laws on the one hand and the existence of generalizations on the other, is too obvious.

Richard von Mises even rejected attempts to establish a difference between the natural and historical sciences on the basis of their subject. For von Mises, the criteria for differentiating between sciences were the length of time the phenomena under study lasted and the provability of the statements. He, however, did not consider these differences to be so significant as to establish the idea of a fundamental difference between the natural and historical sciences.

Similar to other positivists, von Mises' point of view basically means the subordination of the non-physical sciences to the model used for the natural sciences. One result of this is a certain lack of cogency in von Mises' theses. While he may be justified in criticizing supporters of this method of understanding in the sense that they lack experience in the natural sciences, this criticism may be turned against him: he also discusses history and the social sciences as an outsider. Thus does his belief in the more extensive application of theory in historiography and the social sciences become a mere declaration and fervent wish. This can also be seen in his attempts to predict future developments in the fields human behavior and human understanding. This attempt was basically an extrapolation of trends he believed that he had discovered. The natural, historical and non-physical sciences do not have at their disposal theory in the way he himself understood it.

### *Karl R. Popper*

From the very beginning, Karl Popper's philosophy of science developed in opposition to neo-positivism. It was not an opposition based on irrational positions, but rather an attempt to show the connection of scientific research to the wider context of thinking. This is associated with Popper's rejection of the inductive method as a basic method of knowing. Popper did not see the beginnings of science in observation or experiment but in the origin of the problem itself. At all levels - animal, ordinary consciousness and even scientific - a problem arises when an expectation has not been met. Expectation originates in advance knowledge. If this expectation is not met, then it is clear that this advance knowledge has some deficiency which should be removed through further examination. This process leads to a focus on one specific part of reality and finally to the formulation of a question. Only then can we begin to observe or experiment. Popper stressed the role of the subject's activity in the process of knowing.

The criterion for progress in science is moving closer to the truth (the world is inexhaustible, but individual theories may be considered on the basis of the relative truthfulness of their content). In general, Popper saw progress in science in the creation of theories with ever richer content, ever more universal and exact.

Falsifiability is the criterion for determining how scientific a theory is. Popper understood this falsifiability as a logical property. A theory must be constructed in such a way that it includes at least one statement which can be empirically controlled and which can therefore turn out to be false. Of course, a good theory will not contain only one such statement. According to Popper, a good theory is one with a high degree of empirical content, i.e. one containing many falsifiable statements.

Popper was also interested in questions of understanding society. His well-known critique of historicism includes elements of criticism of the method of knowing and criticism of methods of interference in society. This critique was probably most important for Popper at that time when he was writing the books *The Open Society and Its Enemies* and *The Poverty of Historicism*. This

critique also stresses the contradiction of “holistic” or “utopian” social engineering on the one hand and the method of incremental, small interference on the other.

According to Popper, the development of society is primarily the development of knowledge. From this is derived his emphasis on the theory of “three worlds” and the methods behind his attempts at explanations in history as well as in society. In Popper’s view, the analysis of social situations to a large degree replaces in the social sciences a type of explanation which is typical for the natural sciences, i.e. explanation using scientific laws and initial conditions. It is precisely for this reason that the social sciences have a much more difficult time coming to terms with objectivity. Popper’s solution to this problem is basically to abandon attempts at objective understanding in the social sciences. Popper recommends that we should be consciously aware of the fact that we write that history which interests us, which we have in advance chosen for some specific reason or reasons. This gives rise to what Popper called the advance selection point. Popper described this point as having a role similar to that of theory in the theoretical sciences. With one exception: they are not verifiable. They are not theories as such but rather historical interpretations. The robustness of such historical interpretation is not a proof of its correctness.

Popper believes that philosophy is a necessary part of human knowledge, which, however, is a form of belief. In this context, Popper asserted that the conflict between science and faith, typical for the nineteenth century, appears to have been overcome. The point is that we must choose between two types of belief and Popper chooses science, which is belief in reason.

