

Karl Raimund Popper

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Karl Popper is the greatest philosopher of the 20th century. No other philosopher of the period has produced a body of work that is as significant. What is best in Popper's output is contained in his first four published books. These tackle fundamental problems with ferocious, exemplary integrity, clarity, simplicity and originality. They have widespread, fruitful implications, for science, for philosophy, for the social sciences, for education, for art, for politics and political philosophy.

In his first published book The Logic of Scientific Discovery (1959, first published in German in 1934), Popper argues that, although scientific theories cannot be verified, or even rendered probable, by evidence, they can be falsified. Science makes progress by putting forward falsifiable conjectures - theories which say as much as possible about the world, and which thus expose themselves as much as possible to the risk of empirical refutation; they are then subjected to a ruthless onslaught of attempted observational and experimental refutation. When finally a scientific theory is falsified empirically, the task then becomes to think up an even better theory, which says even more about the world. The new theory must predict all the success of the old theory, predict successfully the phenomena that falsified the old theory, and predict new phenomena as well. In his next book, The Open Society and Its Enemies, written during the second war and published in 1945, Popper tackles problems that arise in connection with creating an "open" society, one which tolerates diversity of views and ways of life. Popper argues that some of the greatest thinkers have been opposed to the "open" society, most notably Plato and Marx. In The Poverty of Historicism Popper is concerned to demolish the view that social science should, or can, predict the way societies evolve. Popper spells out his view of how social science should be developed, closely modelled on the account of natural science given in The Logic of Scientific Discovery. The next book, Conjectures and Refutations, is a collection of essays which restate in a more accessible way Popper's falsificationist view of science, and draw out implications for a range of philosophical problems. Further books include Objective Knowledge, a collection of essays which draw on the analogy between Darwinian evolution and scientific progress, and which expound Popper's view that there exists, in addition to the material world and the psychological world, a third world of theories, problems and arguments; The Self and Its Brain, written with the neurologist John Eccles, which applies Popper's "third world" view to the mind-body problem; and the three volume The Postscript which amounts to a massive restatement and development of Popper's falsificationist conception of science. A volume of The

Library of Living Philosophers is devoted to Popper's work; this includes Popper's intellectual autobiography, published subsequently as a separate book with the title Unended Quest. This gives a fascinating and gripping account of the development of Popper's thought.

Fundamental to Popper's philosophy is the idea that criticism lies at the heart of rationality. It would be a betrayal of Popper's philosophy to give an entirely uncritical exposition of his work; some criticism of key tenets of his philosophy will therefore be included in what follows.

Karl Raimund Popper was born in Vienna on 28th July 1902. His parents were Jewish but converted to Protestantism before their children were born. Popper's father, Simon Carl Siegmund (1856-1932), was a doctor of law of the University of Vienna. He had a successful legal practice in Vienna, at which he apparently worked hard, but his real interests lay in the direction of scholarship and literature. Popper's mother, Jenny Schiff (1864-1938), came from a musical family, and was herself musical. Popper tells us that she played the piano beautifully; music had an important place in Popper's life.

During Popper's early childhood, his parents were prosperous. They lived in a large apartment in an 18th century house in the centre of Vienna, where Popper's father conducted his legal practice. Popper's father had an enormous library, which included many works of philosophy; books were everywhere, Popper tells us, except in the dining room, where stood a concert grand piano.

As a young boy, Popper was much concerned with the poverty he saw all around him in Vienna. In his autobiography, Popper recounts an early brush with philosophy. His father had suggested he read some volumes of Strindberg's autobiography. Finding that Strindberg gave much too much importance to words and their meanings, Popper tried to point this out to his father, and was surprised to discover that he did not agree. Popper, later, saw this as his first brush with a life-long battle to combat the influential view that philosophy must concern itself with analysis of meaning.

Popper left school at 16 because of the tedium of the classes, and enrolled at the University of Vienna, initially as a non-Matriculated student. Four years later, at the second attempt, he passed the exam to become a Matriculated student. Any student could take any lecture course. Initially, Popper sampled lectures in a wide range of subjects - history, literature, psychology, philosophy - but then concentrated on physics and mathematics. In these fields Popper had excellent, if remote and autocratic, teachers: Hans Thirring, Wirtinger, Furtwängler and Hans Hahn. Later, Popper devoted himself to the study of the psychology of thinking, influenced by Karl Bühler and the writings of Otto Selz.

The first world war and its aftermath brought dramatic changes to conditions of life in Vienna. Popper's father lost much of his savings. Popper left home and moved into part of a disused military hospital converted by students into a primitive students' home, and joined socialist groups seeking political change. For a time, Popper thought of himself as a communist. But an event then occurred which

Popper was later to describe as one of the most important in his life, which caused him to become critical of communism and Marxism, and which, years later, led to the writing of his The Open Society and Its Enemies. The communists organized a demonstration with the intention of freeing communists held in a police station in Vienna. The police opened fire, and some of the demonstrators were killed. Popper was deeply shocked, and even felt some personal responsibility for the tragedy, in that he had endorsed a doctrine, Marxism, which required that there should be just such incidents, so that the struggle to overcome capitalism might be intensified.

Popper nevertheless continued to think of himself as a socialist, and to associate with socialist groups. In his autobiography, Popper celebrates these groups of working people for their dedication, their eagerness to become educated. Even though the times were troubled, the economic and political outlook bleak, Popper says that he and his friends were often exhilarated at the intellectual and political challenges that lay before them. For a time Popper worked as a labourer, but found the work too hard; he then tried his hand at cabinet making, but was distracted by the intellectual problems that he was working on. Popper also worked for the psychologist Adler, and as a social worker concerned with neglected children.

Shortly before submitting his dissertation for his Ph.D., the focus of Popper's interest switched from the psychology, to the methodology, of thought and problem-solving, and in particular to the methodology of science. This came about partly as a result of long discussions with two friends, the philosophers Julius Kraft and Heinrich Gomperz. The dissertation was hastily written; Popper's examiners were Bühler and Schlick; Popper thought he had failed, but in fact he passed with distinction.

At this time a Pedagogic Institute was created in Vienna to train teachers in new methods of education. Popper decided to become a teacher, joined the course, held informal seminars for fellow students, and duly became qualified to teach physics and mathematics in secondary schools. He met, and later married, a fellow student, Josephine Henninger (Hennie), who also became a teacher.

While employed full-time as a teacher, Popper continued to work hard at epistemological and methodological problems of science, writing down his thoughts as an aid to research, rather than with the idea that the work might eventually be published. During this time, Popper got to know a number of people associated with the Vienna Circle, famous for promoting logical positivism. The Vienna Circle was essentially a seminar which one attended when invited by its convenor, Moritz Schlick. Rudolf Carnap, Otto Neurath, Herbert Feigl, Kurt Gödel, Friedrich Waismann, Victor Kraft, Karl Menger, Hans Hahn, Philipp Frank, Richard von Mises, Hans Reichenbach and Carl Hempel were among the members; Ludwig Wittgenstein, much admired by Schlick, was the intellectual godfather (together, perhaps, with Ernst Mach and Bertrand Russell). Visitors from abroad included A. J. Ayer and Frank Ramsey from England, Ernst Nagel and W. V. Quine from the USA, Arne Naess from Norway, and Alfred Tarski from Poland. But Popper was never invited to join the Circle (possibly because Schlick was aware of Popper's low opinion of Wittgenstein). Nevertheless, Popper did attend, and give papers at, a number of fringe seminars, and Popper's work was strongly influenced

by, but also critical of, the doctrines of the Circle.

