A postmodernist attack on science

The End of Science, Facing the Limits of Knowledge in the Twilight of the Scientific Age by John Horgan, Little Brown and Company, 1996

Chris Talbot
18 May 1999

John Horgan is a science journalist who writes for *Scientific American*. His book was originally published in 1996, updated in 1997 and recently brought out as a paperback. It is a collection of interviews with dozens of leading scientists, to which Horgan has added also his own reflections and opinions on the state of modern science. Whilst many of the interviews are interesting in their own right, the book's main significance is Horgan's attack on science from a postmodernist standpoint. It is symptomatic of an anti-science trend which has emerged in the last decade or so.

Unlike most of these anti-science writers, Horgan does have some knowledge of science and the mood amongst scientists. He is able to claim, not without foundation, that many scientists are "gripped by a profound unease" about the future of science.

The interviews that make up the main content of Horgan's book read like a roll call of late twentieth century science and philosophy. They include philosophers Karl Popper and Paul Feyerabend, physicists Hans Bethe, John Wheeler, Murray Gell-Mann, and David Bohm, biologists Francis Crick, Richard Dawkins and Stephen Jay Gould, and complexity theorist Ilya Prigogine. In someone else's hands this would have made a fascinating book. But instead of using his privileged access to these people to produce an objective appraisal of the problems at the frontiers of scientific knowledge, Horgan simply uses the interviews as an occasion for a series of pessimistic assertions.

In the chapters on particle physics and cosmology we are told that science has become "postempirical"—more empirical evidence is well beyond our present resources. In successive chapters Horgan tells us that in biology a theory of the origins of life "would always be subject to doubt"; that the "mysterians" who have argued that the understanding of human consciousness is beyond our capabilities may well be correct; that the mathematical and computer-based theories of complexity, chaos and artificial life "will not achieve any great insights into nature—certainly none comparable to Darwin's theory of evolution or quantum mechanics", etc., etc.

Instead of elucidating the astonishing developments made by scientists in the course of the twentieth century and explaining the new scientific challenges, he examines all of the current problems and difficulties from the standpoint of “proving” that science in all areas, from physics to biology, has reached an end. His argument is essentially the following: "If one believes in science, one must accept the possibility—even the probability—that the great era of scientific discovery is over. By science I mean not applied science, but science at its purest and grandest, the primordial human quest to understand the universe and our place in it. Further research may yield no more great revelations or revolutions, but only incremental, diminishing returns."

Horgan contends that those who want to make fundamental breakthroughs in this era are practising what he terms "ironic" science, because the questions which science is asking seem to take us beyond what can be experimentally tested. How was our universe created? Are electrons and quarks composed of still smaller particles? How do we understand the foundations of quantum mechanics? How did life begin on earth? Is the development of life inevitable? This, says Horgan, is science in a "speculative, postempirical mode... Ironic science resembles literary criticism in that it offers points of view, opinions, which are, at best, interesting, which provoke further comment. But it does not converge on the truth. It cannot achieve empirically verifiable surprises that force scientists to make substantial revisions in their basic description of reality."

What does Horgan mean by the term "ironic science"? The Oxford English Dictionary defines irony as "use of language that has an inner meaning for a privileged audience and an outer meaning for the persons addressed or concerned". Horgan is arguing that in their inner world scientists are addressing questions which they know have no chance of being empirically tested and proven to be true, even if they maintain otherwise to the outer world, the general public.

Well aware that few people would wish to give up the advantages of modern technology, Horgan assures the reader that "applied science will continue for a long time to come" and, "make us healthier, stronger, longer-lived". We may even overcome the aging process and "achieve immortality", he complacently remarks, but there will be no new "shifts in our basic knowledge", "no great revelations in the future comparable to those bestowed upon us by Darwin or Einstein or Watson or Crick".

Cuts in fundamental research spending

As far as Horgan is concerned, such far-ranging questions as scientists are now posing run up against inherent limitations of science and of human understanding. No matter how much money were to be spent or how many scientists employed, these questions could never be answered. This sentiment fits in very well with the cuts in public spending on fundamental scientific research which have taken place all over the world, especially since the end of Cold War. One of the major casualties in the West was the Superconducting Super Collider, the massive particle accelerator that was designed to test the latest theories of elementary particles. It was axed in 1993, with a serious impact on the scientific community. Not only were jobs lost, but it contributed to the "profound unease" which Horgan notes amongst scientists.

