Philosophy of Science PHF 600 Manual by Grzegorz Trela

1 Historical background and introduction

Science grew out of philosophy; and, even after recognizable, if flexible, interdisciplinary boundaries developed, the most fruitful philosophical investigations have often been made in close connection with science and scientific advance. The major modern innovators - Bacon, Descartes, Leibniz and Locke among them - were all centrally influenced by, and in some cases significantly contributed to, the science of their day. Kant's fundamental epistemological problem was generated by the success of science: we have obtained certain knowledge, both in mathematics and - principally due to Newton - in science, how was this possible? Unsurprisingly, many thinkers who are principally regarded as great scientists, had exciting and insightful views on the aims of science and the methods of obtaining scientific knowledge. One can only wonder why the epistemological views of Galileo and of Newton, for example, are not taught along with those of Bacon and Locke, say, in courses on the history of modern philosophy.

Certainly, it can be argued very convincingly that the former two had at least as much insight into the aims and methods of science, and into how scientific knowledge is gained and accredited as the latter two. In the nineteenth century, Maxwell, Hertz and Helmholz all had interesting views about explanation and the foundations of science, while Poincaré who was undoubtedly one of the greatest mathematicians and mathematical physicists, was arguably also one of the greatest philosophers of science - developing important and influential views about, amongst other things, the nature of theories and hypotheses, explanation, and the role of probability theory both within science and as an account of scientific reasoning. The period from the 1920s to 1950s is sometimes seen as involving a movement towards more formal issues to the exclusion of detailed concern with the scientific process itself. While this has been over-exaggerated - Carnap, Hempel, Popper and especially Reichenbach for example all show sophisticated awareness of a range of issues from contemporary science - there is no doubt that general attention in philosophy of science has been redirected back to the details of science, and in particular of its historical development, by ‘post-positivist’ philosophers such as Hanson, Feyerabend, Kuhn, Lakatos and others.

Current philosophy of science has developed this great tradition, addressing many of the now standard philosophical issues – about knowledge, the nature of reality, determinism and indeterminism and so on - but by paying very close attention to science both as an exemplar of knowledge and as a source of (likely) information about the world. This means that there is inevitably much overlap with other areas of philosophy - notably epistemology (the theory of scientific knowledge is of course a central concern of philosophy of science) and metaphysics (which philosophers of science often shun as an attempted a priori discipline but welcome when it is approached as an investigation of what current scientific theories and practices seem to be telling us about the likely structure of the universe). Indeed one way of usefully dividing up the subject would see scientific epistemology and what might be called scientific metaphysics as two of the main branches of the subject (these two together in turn forming what might be called general philosophy of science), with the third branch consisting of more detailed, specific investigations into foundational issues concerned with particular scientific fields or particular scientific theories (especial, though by no means exclusive, attention having been paid of late to foundational and interpretative issues in quantum theory and the Darwinian theory of evolution). Again not surprisingly, important contributions have been made in this third sub-field by scientists themselves who have reflected carefully and challengingly on their own work and its foundations, as well as by those who are more usually considered philosophers.

2 Contemporary philosophy of science: the theory of scientific knowledge

Scientists propose theories and assess those theories in the light of observational and experimental evidence; what distinguishes science is the careful and systematic way in which its claims are based on evidence. These simple claims, which I suppose would win fairly universal agreement, hide any number of complex issues. First, concerning theories: how exactly are these best represented? Is Newton's theory of gravitation, or the neo-Darwinian theory of evolution, or the general theory of relativity, best represented - as logical empiricists such as Carnap supposed - as sets of (at least potentially) formally axiomatized sentences, linked to their observational bases by some sort of correspondence rules? Or are they best represented, as various recent 'semantic theorists' have argued, as sets of models (see Models; Theories, scientific)? Is this simply a representational matter or does the difference between the two sorts of approach matter scientifically and philosophically? This issue ties in with the increasingly recognized role of idealizations in science and of the role of models as intermediates between fundamental theory and empirical laws. It also relates to an important issue about how best to think of the state of a scientific field at a given time: is a scientist best thought of as accepting (in some sense or other) a single theory or set of such theories or rather as accepting some sort of more general and hierarchically-organized set of assumptions and techniques in the manner of Kuhnian paradigms or Lakatosian research programmes? It seems likely that arriving at the correct account of scientific development and in particular of theory-change in science will depend on identifying the 'right' account of theories.