Two issues were of central concern to Popper. The first was the problem of how to distinguish science from pseudo-science. Popper was impressed by the difference between the theories of Marx, Freud and Adler on the one hand, and Einstein's general theory of relativity, on the other. The former theories seemed able to explain phenomena whatever happened; nothing, it seemed, could tell against these theories. Einstein's theory, by contrast, issued in a definite prediction; light travelling near the sun would pursue a curved path due to the gravitational field of the sun. If this did not happen, Einstein's theory would be refuted. Popper decided, around 1921 (he tells us) that this constituted the key difference between pseudo and genuine scientific theories: whereas the former were unrefutable, the latter were open to empirical refutation.

The other problem that preoccupied Popper was that of the logic, or methodology, of scientific discovery: How does science acquire new knowledge? This was the problem that confronted Popper when his earlier interest in the psychology of thinking transmuted into interest in the logic of thinking, the logic of discovery.

Suddenly, Popper tells us, he put two and two together. His earlier solution to the first problem also solves the second problem. There is no such thing as the verification of theories in science; there is only refutation. Scientists put forward theories as empirically falsifiable conjectures or guesses: these are then subjected to sustained attempted empirical refutation. Science advances through a process of trial and error, of conjecture and refutation.

Encouraged by Feigl, Popper wrote the first volume of what was intended to be a two volume work, entitled Die beiden Grundprobleme der Erkenntnistheorie (The Two Fundamental Problems of the Theory of Knowledge). The first volume was accepted for publication by Schlick and Frank, the editors of a series of publications written mostly by members of the Vienna Circle. The publisher, Springer, insisted the book must be shortened. But in the meantime Popper had finished the second volume. He offered a new work consisting of extracts from both volumes; but this was still judged by Springer to be too long. Popper's uncle, Walter Schiff, cut the manuscript by about a half, and this was finally published late in 1934 as Logic der Forschung. Thus emerged into the public domain, in the shadow of Hitler and impending war, what is, perhaps, the most important book on scientific method to be published in the last century. The book was only published in English translation, as The Logic of Scientific Discovery (with many additional appendices and footnotes), in 1949. (Die beiden Grundprobleme der Erkenntnistheorie was not published until much later, in 1979.)

The Logic of Scientific Discovery (L.Sc.D.) begins by spelling out what are, for Popper, the two fundamental problems concerning the nature of scientific inquiry. (1) The problem of induction: How can scientific theories be verified by evidence, in view of Hume's arguments which seem to show that this is impossible? (2) The problem of demarcation: How is science to be demarcated from non-science (pseudo science and metaphysics)? As we saw above, Popper's solution to the second problem is that, in order to be scientific, a theory must be empirically

falsifiable. This, for Popper, solves the first problem as well. Scientific laws and theories cannot be verified by evidence at all; they can only be falsified. However much evidence may be amassed in support of a theory, its probability remains zero. But despite this negative conclusion, science can still make progress. This comes about as a result of theories being proposed as conjectures, in response to problems: these conjectures are then subjected to a ruthless barrage of attempted empirical refutation. The purpose of observation and experimentation is not to verify, but to refute. When a theory is refuted empirically, this creates the problem of discovering a new conjecture, a new theory, even more successful than its predecessor in that it meets with all the success of its predecessor, successfully predicts the phenomena that refuted its predecessor, and predicts new phenomena as well. When such a theory is formulated, the task then becomes to try to refute this new theory in turn. Thus science advances, from one falsifiable conjecture to another, each successfully predicting more than its predecessor, but none ever having probability greater than zero. All theoretical knowledge in science is irredeemably conjectural in character. But science makes progress precisely because, in science, it is possible to discover that theories are false, and thus need to be replaced by something better.

Popper has been much criticized for not appreciating that even empirical refutations are not decisive: it is always a conjecture that a theory has been falsified, since it is always a conjecture that a given observation or experiment has yielded a falsifying result. But Popper has at least two replies to such criticisms.

First, there is a decisive logical asymmetry between verification and falsification. Any theory has infinitely many empirical consequences, for infinitely many times and places. We, however, can only ever verify finitely many of these consequences, and thus must forever be infinitely far away from verifying the theory. But we only need to discover one false empirical consequence of a theory in order to show decisively that the theory is false.

Second, Popper emphasizes that a theory is only falsifiable with respect to the adoption of a methodology. Given that a theory is empirically falsified, it is always possible to rescue the theory from falsification by adopting what Popper calls "conventionalist stratagems". These include explaining the experimental result away in some way, or modifying the theory, in an ad hoc way, so that it no longer clashes with the empirical result. Popper proposes that science should adopt methodological rules governing the way theories are to be accepted and rejected in science in the light of evidence: these rules need to be designed to expose theories to the maximum risk of empirical refutation. Conventionalist stratagems, in particular, are to be banned. Faced by a refutation, a theory may be modified so as to overcome the refutation, but only if the modification increases the empirical content, the degree of falsifiability, of the theory - the modified theory predicting more, excluding more potentially falsifying observational statements, than before. Scientists should always strive to put forward theories that say as much as possible about the empirical world, that expose themselves to the greatest risk of refutation, that have the highest possible degree of falsifiability. The supreme methodological principle of science, for Popper, "says that the other rules of scientific procedure must be designed in such a way that they do not protect any statement in science

against falsification" (L.Sc.D., p. 54).

Even though theories cannot be verified, they can be "corroborated". For Popper, corroboration is a measure of how well a theory has stood up to attempts to refute it. If a highly falsifiable theory has survived an onslaught of severe testing, then it has proved its worth. It deserves to be taken more seriously than an untested theory, or an unfalsifiable speculation.

According to Popper, then, science makes progress by means of wild imagining, bold guesswork, on the one hand, controlled by ferocious attempted empirical refutation on the other hand.

L.Sc.D. was influenced by the thought of the Vienna Circle, but also differs from, and is highly critical of, some of the main tenets of the Circle. Logical positivism sought to demarcate the meaningful from the meaningless, only those propositions capable of being verified being meaningful, the hope being that all meaningful factual propositions would be scientific. Popper stressed that any such criterion would condemn scientific theories to being meaningless, since they cannot be verified. Popper's demarcation problem differed from that of the positivists. For Popper, as we have seen, the problem was to demarcate science from non-science (pseudo-science and metaphysics); falsifiability, not verifiability, is the key requirement; but non-scientific, metaphysical theories, though neither verifiable nor falsifiable, may nevertheless be entirely meaningful, and may even have a fruitful role to play in the development of science. Metaphysical theses, such as atomism, may suggest, and may (as a result of acquiring precision) be transformed into, falsifiable scientific theories.

Does L.Sc.D. succeed in solving its two basic problems? Three great merits of the book are its originality, its clarity, and its tight structure: everything devolves from the key idea of falsifiability. This makes the book especially open to criticism, and to improvement. In the end, the book fails to solve its basic problems, due to its treatment of simplicity.

Popper claims that the more falsifiable a theory is, so the greater its degree of simplicity. (There is a second method for assessing degrees of simplicity, in terms of number of observation statements required to falsify the theories in question, but Popper stresses that if the two methods clash, it is the first that takes precedence.) It is easy to see

that Popper's proposal fails. Given a reasonably simple scientific theory, T , one can readily increase the falsifiability of T by adding on an independently testable hypotheses, h_1 , to form the new theory, $T + h_1$. This new theory will be more falsifiable than T but, in general, will be drastically less simple. And one can make the situation even worse, by adding on as many independently testable hypotheses as one pleases, h_2 , h_3 and so on, to form new theories $T + h_1 + h_2 + h_3 + \dots$, as highly empirically falsifiable and as drastically lacking in simplicity, as one pleases. Thus simplicity cannot be equated with falsifiability.