Popper considers himself to be an anti-inductivist, an anti-sensualist, a fighter for the primacy of the theoretical and hypothetical and a critical realist. He believes that realism is the only reasonable hypothesis, a supposition without a reasonable alternative. He found many reasons to prefer realism over idealism. In this context, we can understand his later inclination towards “modified essentialism” and his concept of law.

The objectivity of science was close to Popper’s heart. Although he denied the possibility of absolute knowledge, he tried to find ways to secure the greatest possible objectivity for science. He saw guarantees of objectivity in the criticism and self-criticism of scientists and in the institutions which make this possible, i.e. institutions which allow wide-ranging scientific discussions.

### *Paul Feyerabend’s Alternative Science and Alternative Society*

The author of this contribution would characterize Paul Feyerabend as one of the leading representatives of postmodernism. His inclination towards postmodernism could partially be explained by some events which have taken place during his life.

Feyerabend’s rejection of “cultural imperialism” has two levels. The first level deals with science, where he discusses Thomas Kuhn’s concept of scientific revolution, especially that portion which deals with changes in paradigms. For Feyerabend, “normal” scientific development is that which can be characterized as a permanent scientific revolution.

The second level of Feyerabend's rejection of "cultural imperialism" has a much wider scope, dealing not only with science, but with culture as a whole. While on the one hand, Feyerabend emphatically supports the idea of competition between incommensurable theories in science, on the other hand, he rejects the idea of demarcation. He applies the principle of open competition between theories not only within the framework of the sciences but also within the framework of relations between various cultural activities. As a consequence, he blames contemporary European and American societies for the suppression of non-European cultures through an emphasis on the universality of scientific knowledge coming out of cultural imperialism.

Although the author does not agree with Feyerabend's views, she believes that they might be taken as the basis for an open discussion.

*Stephen Toulmin: Science, Society and Postmodernism*

Stephen Toulmin is also one of those authors who has attempted to come to terms with postmodernism. One of the goals of this contribution is to show the difference between the approaches of Feyerabend and Toulmin.

Toulmin views the main task of his analysis as being an attempt to come to terms with the problem of relativism in human knowledge. He considers this to be the fundamental principle of scientific knowledge. He however does not consider scientific knowledge to be separate from other types of human knowledge or to be fundamentally different in any way. On the contrary, he often tries to explain the development of scientific knowledge through references to other types of knowledge. He is fond of using examples from the Anglo-Saxon legal system, with its use of precedents.

Toulmin rejects the identification of rationality with logic and systematicness and tries to expand the concept of rationality beyond the boundaries of formal logic so that it can once again be used in theory change. For Toulmin, the rationality of intellectual statements is not measured in the internal consistency of conventional ideas, but rather in changes in the scientists' approach when faced with a new and unpredicted experience.

Toulmin claims that a usable theory of idea change must answer the following question. What are the causes of and the processes by which one system of collective ideas (in the sciences or elsewhere) is replaced by another? The answer must deal with questions of continuity and discontinuity and with relations between reasons and causes. Instead of an analysis stressing rapid revolutionary change, Toulmin calls for evolutionary analysis which is able to explain the slower evolution of the "population of ideas".

Toulmin rejects "philosophical" writing about science and his explorations focus on scientific praxis. He therefore reduces the emphasis on questions of the role of the *a priori* in knowledge and considerations of causes, laws and theories.

For Toulmin, discovery in science means firstly the creation of a technical explanation for a given phenomenon, which can be applied to a wider range of realities, and secondly the acceptance of a new model, which is associated with this technical explanation and allows a new understanding of these phenomena

and an understanding of why they are the way they are. The question of truthfulness retreats into the background and more emphasis is placed on the concept of the robustness of theory.

In his book *Human Understanding*, Toulmin stresses the importance of the question of continuity in scientific understanding. As a means of dealing with this question he uses the concept of discipline and its goals. One sign that a discipline has reached its theoretical goals, and thus become a true discipline, is the appearance of recognized fundamental ideas and criteria for choice. If it is not the fundamental goals of a science that change, but only the means used by the scientists to address these fundamental goals, it is Toulmin's opinion that continuity has been preserved and it is not possible to speak about incommensurability.