Closing down the Super Collider project marked a change in the political attitude towards research in the United States, which had led fundamental research in physics throughout the post-war period. Horgan is well aware of this. He interviews leading physicists Sheldon Glashow and Steven Weinberg who explain its devastating impact. As well as

fundamental research being axed, the remaining research is being more and more oriented to immediate short-term results for corporate profit and the military. Horgan uncritically accepts this situation, which subordinates science to profit and the state.

A vulgar, mechanistic method of thought underlies Horgan's contention that applied science and technology will continue to progress, whilst theoretical research has reached its limits. His conception that contemporary science is "ironic" and "postempirical", whilst by contrast the science of the past could be tested out empirically, demonstrates the same vulgar method of thought. In counterposing applied and theoretical science, "ironic" and empirically verifiable science in this way, Horgan completely ignores the complex interplay between the two.

Consider the relationship between pure science and technology. For the last two centuries at least technology has been driven by constant revolutionary developments in theoretical science. At the same time, the search for new technologies has fuelled new breakthroughs in fundamental science. Nor can developments in theoretical science often be verified without experiments that rely on apparatus that has been developed in technologies that were originally for other purposes. For example, every time we turn on an electric light we are relying on the theoretical advances made by Michael Faraday. Our understanding of the chemical structure of matter is derived from research carried out by an industry whose purpose was to produce better dyes, bleaches and explosives. Satellite technology developed for military use has enabled the Hubble telescope to be built, which has vastly increased our understanding of the universe.

Mutually interdependent

The relationship between theoretical and applied science cannot be separated into watertight compartments as Horgan tries to do. They are mutually interdependent, the one can have no vitality without the other. To imagine that applied science will continue merrily on its way, while theoretical science comes to an end, is the product of an inflexible method of thinking that cannot comprehend the rich relationships of the real world.

Horgan's schematic conceptions are unable to penetrate the relationship between scientific hypotheses and empirical testing. Science has always been, in Horgan's terms, "ironic". In making new developments, science proceeds by putting forward theoretical hypotheses which may not be empirically verified for decades or even centuries. One can cite Democritus's atomic theory, empirically verified—albeit in a more developed form—over 2000 years later. Ernst Mach, the philosopher and scientist who claimed at the beginning of this century that atoms were merely a convenient mathematical fiction which didn't exist outside of the imagination of scientists (the postmodern term "ironic" was not yet in use), has been made to look somewhat ridiculous. When Wolfgang Pauli hypothesised the existence of the neutrino in 1930, he declared, "I have committed the ultimate sin, I have predicted the existence of a particle that can never be observed." Although trillions of neutrinos emitted from the sun are passing through us all the time, virtually all of them pass right through us and the earth as well without collision. It was 26 years after Pauli's theoretical prediction when their existence was finally confirmed with great difficulty—a ton-sized container detected five to ten neutrino induced collisions per day.

Horgan envisages the known well-established areas of science and the unknown, as yet only hypotheses, as fixed opposites. The history of science demonstrates the Marxist conception that the known and the unknown, knowledge and ignorance, constantly interpenetrate and transform into each other. A theory which has not yet been empirically verified becomes the basis for a whole programme of experimental work, in the course of which the theory may be refined and developed or even completely overthrown and discarded. Conflict between contending theories is not, as Horgan implies, a reason to doubt the objective validity of modern science, but a necessary part of the process by which scientific truth is established.

"Limits on our understanding"

Few of Horgan's interviewees responded favourably to his thesis that science is coming to an end. He found support only from a select group, most notably the radical linguist Noam Chomsky, Thomas Kuhn, one of the founding fathers of postmodernism, and Clifford Geertz, who has pioneered postmodernism in anthropology. Geertz declares anthropology to be "telling stories, making pictures, concocting symbolisms and deploying tropes." Kuhn's theory that science cannot attain objective truth but only arrives at a consensus among the community of scientists has laid the basis for more recent postmodern theories. He readily agreed that science might come to an end. The more typical response to Horgan's "end of science" thesis came from Ed Witten, the pioneer of string theory in particle physics. Witten berated Horgan for his "shoddy journalistic ethics". He particularly attacked an article in which Horgan accepted Thomas Kuhn's conception that science "does not converge on the truth". Witten scathingly challenged those like Kuhn who purport to believe that science is not objective, but make use of the technological benefits which are derived from it. "Did Kuhn go to a doctor when he was sick? Did he have radial tires on his car?", he asked.