Next concerning the evidence: it has long been recognized that many of the statements that scientists are happy to regard as 'observation sentences' in fact presuppose a certain amount of theory, and that all observation sentences, short perhaps of purely subjective reports of current introspection, depend on some sort of minimal theory (even 'the needle points to around 5 on the scale' presupposes that the needle and the scale exist independently of the observer and that the observer's perception of them is not systematically deluded by a Cartesian demon). Does this mean that there is no real epistemic distinction between observational and theoretical claims? Does it mean that there is no secure basis or foundation for science in the form of observational and experimental results? If so, what becomes of the whole empiricist idea of basing scientific theories on the evidence? It can be argued that those who have drawn dire consequences from these considerations have confused fallibility with (serious) corrigibility: that there are observation statements, such as reports of meter readings and the like, of a sufficiently low level as to be, once independently and intersubjectively verified, not seriously corrigible despite being trivially strictly fallible. Aside from this issue, experiment was for a long time regarded as raising barely any independent, philosophical or methodological concern - experiments being thought of as very largely simply means for testing theories. More recently, there has been better appreciation of the extent to which experimental science has a life of its own, independent of fundamental theory, and of the extent to which philosophical issues concerning testing, realism, underdetermination and so on can be illuminated by studying experiments.

Suppose that we have characterized scientific theories and drawn a line between theoretical and observational statements, what exactly is involved in 'basing' theoretical claims 'systematically and carefully' on the evidence? This question has of course been perhaps the central question of general philosophy of science in this century. We have known at least since David Hume that the answer cannot be that the correct theories are deducible from observation results. Indeed, not only do our theories universally generalize the (inevitably finite) data as Hume pointed out, they also generally 'transcend' the data by explaining that data in terms of underlying, but non-observable, theoretical entities. This means that there must always in principle be (indefinitely) many theories that clash with one another at the theoretical level but yet entail all the same observational results. What extra factors then are involved over and beyond simply having the right observational consequences? What roles do such factors as simplicity and explanatory power, play in accrediting theories on the basis of evidence? Moreover, what status do these factors have - are they purely pragmatic (the sorts of features we like theories to have) or are they truth-indicating, and if so why? Some have argued that the whole process can be codified in probabilistic terms – the theories that we see as accredited by the evidence being the ones that are at any rate more probable in the light of that evidence than any of their rivals.

Finally, suppose we have characterized the correct scientific way of reasoning to theories from evidence, what exactly does this tell us about the theories that have been thus ‘accredited’ by the evidence? And what does it tell us about the entities - such as electrons, quarks, and the rest - apparently postulated by such theories? Is it reasonable to believe that these accredited theories are true descriptions of an underlying reality, that their theoretical terms refer to real, though unobservable entities? (Or at least to believe that they are probably true? or approximately true? or perhaps probably approximately true?) More strongly still, is any one of these beliefs the uniquely rational one? Or is it instead more, or at least equally, reasonable - at least equally explanatory of the way that science operates - to hold that these ‘accredited’ theories are no more than empirically adequate, even that they are simply instruments for prediction, the theoretical ‘entities’ they involve being no more than convenient fiction? One major problem faced by realists is to develop a plausible response to once accepted theories that are now rejected either by arguing that they were in some sense immature - not ‘fully scientific’ - or that, despite having been rejected, they nonetheless somehow live on as ‘limiting cases’ of current theories.

Clearly an antirealist view of theories would be indicated if it could convincingly be argued that the accreditation of theories in science is not simply a function of evidential and other truth-related factors or even of epistemic pragmatic factors, but also of broader cultural and social matters. Although such arguments are heard increasingly often, many remain unconvinced - seeing those arguments as based either on confusion of discovery with validational issues or on fairly naïve views of evidential support.