In the connection with the problem of relativism, Toulmin rejects the idea of immutable (Platonic) ideals or mechanisms of human understanding. In spite of this, he believes that cultural and historical diversity is not so great as to not allow us to find something common to all humankind within its framework, something which would allow comparison. A certain type of comparison should be possible not only within the framework of humanity as a whole, but also within the framework of humankind and some animal species.

In his book *Cosmopolis: The Hidden Agenda of Modernity*, he focuses on European understanding over the last three or four centuries. According to Toulmin, the beginnings of modernism can be divided into two separate phases, the first phase dating to the second half of the sixteenth century and the second to the seventeenth century. The first phase is characterized by, e.g. Montaigne's philosophy. This phase of modernism is also characterized by tolerance and skepticism in the Classical sense. In contrast, the second phase, which Toulmin identifies as classic modernism, uses skepticism merely as methodological tool. In fact this phase can be characterized as very intolerant and by attempts to achieve indisputable knowledge. If postmodern criticism rejects this, it is justified in doing so.

Toulmin's criticism of modernism, and in part, of postmodernism, is based on an analysis of contemporary society and its problems. He rejects the myth of a possibility of returning to the very beginning, to a *tabula rasa* and asserts that the contemporary era should follow the positive features both of sixteenth century humanism and seventeenth century sciences.

Toulmin is a part of the postmodernist movement in the sense that he sometimes asks the same questions and similarly criticizes some earlier ideas. However, his answers to these questions are not altogether postmodern. This is also indicated by his considerations of contemporary events, which he does not characterize as "postmodern" but rather as "the third phase of modernism."

This notwithstanding, it would be difficult to place Toulmin somewhere on the way between modernism and postmodernism. His considerations might be more properly characterized as a reflection of the current situation, a reflection which attempts to deal with a justified critique of recent centuries in ways which are at least in part different than those of postmodernism.

### *Science and Philosophy*

In this section, the author will attempt to point out the relation between science and philosophy, first from a historical perspective. As long as science was studied only within the framework of knowledge, questions of the relationship between science and philosophy were not asked. But at that moment in the nineteenth century when scientism began to be promoted, the situation has changed.

As scientism has shown, the connection between science and philosophy is something which neither science nor philosophy can escape. Every statement breaching the boundaries of a mere factual statement, e.g. statements about the validity of science, the goals of science, etc., is a statement of philosophical validity. What is more, even factual statements are based on unstated (philosophical) considerations about what the facts are and whether and how they exist.

The relation between science and empirical reality and indirectly, the relation between science and praxis are philosophical questions. The author deals with a critique of positivistic approaches to solving the problem of factuality. She continues with questions of the cultural dependence of science and the associated problem of relativism, especially in relation to rationality. She points out the solutions offered by some contemporary authors (Toulmin, Feyerabend, etc.). It is precisely in this context that the question of the function of philosophy in scientific understanding comes to the fore. What tends to be considered important in science often seems to be connected in some way with the big picture of the world, which is of course provided in its most complete form by philosophy. Associated with this are the problems of values, especially the internal values required for scientific research, values and terms brought into science from "outside," from philosophy, and finally the evaluation of science as such.

Values are created both within science and outside science, they mingle and thus form a context in which the entire society, including science, operates. From this point of view, it would be dishonorable to turn one's back on questions of science and philosophy.

### *The Problem of Relativism in Contemporary Science*

It seems that the rapid development of the natural sciences and the questioning of progress in the second half of the twentieth century have come together to suppress the idea in science that science is an understanding which is slowly but surely moving towards absolute truth. If this truth cannot be reached, we can at least continue to come nearer to it. This could first be seen in conventionalism and later in part in the works of Karl Popper, who also rejected the notion of reaching an "ultimate" truth. Further development took place primarily within the framework of historical schools of the philosophy of science, where Kuhn, Imre Lakatos and Toulmin tried to defend the absolute relativization of scientific knowledge, a goal which was attained by Feyerabend.

The rational core of Feyerabend's thesis is the question of the compatibility and incompatibility of ideas which have originated in different cultures. Today, no one disputes the fact that cultures function as a filter through which we per-

ceive our environment and that members of various cultures will perceive the same environment in different ways, using different techniques to adapt to it.