And there is a further, even more devastating point. Popper's methodological rules

favour $T + h_1 + h_2 + h_3$ over T , especially if h_1 , h_2 and h_3 have been severely tested, and corroborated. But in scientific practice, $T + h_1 + h_2 + h_3$ would never even be considered, however highly corroborated it might be if considered, because of its extreme lack of simplicity or unity, its grossly ad hoc character. There is here a fundamental flaw in the central doctrine of L.Sc.D..

Later, in Conjectures and Refutations (1963), Popper put forward a new methodological principle which, when added to those of L.Sc.D., succeeds in excluding theories such as

$T + h_1 + h_2 + h_3$ from scientific consideration. According to Popper, a new theory, in order to be acceptable, "should proceed from some simple, new, and powerful, unifying idea about some connection or relation (such as gravitational attraction) between hitherto unconnected things (such as planets and apples) or facts (such as inertial and gravitational mass) or new "theoretical entities" (such as field and particles)" (p. 241). $T + h_1 + h_2 + h_3$ does not "proceed from some simple, new and powerful, unifying idea" and is to be rejected on that account, even if more highly corroborated than T .

But the adoption of this "requirement of simplicity" (as Popper calls it) as a basic methodological principle of science has the effect of permanently excluding from science all ad hoc theories (such as $T + h_1 + h_2 + h_3$) that fail to satisfy the principle, however empirically successful such theories might be if considered. This amounts to assuming permanently that the universe is such that no ad hoc theory, that fails to satisfy Popper's principle of simplicity, is true. It amounts to accepting, as a permanent item of scientific knowledge, the substantial metaphysical thesis that the universe is non-ad hoc, in the sense that no theory that fails to satisfy Popper's principle of simplicity is true. But this clashes with Popper's criterion of demarcation: that no unfalsifiable, metaphysical thesis is to be accepted as a part of scientific knowledge.

It is, in fact, important that Popper's criterion of demarcation is rejected, and the metaphysical thesis of non-ad hocness is explicitly acknowledged to be a part of scientific knowledge. The thesis, in the form in which it is implicitly adopted at any given stage in the development of science, may well be false. Scientific progress may require that it be modified. The thesis needs to be made explicit, in other words, for good Popperian reasons, namely, so that it can be critically assessed, and perhaps improved. As long as Popper's demarcation criterion is upheld, the metaphysical thesis must remain implicit, and hence immune to criticism. Popper's falsificationism can be modified, however, so that substantial metaphysical theses, implicit in methods that exclude ad hoc theories, are made explicit within science, and are thus rendered available to critical scrutiny and revision (see Maxwell, 1998).

On publication, L.Sc.D. achieved a certain impact; it was quite widely reviewed and discussed, and led to Popper being invited to give lectures, in England, Denmark and elsewhere. Popper himself later claimed that his criticisms of logical positivism led eventually to the downfall of that doctrine.

Having dealt with the methodology of the natural sciences, Popper turned his attention again to what had long been of concern to him, the intellectual defects of Marxism, and the philosophy of the social sciences. But before he could get very far with that work, Popper was offered a lectureship at the University of Canterbury, New Zealand. He accepted, and Popper and his wife left Vienna for New Zealand early in 1937.

For some years Popper had been privately highly critical of policies of socialists in Germany and Austria for playing into the hands of the Fascists and Hitler. This was due, in Popper's view, to the harmful influence of Marxism. But he had kept these criticisms to himself, as he felt any public criticism could only weaken the forces opposing Hitler. Then, in March 1938, Hitler occupied Austria, and Popper felt all grounds for restraint had disappeared. He decided to put his criticisms of Marxism, and his views on the social sciences, into a publishable form.

He began work on what was to become The Poverty of Historicism. But then, unexpectedly, sections on essentialism, and on totalitarian tendencies in Plato, grew and grew (driven by the desperation of the times), and Popper found he had a new work on his hands: it became what is perhaps his best known, most influential and greatest work, The Open Society and Its Enemies (1945). Without referring anywhere to Hitler or Stalin, the book is, nevertheless, an urgent and passionate investigation into the problem and threat of totalitarianism, whether of the right or left. It seeks to understand what the appeal of totalitarianism can be, and why it should have come to be such a threat to civilization. Popper regarded the writing of the book as his contribution to the war effort.

In The Open Society and Its Enemies (O.S.E.), Popper argues that a fundamental problem confronting humanity is that of moving from a closed, tribal way of life to an open society. The closed society is a society that has just one view of the world, one set of values, one basic way of life. It is a world dominated by dogma, fixed taboos and magic, devoid of doubt and uncertainty. The open society, by contrast, tolerates diversity of views, values and ways of life. In the open society learning through criticism is possible just because diverse views and values are tolerated. For Popper, the open society is the civilized society, in which individual freedom and responsibility, justice, democracy, humane values, reason and science can flourish.

But moving from the closed to the open society imposes a great psychological burden on the individuals involved, "the strain of civilization". Instead of the security of the tribe, organic, dogmatic and devoid of doubt, there is all the uncertainty and insecurity of the open society, the painful necessity of taking personal responsibility for one's life in a state of ignorance, the lack of intimacy associated with the "abstract society" in which individuals constantly rub shoulders with strangers. This transition, from the closed to the open society is, for Popper, "one of the deepest revolutions through which mankind has passed" (O.S.E., vol. 1, p. 175). Many cannot bear the burden of freedom and doubt, and long for the false security and certainties of the closed society. In particular, some of the greatest thinkers of western civilization have given into this temptation and have, in one way or another, urged upon long suffering humanity a return to something like a

closed society under the guise of Utopia. This is true of Plato and Aristotle; and it is true, in more recent times, of Hegel and Marx. The lure of totalitarianism is built deep in our history and traditions.

The revolutionary transition from closed to open society first occurred, according to Popper, with the "Great Generation" of ancient Athens in the fifth century BC. Those to be associated with the birth and affirmation of the open society include Pericles, Herodotus, Protagoras, Democritus, Alcidas, Lycophron, Antisthenes and, above all, Socrates.

It is from Plato, especially, that we learn of Socrates' passionate scepticism, his searching criticism of current beliefs and ideals, his conviction that first one must acknowledge one's own ignorance before one could hope to acquire knowledge and wisdom. But Socrates, Popper argues, was ultimately betrayed by Plato. The greatest advocate of the open society became, in Plato's Republic, the spokesman for a return to a closed society.

Popper's devastating account of Plato's "propaganda" for the closed society, in bald outline, amounts to this. Deeply disturbed by the democracy, and the beginnings of the open society, in contemporary Athens, Plato came to fear all social change as embodying decay and corruption. Synthesizing elements taken from Parmenides, from the Pythagoreans, and from Socrates, Plato turned these fears into an entire cosmology and social theory. Every kind of material object has its perfect copy, its ideal representation, as a Form in a kind of Platonic Heaven (Plato's famous theory of Forms). These Forms initiated the material universe by printing themselves on space, thus producing initial material copies. But, as time passes, copies of copies gradually become more and more corrupt, further and further removed from their ideal progenitors. And this is just as true in the social and moral sphere as the material. The primary task for the rulers of society is to arrest all social change, and try to keep society resembling, as far as possible, the ideal Forms of order, justice and the Good. Most people know only of imperfect material things; but a very few philosophers, as a result of studying mathematics (which enables us to acquire knowledge of abstract, perfect objects and not just their imperfect material copies), are able to come to see, intellectually, the Forms, and eventually the supreme Form of the Good (represented as the sun in Plato's famous myth of the cave in The Republic). Enlightened philosophers alone have seen the Form of the Good; they alone know what ideal form society should take, and how it can be protected from the corrupting effects of change. Philosophers, then, must rule, aided by guardians, a class of soldiers or police, who ensure that the rest of the population obeys the strictures of the ruling philosophers. Plato's republic is a nightmarish totalitarian, closed society, rigidly ordered, individual liberty, freedom of expression and discussion, art, democracy and justice ruthlessly suppressed. But Plato presents all this with great subtlety, with a kind of twisted logic, so that ostensibly he is arguing for a just, wise and harmonious society, one of legal and moral perfection. Popper even suggests that Plato wrote The Republic as a kind of manifesto, to aid his adoption as philosopher-ruler.