Noam Chomsky told Horgan that "the innate structure of our mind imposes limits on our understanding". He said that he rejected the notion that "evolution shaped the brain into a general-purpose learning and problem solving machine". The philosopher Colin McGinn, who is influenced by Chomsky, puts the matter even more plainly: "The great problems of philosophy are real, but they are beyond our cognitive ability. We can pose them, but we cannot solve them—any more than a rat can solve a differential equation," he said. This crude zoological theory of human understanding ignores the millennia of social development which have created the culture that allows human beings to solve differential equations or ask questions about the nature of truth. To state the obvious, neither rats nor the great apes, man's closest living relatives, have developed to the point of posing addition and subtraction in abstract terms, let alone solving differential equations.

The human brain is the most complex product of nature. Marvin Minsky, the famous expert on artificial intelligence, who spends his time trying to create a machine that will replicate the brain's functions, has a higher opinion of human ability to understand the world and change it. In his interview he told Horgan, "The concern that scientists will run out of things to do is pitiful." Minsky himself is a living example of intellectual achievement, a child prodigy in music, an expert in mathematics, philosophy, physics, neuroscience, robotics and computer science as well as having written several science fiction novels.

Despondency amongst physicists

Horgan did manage to find a response in some of his interviews with physicists, some of whom projected a sense of profound despondency arising from scientific and philosophical difficulties in their own discipline and savage spending cuts which have hit research. The astonishing development of theories dealing with the particles and forces at a sub-atomic scale—giving incredibly precise mathematical predictions for the properties of elementary particles—had seemed assured of continuing success. Ever larger particle accelerators, whose purpose was to create high energy collisions giving rise to short lived particles with increasingly exotic names, characterised this branch of physics. By the 1980s physicists were returning to the quest which Einstein had begun in the 1930s for a Unified Field Theory. This would combine the theory on which particle physics is based—quantum mechanics—with Einstein's theory of gravitation, General Relativity, and provide a unified theory of all matter, space and time.

Physicists hoped that the Super Collider, the biggest accelerator yet, would have not only confirmed or refined the so-called Standard Model,

the widely accepted theory of particles and forces between them excepting gravity, but would have produced even more exotic particles throwing light on a possible unified field theory. The main contenders for this are various versions of string theory. Strings are mathematically defined entities which are roughly one hundred billion billion times smaller than the "elementary" particles they give rise to, about the same comparison in size as an atom to the solar system. Such extraordinarily small scales and high energies involved in string theory, as well as very complex mathematics, have made it so difficult to get or even envisage empirical verification, that some scientists have doubted whether it will ever be possible. It is this inherent complexity of string theory, added to which came the axing of the Super Collider project, that has contributed to a "crisis" in theoretical physics.

Stephen Hawking put the idea forward at his inaugural professorial lecture in 1980 that such a unified theory of elementary particles and gravity would be a "Theory of Everything". At first this was advanced somewhat tongue in cheek. Physicists would joke that the Theory of Everything would be encapsulated in an equation which could be printed on a T-shirt. But the ridiculous claim that scientists were on the brink of finding a kind of absolute knowledge from which all other science could be derived took hold of some physicists' imagination. Foremost among them is Steven Weinberg, who explained in his interview that the achievement of a Theory of Everything would mean the end of science, giving Horgan some support.

This conception of a Theory of Everything, or rather a unified field theory, as not merely one stage in the development of scientific knowledge, but as the absolute truth, is a prime example of the method of seeing the world in terms of fixed opposites. Neither Horgan nor Weinberg can accept that all knowledge develops as a series of relative truths, which approximate more and more closely to objective reality. For example, Newton's mechanics are still valid for determining the motion of satellites and spacecraft. If the rockets were to move close to the speed of light, Newton's laws have to be replaced by Einstein's Special Theory of Relativity. The unification of quantum mechanics and general relativity in a so-called Theory of Everything, would undoubtedly lead to new theoretical challenges and problems, so that it, in turn, would be found to be only a relative truth that would be surpassed by other theories.