3 Contemporary philosophy of science: 'scientific metaphysics'

Suppose that we take a vaguely realist view of current science, what does it tell us about the general structure of reality? Does a sensible interpretation of science require the postulation, for example, of natural kinds or universals? Does it require the postulation of a notion of physical necessity to distinguish natural laws from 'mere' regularities? What is the nature of probability - is a probabilistic claim invariably an expression of (partial) ignorance or are there real, irreducible 'objective chances' in the world? What exactly is involved in the claim that a particular theory (or a particular system described by such a theory) is deterministic, and what would it mean for the world as a whole to be deterministic? Does even 'deterministic' science eschew the notion of cause (as Russell argued)? Does this notion come into its own in more 'mundane' contexts, involving what might be called 'causal factors' and probabilistic causation? What exactly is the relationship between causal claims - such as 'smoking causes heart disease' – and statistical data? How should spacetime be interpreted: as substantive or as 'merely' relational? Does current science plus whatever ideas of causality are associated with it unambiguously rule out the possibility of time travel, or does this remain at least logically possible given current science? Finally, and most generally, what is science (or, perhaps more significantly, the direction of scientific development) telling us about the overall structure of the universe - that it is one simple system governed at the fundamental level by one unified set of general laws, or rather that it is a 'patchwork' of interconnected but separate, mutually irreducible principles? Although it is of course true - despite some exaggerated claims on behalf of 'theories of everything' -that science is very far from reducing everything to a common fundamental basis, and although it is of course true that, even in cases where reduction is generally agreed to have been achieved, such as that of chemistry to physics, the reduction is ontological (that is, chemistry has been shown to need no essential, non-physical primitive notions) rather than epistemological (no one would dream of trying actually to derive a full description of any chemical reaction from the principles of quantum mechanics), some would nonetheless still argue that the overall tendency of science is in the reductionist direction. These are examples of the more or less general, and impressively varied, 'metaphysical' issues informed by science that have attracted recent philosophical attention.

4 Contemporary philosophy of science: foundational issues from current science

Many of the most interesting issues in current philosophy of science are closely tied to foundational or methodological concerns about current scientific theory. One fertile source of such concerns is quantum theory. How much of a revolutionary change in our general metaphysical view of the world does it require? Is the theory irreducibly indeterministic or do 'hidden variable' interpretations of some sort remain possible despite the negative results? What does quantum mechanics tell us about the notion of cause? Does quantum mechanics imply a drastic breakdown of 'locality', telling us that the properties of even vastly spatially separated systems are fundamentally interconnected - so that we can no longer think of, for example 'two' spatially separated electrons as separate, independent 'particles'? More directly, is there, in view of the 'measurement problem' a coherent interpretation of quantum mechanics at all? (It has been argued that when the theory is interpreted universally so that all systems, including 'macroscopic' ones, such as measuring apparatuses, are assigned a quantum state then the two fundamental principles of quantum theory - the Schrödinger equation and the projection postulate - come into direct contradiction. Although perhaps attracting relatively less attention than quantum theory, the other two great theories that form the triumvirate at the heart of contemporary physics - relativity (both special and general) and thermodynamics - pose similarly fascinating problems. In the case of relativity theory, philosophers have raised both ontological issues (for example, concerning the nature of spacetime) and epistemological issues (concerning for example the real role played in Einstein's development of the theory by Machian empiricism, the role of allegedly crucial experiments such as that of Michelson and Morley, and the evidential impact on the general theory of the Eddington star-shift experiment). There are also important issues about the consistency of relativity and quantum theory - issues that in turn feed into the more general questions concerning the unity of science and realism. Thermodynamics raises issues about, amongst other things, probability and the testing of probabilistic theories, about determinism and indeterminism, and about the direction of time. Other current areas of physics, too, raise significant foundational issues. For a long time, philosophy of science meant in effect philosophy of physics. A welcome broadening-out has occurred recently - especially in the direction of philosophy of biology. The central concern here has been with foundational issues in the Darwinian theory of evolution (or more accurately the neo-Darwinian synthesis of natural selection and genetics). Questions have been raised about the testability and, more generally, the empirical credentials of that theory, about the scope of the theory (in particular what it can tell us about humans and human societies), about the appropriate 'unit of selection' (individual, gene, group), about what exactly are genes and what exactly are species, and about whether evolutionary biology involves distinctive - perhaps even in some sense 'teleological' - modes of explanation.

More recently philosophy of biology has started to widen its own scope by considering issues outside of evolutionary theory, where, however, issues of reductionism and of the possibility of distinctive modes of explanation still loom large.