Popper's two big enemies of the open society are Plato (volume 1 of O.S.E.), and Marx (volume 2). Both uphold versions of historicism - the doctrine that history

unfolds according to some fixed pattern, to some rigid set of laws of historical evolution. Plato, as we have seen, was a pessimistic historicist: historical change involves decay and degeneration, and all that enlightened philosopher-rulers can do is arrest change somewhat. Marx, by contrast, is an optimistic historicist: historical development will eventually result in socialism and freedom.

Popper traces a direct link from Plato to Marx, via Aristotle and Hegel. Prompted in part by his biological interests, Aristotle modified Plato's doctrine of the Forms so that it could give an account of biological growth and development. Aristotle inserts a Platonic Form into each individual object so that it becomes the essence of that object, an inherent potentiality which the object, through movement, change or growth, strives to realize. Thus the oak tree is inherent as a potentiality in the acorn. Germination and growth are to be understood as the acorn striving to realize its potentiality, thus becoming an oak tree.

In short, Aristotle modifies Plato's doctrine of the Forms so that the Form ceases to be the perfect copy of an object from which the object can only decay, and becomes instead an inherent potentiality which the object strives to realize. This modification potentially transforms Plato's pessimistic historicism of inevitable decay into an optimistic historicism of social growth, development and progress. But not until Hegel did anyone fully exploit Aristotelianism in this way.

Popper depicts Hegel as a complete intellectual fraud. He agrees with Schopenhauer's verdict: "Hegel, installed from above, by the powers that be, as the certified Great Philosopher, was a flat-headed, insipid, nauseating, illiterate charlatan, who reached the pinnacle of audacity in scribbling together and dishing up the craziest mystifying nonsense" (quoted in O.S.E., vol. 2, pp. 32-3). Hegel's great idea was to depict history as the process of Spirit, the Aristotelian essence and potentiality of the State and the Nation, striving to realize itself through war and world domination. Taking over and corrupting the antinomies of Kant's Critique of Pure Reason, Hegel depicted history as a kind of pseudo rational or logical dialectical process, thesis giving way to antithesis, which then results in synthesis. What matters is not individual liberty or democracy, but rather the triumph of the strongest State on the stage of history, its inner essence interpreted and directed by the Great Leader by means of dictatorial power.

Despite (or because of) his intellectual fraudulence, Hegel exercised - Popper argues - a powerful influence over the development of subsequent nationalist, historicist and totalitarian thought, of both the extreme right and the extreme left. Both Hitler and Stalin stumble onto the world stage out of Hegel, Popper implies (although neither is mentioned by name in O.S.E., as indicted above). In particular, Hegel exercised a powerful and corrupting influence on Karl Marx.

For Popper, Marx is in a quite different category from Hegel. Popper pays tribute to Marx's sincerity, his humanitarianism, his intellectual honesty, his hatred of moralizing verbiage and hypocrisy, his sense of facts and his sincere quest for the truth, his important contributions to historical studies and social science, his burning desire to help the oppressed. Nevertheless Marx is one of the most dangerous enemies of the open society, his thought disastrously corrupted by its

Hegelian inheritance.

In a well known passage in Capital, Marx declared that Hegel "stands dialectics on its head; one must turn it the right way up again" (quoted in O.S.E., vol. 2, p. 102). And in another passage, Marx declared "It is not the consciousness of man that determines his existence - rather, it is his social existence that determines his consciousness" (quoted in O.S.E., vol. 2, p. 89). Whereas, for Hegel, an idealist, history is the dialectical development of ideas, for Marx history is determined by the dialectical development of material processes, in particular those associated with the means of production. Distinct historical phases - pre-feudal, feudal, capitalistic, post-revolutionary socialist - owe their existence to distinct phases in the means of production, and the social arrangements these phases generate. Each phase leads, as a result of inevitable dialectical processes, to its own destruction and the creation of the next phase. Thus capitalism concentrates wealth and ownership of the means of the production into fewer and fewer hands until, eventually, the workers unite, overthrow the capitalists and establish socialism. The historical processes of dialectical materialism work themselves out through class struggle, classes and the conflicts between them being determined by the means of production. It is the laws determining the evolution of the economic base that decide the path of history; ideas, democratic and legal institutions form an ideological superstructure, which reflects the economic base and the interests of the dominant class, but is powerless to influence the path of history. Marx condemned as "Utopian" those socialists who sought to bring about the revolution by means of political policies and plans. The proper "scientific" approach to bringing about socialism is, first, to discover the dialectical laws governing the evolution of the economic base of society, and then to help this evolution along, in so far as this is possible, thus speeding up the coming of the final, inevitable socialist revolution.

Popper argues that a number of elements of Marxist thought are of value, if not taken too far. There is the idea that the social cannot be reduced to the psychological, sociology not being reducible to psychology. There is the thesis that much of history has been influenced by class struggle, and the idea that the means of production, economic circumstances, play an important role in influencing the development of other aspects of social and cultural life, even something as apparently remote from economic conditions as mathematics. Above all, there is the recognition and depiction of the appalling conditions of life of the poor in the unrestrained capitalist conditions of Marx's time, and the recognition, too, of the hypocrisy of much of the morality, the legal system and the politics of those times. Having described Marx's account of the working conditions of children as young as 6 years, Popper writes: "Such were the conditions of the working class even in 1863, when Marx was writing Capital; his burning protest against these crimes, which were then tolerated, and sometimes even defended, not only by professional economists but also by churchmen, will secure him forever a place among the liberators of mankind" (O.S.E., vol. 2, p. 122).

But these good points are, for Popper, more than counterbalanced by the dreadful defects, most of which stem from Marx's historicism, inherited from Hegel. For the central tenet of Marxism is the idea that the laws of dialectical materialism

determine the evolution of the means of production, and this in turn determines the evolution of everything else, from class struggle to culture, religion, the law and politics. But this is manifestly false. For one thing, there is a two-way interaction between economic conditions and ideas; eliminate scientific and technological ideas, and the economy would collapse. For another, ideas can themselves influence the course of history, Marxism itself being an example. Historical predictions made by Marx, on the basis of his economic historicism, have been falsified by subsequent historical events. The Russian revolution is, for example, entirely at odds with Marx's theory, as is the way in which the unrestricted capitalism of Marx's time has subsequently become both more economically successful and more just and humane as a result of diverse political interventions. Marx's economic historicism is not just false; it is pseudo-scientific. Only for exceptionally simple systems, such as the solar system, is long-term prediction, based on scientific theory, possible. In the case of social systems, incredibly complex and open to the influence of a multitude of unpredictable factors, the idea that science should be able to deliver long-term predictions is hopelessly unwarranted. Marx's historicism leads him to turn good points into bad ones by exaggeration. "The history of all hitherto existing society is a history of class struggle" (quoted in O.S.E., vol. 2, p. 111) is a good point if "all" is not taken too seriously, but as it stands is an oversimplification and exaggeration; it ignores, for example, power struggles within the ruling class. Again, Marx was surely right to see legal and political institutions of his time as being biased in the direction of the interests of the ruling classes; but he was wrong to condemn all legal and political institutions as inevitably having this function, as his economic historicism compelled him to do.