History demonstrates, however, that such crises in science are the result of a build-up of problems in a given field, and generally precede a major breakthrough. There is every indication that, sooner or later, such a new synthesis will be achieved in particle physics. In spite of the loss of the Super Collider, experimental work is proceeding which will test out various versions of string theory. At least three recent proposals have been reported in the scientific press. One, proposed by Giovanni Amelino-Camelia of Oxford University, proposes a study by a specialised telescope of gamma ray bursts. These are intense flashes—whose origin is not yet understood by astronomers—that travel billions of light years across the universe. Because they travel so far, minute differences in the speed of rays with differing frequencies would be detectable. Einstein's theory says that the speed of all gamma rays should be the same as that of light, but string theory predicts the existence of subatomic gravitational fluctuations in "empty" space which would interact with the gamma rays and affect their speed in a frequency dependent way.

A second experimental test of string theories, based on theoretical work by Ed Witten and others, predicts that the new accelerator, the Large Hadron Collider, being built at CERN near Geneva, could generate high enough energies to detect some effects of string theory. Previously it had been thought that only very much higher energies would be needed.

Thirdly, Amelino-Camelia has shown that sensitive laser devices, known as gravitational wave interferometers, can also test the various theories which unite gravity with quantum mechanics. These devices consist of two heavy weights whose distance apart is measured by lasers—down to minute distances less than the width of the nucleus of an atom. They were built to detect gravitational waves, ripples in space-time predicted by Einstein's General Theory of Relativity. Amelino-Camelia has demonstrated that the data from an interferometer at Caltech in Pasadena shows that the minute gravitational fluctuations predicted by some string theories are not present. More sensitive interferometers being built should be able to test other string theories. "Theorists are no longer free to say anything they want", Amelino-Camelia states in the magazine *Nature*.

The application of particle physics to the "Big Bang" origin of the universe—an area pioneered by Weinberg—has now become an active focus of research, another refutation of Horgan's idea that science has become "postempirical". The latest findings on the expansion of the universe, derived from observations of supernovae explosions, challenge existing cosmological theories. Rather than physics coming to an end, there are good reasons to believe that this will throw up new problems which go beyond the scope of current versions of string theory and quantum gravity.

"The Terror of God"

Underlying his prognosis that science has come to an end, Horgan asks the reader to take seriously a mystical experience he had before becoming a science writer. In a chapter entitled “The Terror of God,” he describes a vision of himself as God, alone in the Universe. He explains his initial feeling of ecstasy at a sense of "limitless joy and power", which turned into one of horror that nothing else but himself existed. Such a God must "realise that its lust for final knowledge and unification has brought it to the brink of eternal nothingness," which will, "compel it to flee from itself, from its own aloneness and self-knowledge."

He clearly perceives the world of his vision to be as real as the material world investigated by science, or as he says his "practical, rational mind" is only one of many "minds", some of which embrace mysticism. This chapter more than any other exposes Horgan's real anti-science agenda and shows what is common in Horgan's approach to all postmodernists—their attack on the objective nature of scientific truth, and the argument of mystics that there are limits to scientific and rational explanation. In other words, that the most profound truths are only accessible via individual subjective experience **.**

Horgan's reversion to mysticism shows the connection between this late twentieth century "crisis" in science and one which occurred at the beginning of the century. The earlier crisis was resolved in the course of two decades in a remarkable series of developments: Einstein's Special Theory of Relativity in 1905, his General Theory in 1915, and then the development of Quantum Mechanics in the 1920s by Niels Bohr, Werner Heisenberg and others. But before it had been satisfactorily resolved, it had given rise to mystical currents in which Horgan would find himself at home. Abel Rey, the French philosopher of science noted in 1907:

"If the physical and chemical sciences, which in history have been essentially emancipators, collapse in a crisis that reduces them to the status of mere technically useful recipes but deprives them of all significance from the standpoint of knowledge of nature, the result must needs be a complete revolution both in the art of logic and the history of ideas.... Knowledge of the real must be sought and given by other means.... One must take another road, one must return to subjective intuition, to a mystical sense of reality, in a word to the mysterious, all that of which one thought it had been deprived."

Dialectical materialism

Horgan denies that this previous crisis was used to promote "End of Science" theories. Rey shows that this was exactly what happened. Then as now, a crisis in science was used to promote superstition and reaction. Rey's remarks are preserved in *Materialism and Empirio-Criticism* by V.I. Lenin (*Collected Works*, vol. 14, p. 256). Lenin was challenging a mystical trend which emerged after the defeat of the 1905 Russian Revolution and found expression even in the Bolshevik Party in the form

of the idealist philosophy of the followers of Bogdanov. Bogdanov was taking up the views of Ernst Mach and the Empirio-Critics, who argued that matter was merely a product of human perception. Lenin defended the materialist position that matter was knowable and that it existed independently of human consciousness.