5. Vienna Circle

The Vienna Circle was a group of about three dozen thinkers drawn from the natural and social sciences, logic and mathematics who met regularly in Vienna between the wars to discuss philosophy. The work of this group constitutes one of the most important and most influential philosophical achievements of the twentieth century, especially in the development of analytic philosophy and philosophy of science. The Vienna Circle made its first public appearance in 1929 with the publication of its manifesto, The Scientific Conception of the World: The Vienna Circle (Carnap, Hahn and Neurath 1929). At the centre of this modernist movement was the so-called 'Schlick Circle', a discussion group organized in 1924 by the physics professor Moritz Schlick. Friedrich Waismann, Herbert Feigl, Rudolf Carnap, Hans Hahn, Philipp Frank, Otto Neurath, Viktor Kraft, Karl Menger, Kurt Gödel and Edgar Zilsel belonged to this inner circle. Their meetings in the Boltzmanngasse were also attended by Olga Taussky-Todd, Olga Hahn-Neurath, Felix Kaufmann, Rose Rand, Gustav Bergmann and Richard von Mises, and on some occasions by visitors from abroad such as Hans Reichenbach, Alfred Ayer, Ernest Nagel, Willard Van Orman Quine and Alfred Tarski. This discussion circle was pluralistic and committed to the ideals of the Enlightenment. It was unified by the aim of making philosophy scientific with the help of modern logic on the basis of scientific and everyday experience. At the periphery of the Schlick Circle, and in a more or less strong osmotic contact with it, there were loose discussion groups around Ludwig Wittgenstein, Heinrich Gomperz, Richard von Mises and Karl Popper. In addition the mathematician Karl Menger established in the years 1926-36 an international mathematical colloquium, which was attended by Kurt Gödel, John von Neumann and Alfred Tarski among others.

Thus, the years 1924-36 saw the development of an interdisciplinary movement whose purpose was to transform philosophy. Its public profile was provided by the Ernst Mach Society through which members of the Vienna Circle sought to popularize their ideas in the context of programmes for national education in Vienna. The general programme of the movement was reflected in its publications, such as the journal Erkenntnis (‘Knowledge’, later called The Journal for Unified Science), and the International Encyclopedia of Unified Science. Given this story of intellectual success, the fate of the Vienna Circle was tragic. The Ernst Mach Society was suspended in 1934 for political reasons, Moritz Schlick was murdered in 1936, and around this time many members of the Vienna Circle left Austria for racial and political reasons; thus, soon after Schlick’s death the Circle disintegrated. As a result of the emigration of so many of its members, however, the characteristic ideas of the Vienna Circle became more and more widely known, especially in Scandinavia, Britain and North America where they contributed to the emergence of modern philosophy of science. In Germany and Austria, however, the philosophical and mathematical scene was characterized by a prolongation of the break that was caused by the emigration of the members of the Vienna Circle.

6. Scientific philosophy and philosophy of science

Proponents of ‘scientific philosophy’ think of philosophy not as an autonomous discipline prior to the sciences but as a critical discipline dependent upon the natural and social sciences, logic and mathematics. Changing a motto of Kant, they hold that philosophy without science is empty, science without philosophy is blind. Adoption of this scientific conception of philosophy does not, however, determine the details of one’s epistemology, methodology and ontology. As far as epistemology is concerned, the Austrian tradition offers the contrasting examples of the phenomenology of Franz Brentano and the positivism of Ernst Mach. Similarly, there are those who stress the unity of the natural and the social sciences and those who contrast explanation in the natural sciences with the distinctive type of understanding (verstehen) characteristic of human affairs. Finally, both idealist and materialist ontological positions are compatible with this understanding of philosophy. Nonetheless all proponents of scientific philosophy demand exact methods and an empirical orientation. They oppose irrational and theological systems of philosophy with an attitude that shows their commitment to the ideals of the Enlightenment and to science. Historically, the positivism of Mach's scientific philosophy was the most important precondition for the development of the position adopted within the Vienna Circle. The term 'philosophy of science' was used to describe this position, but by this was meant a general scientific conception of philosophy as well as a commitment to providing a philosophy of the sciences. Thus, within the Vienna Circle, philosophy was regarded both as a general analytic and language-oriented activity and as a discipline working on the foundations of the natural and social sciences. At the same time we find within the Vienna Circle those such as Moritz Schlick who defend a methodological dualism of philosophy and science, and those such as Otto Neurath who seek to absorb philosophy altogether within a scientific conception of the world. Independent of this variety of positions, however, empiricism, an orientation towards the sciences, and an exact logical-mathematical methodology remain essential features of the Vienna Circle.