For Popper, the most damaging feature of Marx's historicism have to do, perhaps, with the severe limitations that it places on the power of politics, on the capacity of people to solve social problems. Marx is famous for his eleventh thesis on Feuerbach: "The philosophers have only interpreted the world in various ways; the point however is to change it" (quoted in O.S.E., vol. 2, p. 84). But Marx's economic historicism leads immediately to a severely restricted view as to what political intervention can achieve. In Capital he declares: "When a society has discovered the natural law that determines its own movement, . . . even then, it can neither overleap the natural phases of its evolution, nor shuffle them out of the world by a stroke of the pen. But this much it can do; it can shorten and lessen its birth-pangs" (quoted in O.S.E., vol. 2, p. 86). Just those actions which were to improve the unrestrained capitalism of Marx's time beyond all recognition, namely political intervention and the actions of trade unions, are discounted at the outset by Marx's economic determinism as necessarily impotent. Political planning and policy making for socialism is condemned by Marx, in line with his central doctrine, as inherently inefficacious and Utopian. One disastrous consequence of this was that when Marxists gained power in Russia, they found their literature contained no guidelines as to how to proceed. Another disastrous consequence was that Marxism, blind to the potency of political power, failed to anticipate the dangers inherent in handing over power to political leaders after the revolution, dangers which, after the Russian revolution, became all too manifest.

The full force of Popper's criticism is devoted, however, to the central argument of

Capital - an argument which seeks to establish the inevitable downfall of capitalism and the triumph of socialism. Popper presents Marx's arguments as having three steps, only the first of which is elaborated in Capital. The first step argues that an inevitable increase in the productivity of work leads to the accumulation of more and more wealth in the ruling class, and the greater and greater poverty and misery of the working class. The second step then argues that all classes will disappear except for a small, wealthy ruling class and a large impoverished working class, this situation inevitably leading to a revolution. The third step argues that the revolution will result in the victory of the working class, which in turn will result in the withering away of the state and the creation of socialism.

Popper demonstrates that none of these steps is inevitable by showing that alternative developments are entirely possible and, in many cases, have actually happened after Marx wrote Capital. Even if there is a tendency under capitalism for the means of production and wealth to be concentrated in fewer and fewer hands (as the first step assumes), the state can intervene to counteract this tendency by such means as taxation and death duties. And as far as the increasing poverty of workers is concerned, this can be counteracted by the formation of trade unions, by collective bargaining backed up by strikes. The brutal, unrestricted capitalism of Marx's time has been transformed since out of all recognition by just such interventionist methods. And Popper makes analogous, decisive points to demolish the second and third steps of Marx's argument. Even if the ruling class did become increasingly wealthy and the working class increasingly poor (as the second step assumes), this does not mean that all classes but these two would necessarily disappear, since landowners, rural workers, and a new middle class may well exist, given Marx's assumptions. And even if violence breaks out, this does not mean it would necessarily constitute the social revolution, as envisaged by Marx. And finally, even if it is granted that the workers unite and overthrow the ruling class (as the third step assumes), this does not mean that a classless society and socialism would necessarily result. It is all too easy to suppose that the new political leaders would seize and hold onto power, justifying this by exploiting and twisting the revolutionary ideology, and by invoking the threat of counter-revolutionary forces. And many other possible outcomes can be envisaged. It is in fact implausible to suppose that the victory of the working class would mean the creation of a classless society, and hence the withering away of the state. (This bald summary does not begin to do justice to the cumulative force of Popper's argument.)

Marx, as we have seen, condemned planning for socialism as Utopian; and in a sense Popper agrees. Popper distinguishes two kinds of social planning or intervention, which he calls Utopian and piecemeal social engineering. Utopian social engineering seeks to attain an ideal social order, such as socialism, by bringing about holistic changes in society; such an approach is, Popper argues, doomed to failure. Piecemeal social engineering, by contrast, searches for and fights against "the greatest and most urgent evils of society": this is the approach that Popper advocates (O.S.E., vol 1, ch. 9). Subsequently, during the course of criticizing Marx, Popper points out that piecemeal social engineering can take the form either of state intervention, or of the creation of legal, institutional checks on freedom of action. The latter is to be preferred, Popper argues, as the former carries with it the danger of increasing the power of the state (O.S.E., vol. 2, pp. 129-133).

There is very much more to Popper's O.S.E. than the above indicates. Central to the book is the idea that reason is a vital component of the open society, reason being understood as "critical rationalism", arrived at by generalizing Popper's falsificationist conception of scientific method. For Popper, both scientific method, and rationality, need to be understood in social terms. Popper criticizes Karl Mannheim's sociology of knowledge for overlooking the "social aspect of scientific method" (O.S.E., vol. 2, ch. 23). Popper criticizes moral historicism, oracular philosophy and the revolt against reason, and the idea that history might have a meaning (O.S.E., vol. 2, chs. 22, 24 and 25 respectively). Both volumes have extensive footnotes containing fascinating discussion of a great variety of issues tangentially related to the main argument, such as the development of ancient Greek mathematics, the problem of putting an end to war, or the proper aims of a liberal education.

Popper's fiercely polemical book has provoked much controversy. His critical onslaughts against Plato, Aristotle, Hegel and Marx have been angrily repudiated by many scholars in these fields; or, much worse, just blandly ignored.

The general doctrine of historicism is expounded and criticized by Popper in his The Poverty of Historicism (P.H.), first published in three parts in Economica in 1944 and 1945 (somewhat before O.S.E.) and only published in book form in 1957. Popper divides historicist views and arguments into two classes: those that hold that the methods of the social and natural scientists are quite different (the "anti-naturalist doctrines") and those that hold they are the same or similar (the "pro-naturalist doctrines").

Anti-naturalist doctrines can be summarised like this. Generalizations, experiments, predictions and understanding have roles in social science that are radically different from those they have in physics. Social phenomena exhibit novelty, complexity, and a holistic aspect that is lacking in physical phenomena. These differences ensure that historicist social science, predicting in more or less rough outline the evolution of society, must employ methods that differ from those of natural science.

Pro-naturalist doctrines of historicism make much of the success of long-term predictions in astronomy. Just as states of the solar system can be predicted by natural science far into the future, so too historicist social science ought to be able to predict states of society far into the future. Such predictions will, however, employ social laws of succession, laws which specify how one characteristic phase of social development give way to a subsequent phase.

Popper effectively criticizes the anti-naturalist doctrines of historicism. It is, however, Popper's criticism of the pro-naturalist standpoint that is the really important nub of the book. Historicist laws of successions are not laws at all, as these are understood in physics. They are trends. And "trends are not laws" (P.H., p. 115). A law provides a causal explanation of an event when the law plus initial conditions imply that the event occurs. Whenever a succession of causally connected events occur in our environment, such as the wind shaking a tree and causing an apple to fall to the ground, laws (usually a number of quite different

laws) plus the specification of a sequence of initial conditions are required to predict the sequence of events. Trends can, then, be explained by means of laws, but it is always laws plus relevant initial conditions which provide such explanations. And the crucial point is that, given some trend, in particular a social trend, initial conditions that must continue to exist if the trend is to continue, are likely to be very many indeed, most of which will be easy to overlook. This ensures that trends, such as the growth of a population, which have persisted for centuries, may quite suddenly cease if some condition, necessary for the persistence of the trend, ceases to exist. "The poverty of historicism", Popper declares "is a poverty of imagination" (p. 130) - the poverty of being unable to imagine that conditions, necessary for the persistence of some trend, might suddenly themselves change. And this is highly relevant to the whole idea of piecemeal social engineering, for the piecemeal engineer may seek to change just such conditions, required for the persistence of some undesirable trend.