The problem of cultural values is, however, something slightly different than the problem of understanding. If people from different cultures can understand each other, there must be something common to all humankind, something which is a basis for human understanding and its objectivity. Anthropologists answer this question with the concept of universals. If in humanity there might be something which may be considered as a core, a core which remains unchanged no matter what approach we apply, do we not have the right to suppose that the exact same core exists in nature as a whole and that constructions in the natural sciences recognize something more than is supposed by Feyerabend? After all, humanity is a sample of the world of nature and can therefore serve as a model for it.

### *Questions of the Social Conditioning of Science*

Although at the beginning of the second half of the twentieth century, it seemed that the dispute between externalism and internalism had been resolved through a compromise. In connection with postmodern philosophy, some of the questions associated with this compromise have resurfaced. The author offers an overview of the theories which deal with questions of progress in science, including theories of Karl Popper, Thomas Kuhn and Paul Feyerabend. For these theorists, the importance of external factors for the development of science increases.

We can basically speak of two types of causes, which are well known and which have contributed to the fact that the postmodern concept of science, at least in the form as it is presented by Feyerabend, is undergoing a crisis in terms of the understanding of science. The first of these causes is the increasing incomprehensibility of science, primarily associated with the quantification of science beginning in the seventeenth century. The second cause is a new concept of the relations between individual cultures in today's ever-shrinking world.

A system of values is an inseparable part of every culture. Each culture has its own system and these systems vary considerably. As there is no such thing as a "super-culture," we have no objective measure with which to compare either the systems of values or the relative scale of individual values within each system. As soon as we realize this, we automatically question the concept of "progress" as it is applied to the development of human society and culture as a whole. This fact gives rise to the following problems: first, the problem of mutual comprehensibility as such; second, the problem of cultural intercourse - acculturation; and third, the problem of the position of science, which is the subject of this work.

The role of science within the history of Europe was different from that of non-European nations. Beginning in the nineteenth century, it was primarily the technological application of science which ensured both European and, later, American dominance in the world and that science dominated European and American views of the world. This goes hand in hand with development of

Eurocentrism in the nineteenth century. This viewpoint has been overcome with the emancipation of colonial nations. Nevertheless, does this mean that it is right to give up one's own values in favor of values which have developed somewhere else, under different conditions and are a part of different structures?

### *Science and Its Social and Cultural Background*

The philosophy of science and the history of science share a critical problem. What is the relationship in science between those ideas which are more or less indirectly influenced by society and are therefore strongly relative and those ideas which represent a theory's "core ideas" and are therefore products of an autonomous development of knowledge? This question is important for solving problems in the relationship between the objectivity and relativity of knowledge.

Culture is an important part of society. But it is precisely in connection with culture that the problem of the relationship between the social and the natural in mankind must be addressed. This is done within the concept of universality. The biological is both a starting point and a determining limitation for culture's and society's possibilities. In addition to this, one other aspect necessary for the comparison of objectivity and relativity of knowledge is an analysis of cultural elements internalized into the subconscious.

Science is a part of culture and through this a part of society. Its relationship to society is, however, more direct as it has become an institution in the modern era and what is more science influences society directly through its technological applications. It is however necessary to realize that as well as society and culture influencing science, science influences (directly or indirectly) both society and culture. Nevertheless, the direction and form of this influence is often difficult to distinguish. Science is a field in which new concepts and ideological schemata originate and from which they sooner or later spread into the general consciousness, including some modern "myths." Through the mediation of culture, some of them then subsequently influence science.

### *The Progress of Science (?)*

The questioning of both progress and science generally reflects a questioning of its technological applications and political decisions on its use. For the most part, this is an ethical questioning, based on the fact that some applications of scientific discovery have resulted in morally questionable consequences, rather than a questioning whether or not developments in science are truly progress.