7. Logical positivism

The name 'Vienna Circle' was used in public for the first time in 1929 in the programmatic essay The Scientific Conception of the World: The Vienna Circle (Carnap, Hahn and Neurath 1929). It was suggested by Neurath and was supposed to have pleasant connotations similar to 'Vienna Woods' or 'Viennese Waltz'. At the same time the term should indicate the origin of this philosophical movement and its collective orientation (Frank 1949), although strictly speaking, it is anachronistic to use it for the period before 1929. In this programmatic essay the position of the 'radical' wing around Neurath, Carnap, Hahn, Frank and others was especially prominent. This wing, institutionalized in the Ernst Mach Society, supported the idea of a unified physicalist science as represented in the programme of the International Encyclopedia of Unified Science. By contrast the more moderate wing of the Vienna Circle around Schlick, Waismann, Feigl and others - in fact the majority - emphasized their adherence to a dualism of science and philosophy with changing names like 'consistent empiricism', 'logical empiricism', or 'logical positivism'. The widely used term 'logical positivism' comes in fact from Albert Blumberg's and Herbert Feigl's paper 'Logical Positivism: a New Movement in European Philosophy', published in the Journal of Philosophy in 1931. Blumberg and Feigl give a concise description of the new synthesis of logical and empirical factors: The new logical positivism retains the fundamental principle of empiricism but… feels it has attained in most essentials a unified theory of knowledge in which neither logical nor empirical factors are neglected. From the point of view of logical positivism, the Kantian synthesis concedes too much to rationalism by assuming the existence of synthetic a priori truths. Against Kant the new movement maintains as a fundamental thesis that there are no synthetic a priori propositions. … it holds that factual (empirical) propositions though synthetic is *a posteriori*, and that logical and mathematical propositions though a priori are analytic. … By means of the theory of knowledge thus constructed, logical positivism … shows that the propositions of metaphysics, in most senses of the term, are, strictly speaking, meaningless. (Blumberg and Feigl 1931: 282) Blumberg and Feigl go on to describe the philosophical transformation from old to new positivism with the adoption of symboli logic, epistemology, and research into the foundations of science. Finally, they explain, following Wittgenstein, their notion of philosophy: 'The purpose of philosophy is the clarification of the meaning of propositions and the elimination of… meaningless pseudo-propositions' (Blumberg and Feigl 1931: 269). Despite its widespread currency, however, the term 'logical positivism' has the disadvantage that it associates the Vienna Circle too closely with positivism, and thus, for example, with the 'positivism dispute' that runs from Lenin to the Frankfurt School. Hence the term 'logical empiricism' is now often preferred: it takes into account the synthesis of rationalism and empiricism, and signals clearly the two most important elements in the philosophy of the Vienna Circle.