In 1945 Popper was appointed to a readership in Logic and Scientific Method at the London School of Economics; he took up the appointment in 1946, and was promoted to a personal professorship in 1949. Initially the only philosopher at the L.S.E., Popper was subsequently joined by J. O. Wisdom in 1948, Joseph Agassi in 1957 (who left in 1960), John Watkins in 1958, W. W. Bartley III and Imre Lakatos in 1960, and Alan Musgrave in 1964. The Department at the L.S.E. was famous for Popper's weekly seminar. Notoriously, visiting speakers rarely succeeded in concluding the announcement of the title of their talk before being interrupted by Popper. Each speaker was subjected to a devastating critical attack by Popper, almost sentence by sentence; quite often, the subject of the seminar would be continued a week later. The seminars were always dramatic, sometimes farcical, but nevertheless created an overwhelming impression of Popper's passionate determination to get at the truth, even if conventions of politeness and good manners had to be sacrificed.

In 1963 Popper published Conjectures and Refutations (C.R.), a collection of essays restating, extending and applying his views on scientific method, philosophy and rationality. This is perhaps the best introduction to Popper's work. Here is a quick survey of some of the items in the book.

In the Introduction Popper makes a number of important epistemological points. He notes the widespread tendency to believe in the false doctrine that truth is manifest - readily available and easy to come by. When truth turns out not to be so easy to obtain, epistemological optimists become pessimists, and deny that knowledge is possible at all, or resort to conspiracy theories to account for the inaccessibility of the truth. Both Descartes and Bacon are famous for their anti-authoritarian stance in epistemological matters; and yet, Popper points out, there is an unnoticed implicit authoritarianism in their views. For Bacon, and for the empiricists who followed him, the senses are authoritative sources of knowledge; for Descartes, and for the rationalists who followed him, reason is the authoritative source of knowledge. Popper, of course, argues against the idea that conjectural knowledge has any authoritative source.

In chapter two, Popper argues that philosophical problems have their roots in

science and mathematics; and he argues against the Wittgensteinian view that philosophical problems are pseudo-problems that arise when ordinary language is misused.

In chapter three Popper distinguishes three views concerning human knowledge: essentialism, which holds that science can grasp the ultimate essence of things; instrumentalism, which holds that scientific theories are merely instruments for the prediction of observable phenomena; and realism, which holds that science puts forward falsifiable conjectures about aspects of reality that often go beyond what is observable. Popper criticizes the first two views, and defends the third view.

In chapter five Popper gives a magnificent account of the Presocratic philosophers - Thales, Anaximander, Anaximenes, Heraclitus, Parmenides - as proposing and critically assessing successive theories about the origins and ultimate constituents of the universe, and about the problem of how to understand change. The Presocratics, Popper argues, almost unintentionally created critical rationality, the tradition of proposing bold conjectures which are then subjected to criticism - a tradition that led eventually to modern science.

In chapter eight Popper tackles the problem of how philosophical or metaphysical doctrines can be rationally assessed given that they cannot be empirically falsified, like scientific theories. His solution is that philosophical doctrines can be assessed from the standpoint of the problems that they are intended to solve; even though irrefutable, they can nevertheless be criticized from the standpoint of the problems they seek to solve.

In chapter ten Popper restates and, as we have seen above, develops somewhat his falsificationist conception of scientific method. In this chapter Popper formulates and tries to solve what has subsequently come to be known as the problem of verisimilitude: What can we mean by scientific progress if science advances from one false theory to another? Popper's solution is that, given two theories, T_1 and T_2 , even though both are false, nevertheless T_2 say, may be closer to the truth than T_1 . Suppose, for example, that T_2 implies everything true that T_1 implies and more besides, but T_2 does not imply anything false that T_1 does not imply. Granted this, there is a perfectly good sense in which T_2 can be said to be "closer to the truth" than T_1 , and thus an advance over T_1 . Unfortunately it was subsequently shown by Tichy (1974) and Miller (1974) that this proposed solution to the problem does not work. If T_2 has more true implications than T_1 does, then T_2 , necessarily, has some false implications which T_1 does not have. Popper's requirements for T_2 to be closer to the truth than T_1 , when both are false, cannot be satisfied.

Chapter fifteen provides an exposition and decisive criticism of dialectic reasoning: it is thus an adjunct to the criticisms of Hegel and Marx to be found in O.S.E.

One of the themes running through C.R., and through much of Popper's subsequent writings, is that the proper task of philosophy is to tackle, in an imaginative and critical way, real, fundamental problems having their roots outside philosophy in science, politics, art, life. This Popperian conception of philosophy stands in sharp contrast both to the pomposities and obscurities of much so-called

"continental" philosophy, and to the poverty and aridity of philosophy in the so-called "analytic" tradition, restricted to ordinary language analysis, the analysis of meaning. Popper has fought against both rival conceptions of philosophy, and has sought to put into practice his own critical rationalist, problem-solving conception of philosophy. His first four books are exemplary in this respect, and have undoubtedly exercised an enormous, healthy influence on much subsequent philosophy, even though this influence has often not been acknowledged. A basic impulse behind these works might almost be summed up in a stray remark tossed out in O.S.E., vol. 2 (p. 59): "We have to learn the lesson that intellectual honesty is fundamental for everything we cherish".

It is important to appreciate the existence of a central backbone of argument running through these four books. In L.Sc.D., as we have seen, Popper argues that all scientific knowledge is irredeemably conjectural in character, it being impossible to verify theories empirically. Science makes progress by proposing bold conjectures in response to problems, which are then subjected to sustained attempted empirical refutation. This falsificationist conception of scientific method is then generalized to form Popper's conception of (critical) rationality, a general methodology for solving problems or making progress. As Popper puts it in L.Sc.D. "inter-subjective testing is merely a very important aspect of the more general idea of inter-subjective criticism, or in other words, of the idea of mutual rational control by critical discussion" (p. 44, note 1*). But in order to make sense of the idea of severe testing in science, we need to see the experimentalist as having at least the germ of an idea for a rival theory up his sleeve (otherwise testing might degenerate into performing essentially the same experiment again and again). This means experiments are always crucial experiments, attempts at trying to decide between two competing theories. Theoretical pluralism is necessary for science to be genuinely empirical. And, more generally, in order to criticize an idea, one needs to have a rival idea in mind. Rationality, as construed by Popper, requires plurality of ideas, values, ways of life. Thus, for Popper, the rational society is the open society. Given pre-Popperian conceptions of reason, with their emphasis on proof rather than criticism (and associated plurality of ideas), the idea that the rational society is the open society is almost a contradiction in terms. There is thus a very close link between L.Sc.D., on the one hand, and O.S.E., P.H. and C.R. on the other. And the direction of argument does not go in just one direction, from L.Sc.D. to O.S.E.: it goes in the other direction as well. For in O.S.E. (vol. 1, ch. 10), Popper argues that rationality, and scientific rationality as well, need to be conceived of in social and institutional terms (and the argument is echoed in P.H., in connection with a discussion about the conditions required for scientific progress to be possible). O.S.E., P.H. and C.R. illuminate and enrich the doctrines of L.Sc.D..

Above, in connection with the discussion of L.Sc.D., it was argued that Popper's falsificationism ultimately fails, because of its failure to exclude highly falsifiable but grossly ad hoc theories from science. The scientific enterprise is obliged to conjecture that the universe is more or less comprehensible, having some kind of unified dynamic structure, only those theories being tentatively accepted which satisfy (a) empirical considerations, and (b) considerations having to do with simplicity, unity, comprehensibility. As science proceeds, we improve our (conjectural) knowledge of the kind of comprehensible unity which may exist in

nature; the aim of science improves, and with it the methods of science. There is, in other words, a kind of positive feedback between improving knowledge and improving aims and methods, improving knowledge about how to improve knowledge. Science adapts its nature to what it finds out about the nature of the universe (which helps to account for the almost explosive growth of scientific knowledge).