In this reactionary period, the accumulation of a number of unanswered problems in physics gave the opportunity to launch a wholesale attack on the materialist outlook. After the First World War, and then the failure of the 1917 October Revolution in Russia to spread to Germany and the rest of Europe, such mystical trends took hold especially amongst intellectuals. For example, in 1927, the internationally renowned physicist Arnold Sommerfeld responded to a respected German monthly magazine devoting a special issue to astrology. He asked:

"Doesn't it strike one as a monstrous anachronism that in the twentieth century a respected periodical sees itself compelled to solicit a discussion about astrology? That wide circles of the educated or half-educated public are attracted more by astrology than by astronomy?... The belief in a rational world order was shaken by the way the war ended and the peace dictated; consequently one seeks salvation in an irrational world order. But the reason must lie deeper, for astrology, spiritualism and Christian Science are flourishing among our enemies also. We are thus evidently confronted once again with a wave of irrationalism and romanticism."

After the 1917 Russian Revolution, the struggle which Lenin took up in *Materialism and Empirio-Criticism* assumed a wider significance. Lenin, Trotsky and other Marxists encouraged the development of a dialectical materialist philosophy amongst scientists. While not a substitute for research in various branches of science, and not to be viewed as a magic key to instant solutions, it was a guide which would enable scientists to avoid getting entangled in the philosophically reactionary trends constantly thrown up by capitalist society.

It is also an important tool for dealing with many of the basic philosophical issues which emerge in physics in particular. The formal thinking which pervades Horgan's writing, his use of rigid polar opposites—theoretical and experimental, etc—is an impediment to dealing with many of the apparent contradictions that appear in modern science. For example in quantum mechanics the opposition of wave and particle, of classical and quantum, cannot be dealt with in terms of traditionally rigid categories.

Within a relatively short space of time, this encouraging development in the Soviet Union of dialectical materialism in relation to science was stifled under the growth of the Stalinist bureaucracy. Marxism was turned into a sterile mechanical dogma and increasingly discredited by the attacks which Stalinist hacks made on relativity theory and quantum mechanics. They rejected these epochal scientific developments as "bourgeois idealism", and scientists who voiced support for these theories were condemned and even banished to the prison camps or murdered.

At the beginning of the century, despite the emergence of mystical trends, the prevailing attitude was still one of optimism based on the tangible advances that science was making and the possibilities of social improvement offered by technology. In a large part this was because of the influence of socialist and Marxist ideas in the working class. Today, at least amongst intellectual circles, there is a widespread pessimism about the future, expressed most acutely in postmodernism which denies the possibility of progress.

Postmodernism did not originate in science, as Horgan's use of terminology from literary criticism indicates. It arises from a more generalised cultural crisis in the arts, humanities and social sciences, which is part of a decline in global capitalist culture. Now it is beginning to have a serious impact on scientists, because they too are vulnerable to the sense that society can no longer make progress. The reasons for the rise of postmodernism are complex, but a major factor has been the collapse of Stalinism and the end of the perspective of social reformism, which were mistakenly conceived of as socialism by radical intellectuals.

Scientists today, as Horgan's interviews show, are no happier than Sommerfeld about the growth of mysticism. Yet they are unable to understand it as a social phenomena. Nor can they deal with the philosophical questions that postmodernists like Horgan raise. As Lenin was to demonstrate, the only firm philosophical basis for defending science is dialectical materialism.

The future of science is bound up with the future of society itself. Science has made staggering advances in the course of the century, yet capitalism is incapable of using these to end the poverty, disease and hunger which still afflicts the majority of mankind. The emergence of trends such as Horgan's "end of science" perspective is symptomatic of the inability of the present profit system to provide a road forward in this area of human endeavour, as in any other. In the most fundamental sense, the confidence and vigour of scientists is connected to the regeneration of a progressive political movement fighting for the reorganisation of society, so that the benefits of modern technological and scientific achievements are available for humanity as a whole rather than being the monopoly of a few. Under such conditions, the mystical philosophical ideas of Horgan will have as little lasting relevance as those described by Rey and Sommerfeld at the beginning of the century.