In Schlick's logical empiricism the classical philosophical positions of empiricism and rationalism were integrated with the help of modern logic and mathematics, but a distinction between philosophy and science was still admitted. Neurath's more radical 'scientific conception of the world' aimed at overcoming philosophy itself within his scheme for a unified physicalist science. This divergence in philosophical approach left room for debates within the Circle on such topics as the merits of phenomenalist and physicalist languages, coherence and correspondence theories of truth, logical syntax and semantics, verification and confirmation, and ideal and natural languages. At the same time there was a consensus concerning the merits of a logical analysis of language, a fallibilist epistemology, a scientific attitude to the world and the unity of scientific explanation and knowledge in general. After Schlick's death, however, his logical empiricist project collapsed following personal and theoretical disagreements. The project of a unified science, however, continued in the unity-of-science movement. An important element of the logical empiricism of the Vienna Circle was the refusal to accept synthetic judgments *a priori*. Following Russell and Whitehead, symbolic logic and mathematics were regarded as purely analytic (because merely 'conventional') and a priori (and thus independent of any experience). Analytic truths of these kinds were contrasted with empirically true statements of the natural sciences and ordinary experience; these were synthetic judgments *a posteriori*. But there was no further class of synthetic a priori judgments; instead there was thought to be an important class of 'meaningless' sentences. The elements of this class, being neither analytic nor synthetic *a posteriori*, are 'metaphysical' in a sense which implies that they are not part of knowledge at all even though they may express some realm of experience. This anti-metaphysical position of the Vienna Circle is most prominently represented by Rudolf Carnap's 'Elimination of Metaphysics Through Logical Analysis of Language' (Carnap 1931). It prepares the logical empiricist programme for a unified reconstruction of science. But the question whether an empirical basis could be a foundation for all knowledge received strongly divergent answers from the coherence theorists around Neurath and the correspondence theorists around Schlick (Hempel 1981; 1993). The apparently strict distinction between analytic and synthetic sentences had also already been questioned (Menger 1979; 1994). Indeed, the ideal of one language of science, logic and mathematics had already been strongly relativized by the Vienna Circle itself, long before Quine put forward his classic critique (Quine 1953). Thus, contrary to its popular reputation, a heterogeneous pluralism of views was in fact characteristic of the Vienna Circle: for example in questions of ethics (Schlick 1930; Menger 1934; Kraft 1937), in regard to 'realism' versus 'positivism' (Schlick 1933; Carnap 1928; Feigl 1929; Kraft 1925), verificationism versus falsificationism (Neurath 1935), and not the least in questions of an ideological and political nature.

8. Logical empiricism and the scientific conception of the world

The relationship between Schlick's logical empiricism and Neurath's distinctive scientific conception of the world is a complex matter. Certain points are of course held in common, such as the view of philosophy as a language-oriented, analytic activity. Again, the principle of verification ('The meaning of a sentence can be given only by giving the rule of its verification.') (Schlick 1938: 341; Hempel 1950), logical atomism (following Russell) and the picture theory of language (following Wittgenstein's Tractatus), are constitutive features of the entire movement but are in themselves insufficient for its characterization. Kamitz (1973), mainly referring to Carnap's positions, characterizes the Vienna Circle up to about 1930 by the following principles: the formal character of mathematics (Logicism: that is, subordination of mathematics under logic which itself is purely analytic), verifiability, methodological phenomenalism (Carnap's epistemological position in The Logical Construction of the World), and 'scientism', which is a claim to the omnipotence of science when compared with alternative forms of knowledge in philosophy and art. For the period 1930-5 the following principles are listed: the hypothetical character of empirical claims (the criterion of verifiability is replaced by a criterion of confirmability), the conventionalist interpretation of logic, physicalism as the foundation of the unified science (a physicalist, quantitative, empirical language as unifying intersubjective language of science), and the conception of philosophy as logical syntax of the language of science. These principles reflect the growing dominance of Neurath's point of view within the Circle. In particular, the last principle restricts questions of truth to comparisons among sentences along the lines of Neurath's coherence theory in order to avoid the dualism of 'language' and 'world' suggested by the correspondence theory of truth. In line with this, Carnap and Neurath deny any absolute 'foundation of knowledge' of the kind sought by Schlick (Schlick 1934). They hold that in any empirical justification it is not single sentences that are tested, but whole systems of sentences, and science in general. This is a form of relativism that makes Neurath in particular a forerunner of recent holistic approaches in philosophy of science (see Hempel, Popper and others in Skirbekk 1977). Although this last point of view is distinctive of Neurath, it is important to grasp that the 'scientific conception of the world' which he and others promulgated within the Circle had a much broader cultural goal. It was not simply a neo-positivist anti-metaphysical scientistic programme. Instead he looked to a unified science and a truly scientific conception of the world to make everyday life more humane and democratic. In portrayals of the Vienna Circle written after the Second World War these practical aspirations are often treated as inessential political ambitions when compared with the scientific programmes of logicism and empiricism, whereas in fact internal debates about them were emphasized and regarded as characteristic of the Vienna Circle. We find the clearest presentation of the claim to social reform that is inherent in the scientific conception of the world in the programmatic essay of the Vienna Circle of 1929: The endeavour is to link and harmonise the achievements of individual investigators in their various fields of science. From this aim follows the emphasis on collective efforts, and also the emphasis on what can be grasped intersubjectively; from this springs the search for a neutral system of formulae, for a symbolism freed from the slag of historical languages; and also the search for a total system of concepts. Neatness and clarity are striven for, and dark distances and unfathomable depths rejected. In science there are no 'depths'; all is on the surface. Experience forms a complex network, which cannot always be surveyed and can often be grasped only in parts. Everything is accessible to man; and man is the measure of all things…. The scientific conception of the world knows no unsolvable riddle. (Carnap, Hahn and Neurath [1929: 15] 1973: 305) This concluding paraphrase of one of Wittgenstein's claims in the Tractatus is the starting point for this late Enlightenment programme of science with its anti-metaphysical orientation. Traditional philosophy with its mannerisms has, in a first step, to be reduced to a critical analysis of language: No special 'philosophic assertions' are established, assertions are merely clarified; and at that assertions of empirical science. … Whichever term may be used to describe such investigations, this much is certain: there is no such thing as philosophy as a basic or universal science alongside or above the various fields of the one empirical science. (Carnap, Hahn and Neurath [1929: 28] 1973: 316)