This "evolving-aims-and-methods" view of science modifies quite considerably Popper's falsificationism. When generalized, it leads to an "evolving-aims-and-methods" view of rationality which in turn modifies quite considerably Popper's critical rationalism. These modifications, if adopted, have far reaching implications for central doctrines of Popper's L.Sc.D., O.S.E., P.H. and C.R.: see Maxwell (1984, 1998, 2001).

Work published by Popper after C.R., though containing much of great value, is not, perhaps, in quite the same league as that of his first four books. Much of this work restates, extends and further applies earlier ideas. Where Popper's subsequent work launches forth in new directions, these are not always well chosen. Battles against subjectivity, anti-realism and physical determinism lure Popper into defending opposing views that are exaggerated, sometimes, almost to the point of absurdity. A subtle shift of perspective, of allegiance, can be discerned as we move from Popper's earlier to his later work. In his early work, Popper speaks up on behalf of humanity, on behalf of any concerned person of good will, and against those traditional "great thinkers" and "experts" who threaten to beguile us and lead us to disaster. In his later work, the allegiances have shifted; now Popper speaks up on behalf of great science and great scientists, and against fraudulent academics, mostly philosophers and social scientists.

In 1970 there appeared Criticism and the Growth of Knowledge, edited by Imre Lakatos and Alan Musgrave, the fourth volume of the proceedings of a conference on philosophy of science held in London in 1968. This volume is devoted to a comparison of the views of Thomas Kuhn and Popper on the philosophy of science, and contains contributions from Kuhn, Popper, Watkins, Toulmin, Lakatos, Feyerabend, and others. In his contribution Popper praises Kuhn for having discovered normal science, science which takes some "paradigm" for granted and devotes itself to puzzle solving. Popper points out that he had himself made the same discovery over thirty years earlier, as recorded in the preface to L.Sc.D.. But the normal scientist "has been badly taught. He has been taught in a dogmatic spirit: he is the victim of indoctrination". Normal science is "a danger to science and, indeed, to our civilization" (p. 53).

In 1972 Popper published a second collection of his essays entitled Objective Knowledge. One of the essays makes the good point that common sense tends to combine two incompatible theses, common sense realism, and the epistemological view that knowledge comes flooding into our minds via the senses, rather like water being poured into a bucket - a view which Popper's dubs "the bucket theory of the mind". Popper argues that these two theses clash, and that philosophers, registering this clash, have all too often held onto the bucket theory and rejected realism. But this, Popper argues, is exactly the wrong thing to do; one should hold

onto realism, and reject the bucket theory.

Much of the rest of the book is devoted to developing and defending Popper's three-world view. There are, according to this view, three worlds: the physical world (world 1), the psychological or mental world (world 2), and the world of objective theories, propositions, arguments and problems (world 3). World 3 interacts with world 1 via world 2. Popper argues that this interaction is demonstrated by the

fact that scientific theories lead to new technology, world 1 phenomena, which would not exist were it not for the prior development of world 3 theories. Popper puts world 3 into a biological and evolutionary context: like the webs, nests and dams created by spiders, birds and beavers, so too world 3 is our creation but, once created, it acquires an objective existence independent of us.

This theme is continued in Popper's contribution to The Self and Its Brain (S.B.) a book written with the neurologist, John Eccles. In this work, Popper develops a sustained argument in support of interactionism and his three-worlds view, and criticizes materialism, physicalism, and the thesis that the physical world is (causally) closed. There is also an interesting chapter on the history of the mind-body problem, in which Popper argues for the questionable thesis that the problem was recognized independently of, and before the arrival of, anything like the modern scientific view of the world.

What is one to make of this three-worlds view? Popper is surely right to hold that the contents of theories need to be distinguished from their linguistic forms (and from the causal effects these linguistic forms can have on appropriately educated brains). Popper is also right, surely, to stress that, in order to make human sense of human action we need to attend to the contents of theories. But it is quite another matter to argue, as Popper does, that world 3 entities, such as contents of theories, exist as full-blooded, almost Platonic entities, poltergeistic intellectual objects capable of influencing material phenomena via their influence on conscious minds. Popper overlooks or ignores the possibility that the material world may be causally closed but not explanatorily closed. He overlooks, that is, the possibility that physical phenomena, such as those associated with human actions and human technology, can be explained and understood in two distinct (but perhaps interdependent) ways: (1) physically and causally, in terms of physical theory, and (2) "personalistically", in terms of the intentions, plans and ideas of people. Such a view would hold that personalistic explanation is compatible with, but not reducible to, physical explanation. This view would give to the contents of theories a vital role in the (personalistic) explanation of human actions and the development of technology, without in any way undermining the existence, in principle, of a purely physical, causal explanation of physical phenomena associated with human action and technology (see Maxwell, 2001).

Popper insists that his world 3 entities differ from Plato's Forms in that they are man-made, consist of theories, including false theories, and problems, rather than reified concepts or essences, and there is no suggestion that world 3 objects can be known with certainty (S.B., pp. 43-4). But even if Popper's world 3 entities do not

have implausible epistemological Platonic features, they most certainly have highly implausible ontological and causal Platonic features, in that they have causal effects on the material world (via their influence on conscious minds). That the elderly Popper should espouse such an implausible Platonic doctrine almost seems like Plato's revenge for the youthful Popper's onslaught against him.

Chapter three of Objective Knowledge is called "Epistemology Without a Knowing Subject". Despite the title, Popper does not altogether neglect the personal dimension of the search for knowledge. What he does argue is that subjective knowledge is irrelevant to the study of scientific knowledge, only knowledge construed in objective, impersonal, world 3 terms being important. But this downplays the point that all of objective knowledge, stored in books and libraries, is of value only in so far as it is understood and used by people. Albert Einstein once remarked: "Knowledge exists in two forms - lifeless, stored in books, and alive in the consciousness of men. The second form of existence is after all the essential one; the first, indispensable as it may be, occupies only an inferior position" (Einstein, 1973, p. 80). Einstein's priorities seem saner than later Popper's. And altogether saner, more humane and down-to-earth than elderly Popper's spooky world 3 objects is the viewpoint of the more youthful Popper of O.S.E., which sees science and reason in personal, social and institutional terms, without any appeal being made to ghostly, quasi-Platonic Forms.

In 1974 Popper became the fourteenth subject of The Library of Living Philosophers, edited by P. A. Schilpp. This two-volume work opens with Popper's "Intellectual Autobiography", subsequently published independently as Unended Quest (1976), continues with descriptive and critical papers on diverse aspects of Popper's work, by Quine, Putnam, Lakatos, Medawar, Watkins, Ayer, Margenau, Grünbaum, Kuhn and others, and concludes with Popper's replies. Unended Quest is a fascinating book, and gives a gripping account of Popper's life-long, passionate engagement with his fundamental problems and concerns. It includes a marvellous discussion of the development of polyphonic music, and provides an account of Popper's battles with subjectivism in physics in connection with quantum theory, and with thermodynamics and the arrow of time. Popper also declares that it was he who killed logical positivism. This book, together with C.R., provides the best introduction to Popper's philosophy.

In 1983 there appeared Postscript to the Logic of Scientific Discovery, a three volume work which extends and elaborates doctrines and arguments of L.Sc.D., and much of which was written in the years 1951-56. The work reached the stage of proofs in 1956-57, but was abandoned because Popper suffered from detached retinas, had operations on both eyes, his sight for a time in question. It was only much later, under the editorship of W. W. Bartley III, and after some additions and rewriting, that the work finally appeared.