Questions about progress in science are associated with questions of values. Within an ideological system which is focused on progress and joins this to the development of science and technology, science is ascribed a high value. This can lead to paradoxes because in the general consciousness there may still remain outdated images of scientism. It is true of course, that in the context of change in science, the image of science changes as well. This is what is happening now, with science being questioned in postmodern theory, as is done by

Paul Feyerabend for example. The most recent developments in humanity have made their arguments increasingly persuasive. There of course remains one question: What about the objectivity of knowledge? Does it make any sense to continue speaking about scientific truth? And if the concept of scientific truth is disproved, what happens to the concept of truth in general?

### *Criticism of Science as such*

If we search for the causes of this increasing distrust of science, we can divide them into two major groups. The first group could be characterized as causes arising from the historical development of science with the second group being causes arising from the technologies developed on the basis of science. The Copernican Revolution is a denial sensory experience and a triumph of abstract reasoning. Even this abstract reasoning has been questioned. The original belief in the infallibility and definiteness of scientific knowledge has been lost. A result of the indefensible technological applications of science (e.g. the construction of weapons or in connection with global problems) is the fact that science is no longer able to morally justify itself. The role of science in improving the lot of humanity on the Earth as the obvious justification for science since the Enlightenment is disappearing.

The position of science in the contemporary world and society is much more widely questioned. This has led scientists, philosophers and all those who are aware of this, to search for a way out of this crisis. They usually search for an ethical solution and its subsequent institutionalization. The basic principle is self-reflection in science, i.e. an attempt to build up knowledge about the social functions of science and scientists among both the scientific community and the public at large. This, however, means that the idea that scientists are not responsible for what happens to the results of their research must be surrendered.

### *Order and Chaos in the Development of Scientific Understanding of Reality*

The origins of science are associated with the idea of order. In Greek philosophy, the world emerges out of chaos as certain order and the task of philosophy and, later, science is to study this order. During the Middle Ages, the idea of (divine) order was accepted as well. Although later philosophies, especially late positivism and postmodernism, have questioned the idea of natural order and the human ability to study it, people do not want to give up the idea of order. The fact that scientific constructions, and their technological application, function led to the aforementioned belief in the objectivity of reality and reality's order and their gradual knowability.

The concept of chaos in and of itself does not call order into question. The role of chaos in scientific thinking is studied on the basis of work by Karl Popper and Edgar Morin. Popper starts with the idea of emergent development, which states that under certain circumstances, old rules cease to be valid and a "moment" of chaos arises. It is from this chaos that the new with its own new rules is born. Chaos is thus incorporated into the order of the world as one of

its fundamental instances, an instance which gives rise to the new. Chaos and order are therefore inseparable within this concept.

The difference between Morin and Popper is in that the former ascribes an even greater importance to chaos and does not reduce the studied world to something that can be rationalized, but rather acknowledges the role of the arational and irrational in this world. Morin believes that earlier thinking was based on the concept of order and needed its postulation in order to make progress. Chaos and its reflection appear exactly at that point when earlier modes of thinking have been exhausted. Chaos appears as both a question and challenge for our times.

### *What is an Individual?*

Questions of the relationship between order and chaos in the context of the individual is a problem of different levels of order (and chaos) and these levels are restricted by what or whom we understand to be an individual. This problem becomes topical in connection with the rejection of an essentialistic approach to the world and its replacement by an approach based on the relational and structural.

That, which in physics has been documented by changes in the theory of the atom could be seen even earlier in the social sciences. We have to understand humanity as being at the crossroads of biological and socio-cultural influences. Even greater "individualities," which may be seen as individual cultural formations, can be understood in different ways. This applies to the definition of their boundaries and their permeability, which is also associated with the dispute between Eurocentrism and cultural relativism.

The goal of this work has been to show that that which is understood as an individual is not known *a priori* in either the natural or social sciences. The definition of the individual lies to a great extent on our own research interests. At the same time, it seems that the inexplicitness and relativity of the definition of an individual has its ontological foundation in the concept of the world as a infinitely complex collection of relations. It is therefore no surprise that some authors, who deal with questions of the individual, use concepts borrowed from systems theory but also use terminology borrowed from ecology. It is precisely here in association with the relationship of individuals to their environment that questions dealing with the concepts of order and chaos can once again appear.

*Translated by Jeffrey Vanderziel*