The practical impulse behind this therapeutic destruction of a philosophy of metaphysical systems and the rational subject was the desire for a unified and empirical conception of the world on the basis of simple human experience, directed against the 'Zeitgeist' of an increasing number of metaphysical movements whose rise was connected with social and economic factors. Social criticism thus becomes an accompaniment of empirical science and replaces the classical philosophical materialism of the labour movement: In previous times, materialism was the expression of this view; in the meantime, however, modern empiricism has shed a number of inadequacies and has taken a strong shape in the scientific conception of the world. (Carnap, Hahn and Neurath [1929: 29] 1973: 317)

Its closeness to real-life issues and its solidarity with the forces of progress led in the time of emerging fascism to an aggressive determination of its position on social issues: We witness the spirit of the scientific conception of the world penetrating in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles. The scientific conception of the world serves life, and life receives it. (Carnap, Hahn and Neurath [1929: 30] 1973: 317)Social criticism, sociology of knowledge, and philosophic-scientific collective work formed in this conception a programmatic unity in hope of comprehensive progress, which was partly put into practice. But whereas in the natural sciences, Neurath thinks, considerable progress has already been achieved, the situation in the social sciences is less clear ([1930-1: 121] 1983: 44). Neurath therefore attempts in his Empirical Sociology (1931) to give a 'physicalist' description of the processes of human social interaction, of the forces that make groups of people cooperate or work against each other and of their influence on the lives of the masses. And his general attitude towards long-term predictions of social sciences is manifested in his cautiously optimistic outlook on possible future developments of society and science (which can nowadays look rather utopian). In this respect it is worth mentioning that after the disintegration of the Vienna Circle (which was also a process of political neutralization) reference to the 'scientific conception of the world' was occasionally used by former members of the Vienna Circle in connection with general ideological questions. For example, Carnap (1963: 81) talks about 'scientific humanism' as a view shared by the majority of the members of the Vienna Circle. By this he means, first, that everyone determines their own life, second, that mankind has the ability to improve their conditions of living and, third, that every liberating action presupposes knowledge about the world, knowledge that is best achieved by scientific means, so that science becomes the most important instrument for an improvement of our lives. According to Carnap, such aims require rational planning which in turn would be best achieved by some form of socialism and a world-government.

9. Encyclopedia of Unified Science

After the dissolution of the Vienna Circle, the forced emigration of most of its members, and the diffusion of the logical empiricist movement from its centres in Vienna, Prague and Budapest, the twin aims of a transformation of philosophy and the establishment of a scientific conception of the world could be envisaged only without reference to their previous cultural context and audience. But even in these difficult times Neurath and his circle still succeeded in organizing well-attended conferences of high standard ('International Congresses for the Unity of Science'), and he also managed to ensure that the unity of science movement continued in the USA (Neurath, Carnap and Morris 1970-1). After 1935 Neurath devoted himself to the model of the 'encyclopedia' as a means for furthering this movement. In cooperation with Carnap, Frank and Morris, he planned an international encyclopedia of the unified science and, corresponding to it, worked on a picture language (Isotype) of visual representation. He presented this programme as a development of the ideas of the philosophers of the French Enlightenment. This vision of an unfinished Enlightenment project remains today a striking challenge for the scientific community.