Volume one, entitled Realism and the Aim of Science, restates and elaborates Popper's earlier views and arguments concerning induction, falsification, corroboration, demarcation, realism, metaphysics and probability. At one point Popper illuminatingly contrasts how a scientific paper might be written in the style of inductivism, and in the critical, problem-solving approach of falsificationism and

critical rationalism: see pages 47-51.

Volume two, entitled The Open Universe: An Argument for Indeterminism, sets out to refute determinism. Popper distinguishes between 'scientific' and metaphysical determinism. 'Scientific' determinism asserts that future states of physical systems can be predicted with any degree of precision by means of theories and initial conditions specified with sufficient precision: see page 36. Metaphysical determinism asserts merely that "all events in this world are fixed, or unalterable, or predetermined" (p. 8). Popper spells out an argument which, he claims, refutes scientific determinism. Even given a universe in which all events occur in accordance with a deterministic physical theory, T, nevertheless a predictor, put within an isolated system, could not predict all future states of the system with unlimited precision. Even if such a predictor had unprecedented powers to acquire knowledge of initial conditions, and make predictions using T, nevertheless it could not acquire up-to-date information about its own state, because the attempt to do so would continually alter its state. This means it would not be possible for the predictor to predict future states of the system of which it forms a part. Popper goes on to argue against metaphysical determinism.

Although full of interesting points, there are two oddities about this discussion. First, as Popper admits, his refutation of 'scientific' determinism does not refute a second version of 'scientific' determinism which asserts that past states of physical systems can be predicted, employing prior initial conditions and physical theory. Second, Popper ignores a rather different third version of 'scientific' determinism, which asserts that the universe is such that there is a discoverable, true, physical 'theory of everything', T, which is deterministic. This version of determinism deserves to be called 'scientific' because T is asserted by it to be scientifically discoverable; furthermore, once discovered, T will be falsifiable, and hence, by Popper's own standards, scientific. It is curious that Popper, who is elsewhere (as we have seen) opposed to instrumentalism and in favour of realism, should here discuss at length a version of 'scientific' determinism which is thoroughly instrumentalistic in character, in that it makes assertions about predictability, and should ignore a version of 'scientific' determinism which is much more in keeping with scientific realism, in that it makes an assertion about the nature of the universe. This oversight seriously weakens Popper's argument for indeterminism.

Volume three is called Quantum Theory and the Schism in Physics (Q.T.S.P.). It is concerned with quantum theory and probability, interconnected issues which preoccupied Popper, on and off, throughout his working life.

Thus in Logic der Forschung (1934), Popper tackled two problems concerning probability: How are probabilistic statements or theories to be interpreted? How can probabilistic theories be falsifiable given that they are in principle "impervious to falsification"? In response to the first problem, Popper defended a version of von Mises' objective, frequency interpretation of probability. In response to the second, he insisted that probabilistic statements become falsifiable as a result of a methodological decision to treat them as falsifiable.

Logic der Forschung also devoted a chapter to problems of quantum theory. The

main task is to criticize Bohr's and Heisenberg's orthodox interpretation of quantum theory (which gives equal weight to the two "complementary" pictures of particle and wave), and to provide an alternative which interprets the theory as an objective, realistic statistical theory about particles. Popper criticizes Heisenberg's interpretation of his uncertainty relations, which interprets these relations as placing restrictions on (simultaneous) measurement. Popper argues that these relations need to be interpreted as "scatter relations", restricting what can be predicted, and not what can be measured. Indeed, Popper argues, not only can we make measurements, for example, simultaneous measurements of position and momentum, that are more precise than allowed by the uncertainty relations as interpreted by Heisenberg; we need to do this in order to test these relations.

These issues are restated and further developed in the Postscript, taking into account relevant developments in quantum physics itself, such as John Bell's proof that local hidden variable versions of quantum theory cannot reproduce all the predictions of orthodox quantum theory, and experiments, such as those of Aspect, which seem to have refuted these local hidden variable theories. The main change in Popper's views is his development of his "propensity" interpretation of probability, and his application of this to quantum theory.

Popper's propensity idea is perhaps best understood in terms of an example. Consider tossing a die on a table. There is a certain probability of obtaining a six, which may or may not equal $1/6$. This is determined by such things as properties of the die (e.g. whether or not it is made of a homogeneous material), the procedure for tossing, and the properties of the table. It is this combination of properties that is, for Popper, the propensity: it is a property, determining a probability associated with some repeatable event (such as tossing the die), "of the whole repeatable experimental arrangement" (p. 71). In particular, then, the probabilistic statements of quantum theory can be interpreted as attributing propensities, not to individual electrons or photons as such, but rather to electrons or photons in the context of some specific, repeatable measurement.

Popper's views on quantum theory have been criticized by Paul Feyerabend (1968), on the grounds that Popper fiercely criticizes Bohr but ends up defending a view very close to Bohr's. Because propensities are properties defined in terms of experimental arrangements, this means that Popper's propensity interpretation of quantum theory, just like Bohr's interpretation, brings in measurement in an essential way. Popper's reply is that propensities relate to "physical situations" which may, but need not be, experimental arrangements (p. 71). But this reply fails in two ways. First, the probabilistic predictions of standard quantum theory are restricted to measurements: if these predictions are to include "physical situations" that are not measurements, then they need to be specified, and need to have specified quantum observables associated with them, so that definite probabilistic predictions may be forthcoming: Popper provides nothing of this. Second, even if Popper did extend the interpretation of quantum theory in the way just indicated, what would result would be a version of quantum theory which would reproduce most of the serious defects of the theory given Bohr's interpretation. These defects include being vague, ambiguous, ad hoc and non-explanatory, all resulting from the fact that the theory is made up of two incoherent parts, a quantum mechanical part,

and a classical part specifying measurement or specific "physical situations".

It may, however, be possible to overcome these defects by modifying Popper's propensity version of quantum theory, so that quantum propensities determine probabilistically how quantum entities, such as electrons and photons, interact with each other (rather than with classically described, macroscopic, measuring instruments or "physical situations"). But this leads to a fully micro-realistic propensity version of quantum theory, very different from Popper's version (see, for example, Maxwell, 1982, 1988, 1994). Quantum theory emerges as a theory that is about, not particles, but a new kind of probabilistic entity, the "propensiton" (as it may be called), which is neither a particle nor a wave, even though it has some features of both. Furthermore, according to such a version of quantum theory, probabilistic transitions involve something like "wave-packet collapse" as a real physical process: for Popper, any such idea is just another part of "the great quantum muddle". But what this indicates is that here, as elsewhere in his work, Popper's ideas, even when wrong or inadequate, are nevertheless rich in fruitful suggestions and implications for further development.

After the Postscript, a number of collections of essays have appeared, restating and elaborating themes already indicated: A World of Propensities (1990), In Search of a Better World (1992), The Myth of the Framework (1994), Knowledge and the Body-Mind Problem (1994), Lesson of this Century (1997), The World of Parmenides (1998), and All Life is Problem Solving (1999).

Popper was knighted in 1965, and became a Companion of Honour in 1982. He retired from his position at the LSE in 1969. He became a Fellow of the Royal Society in 1976. Popper's wife, Hennie, died in 1985, after a long struggle with cancer. In his later years, Popper was showered with academic honours of various kinds: membership of many academic societies, honorary degrees, conferences dedicated to his philosophy, honours, medals and prizes from various sources (see Miller, 1997, pp. 403-6). Popper died a week after a serious operation, on 17th September 1994.

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