# THE NATURE OF SCIENCE

*by R. Hanbury Brown*

"Science" is a word that worries me. Like the word "art," it shows signs of wear. It has been used for too many things. Many of us, I suspect, especially when we go to galleries of modern art, have misgivings about the meaning of art. I often feel the same way about science. Advertisements reassure us that some toothpaste or patent medicine has been tested "scientifically," or we are told that scientists have discovered this or that, the origin of the universe or how to grow bigger tomatoes, the public image of a scientist being a man in a white coat standing beside a computer. I often wonder what we mean by science.

To those who are not working scientists let me say that science, like religion, needs to be lived. It is easy to present the body of science without the spirit, to show the dry bones without the sense of excitement, of community and progress, and of the dedication which science inspires in so many of her followers.

What then is science?

A conventional description of science—the sort one reads in a book on the philosophy of science written a few years ago—goes like this, in three parts:

1. Science, viewed as a process, is a social activity in which we seek to discover and understand the natural world not as we would prefer or imagine it to be but as it really is. The characteristic method of science is the rational, objective, and, as far as possible, impersonal analysis of problems based mainly on observational data and experiment.

2. Science, viewed as a product, is the public knowledge of what so far we have found out and about which the scientific community has agreed. Scientific knowledge therefore is limited to statements on which agreement can be reached and is always open to verification or disproof by anyone. A scientific fact can never be "original" in the same sense as a work of art; only its discovery can be truly original,

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and this, incidentally, explains why scientists are interested in priority of publication and discovery.

3. Science, viewed as an ethical paradigm, is, so Robert K. Merton tells us, a community governed by four imperatives—universalism, communalism, disinterestedness, and organized skepticism.[1] Universalism implies that science is independent of race, color, or creed; it is essentially international. Communalism implies that scientific knowledge is public knowledge. Disinterestedness is, so to speak, the opposite of propaganda. Organized skepticism requires each individual to accept nothing simply on the word of authority; it is encapsulated in the motto of the Royal Society, *nullius in verba*, which, so I am told, means "do not take anyone's word for it."

Now many working scientists, not counting amateur philosophers of science, probably would accept this conventional description of science as being a fair picture. They might think of it perhaps as being a bit old-fashioned, even romantic, but nevertheless on the right track. The trouble is of course that players often see least of the game, and the nature of science is changing. In fact it has changed so much in recent years that the conventional description now applies only to that minor but very important part of science which seeks to understand the world rather than to change it. I shall call this fundamental science to distinguish it from applied science. By the way, I shall avoid the usual term "pure science" because, in my view, it is absurd to use the word "pure" as antonym for "applied"; furthermore, I doubt whether there is any scientific knowledge which cannot be applied.

To arrive at a more realistic description of modern science we must take notice of the fact that in the past few decades science has been industrialized and has allied itself with power. In changing the world it has changed itself, so that the manifest, dominant activity of science is no longer the disinterested pursuit of knowledge but the pursuit of knowledge for industry and other social purposes, such as defense, agriculture, health, and so on. Less than 5 percent of the world's expenditure on science is now devoted to fundamental science. The vast majority of scientists are busy applying science to reach material and social goals, and their work is controlled largely by governmental agencies serving national, military, and civil interests and by big industrial firms serving the market.

The industrialization of science has transformed not only the goals of science but also its practice as a craft. Scientific research has taken on many of the features which we usually associate with industrial processes; much of it is done by large teams using large and expensive machinery. As a consequence research tends to concentrate in the highly developed countries. It has been estimated that only 4 percent of the world's research and development is conducted in areas of the world where 70 percent of the population live. This change in the craft of science is also true of most fundamental research. One has only to compare the discovery of the moons of Jupiter by Galileo Galilei in 1610 with the recent observation of these moons by Voyager I or to visit a modern high-energy physics laboratory to see how these parts of science have taken on the character of an industry.

Industrialization also has tranformed the ethos of much of science as modern critics, such as Jerome R. Ravetz, Theodore Roszak, Jürgen Habermas, Herbert Marcuse, and Hilary and Steven Rose, and all the other Jeremiahs of science, are fond of telling us. Clearly we must accept that all four imperatives governing the scientific community cannot possibly be obeyed by most of those engaged in applied science. I need hardly labor the point that universalism, communalism, and disinterestedness are inconsistent with most military or industrial research. Thus, as it increasingly has become industrialized, much of science has lost some of those precious qualities (such as the disinterested love of truth) which flow from the four imperatives. Inevitably the public respect for science has declined, and this in turn has weakened its authority. This is one of the many reasons why we must preserve a significant body of science which is autonomous or, in other words, is not controlled closely by agencies primarily interested in its application.

Bearing in mind these recent changes in the character of science, I now will discuss some of the principal points which seem to me to be particularly relevant to the relations between science and faith. I shall not be able to give much time to the economics and politics of science.

## Observation and Experiment

Let us look at the role of observation and experiment. Histories of science usually are written in terms of outstanding people such as Isaac Newton and Albert Einstein and give the impression that the progress of science depends largely on the development of new theories. It would be nearer the truth to say that all science, both fundamental and applied, depends largely on the development of new instruments. The progress of astronomy, for example, owes more to two technological inventions, the telescope and the spectroscope, than to any other factor, and yet there are very few astronomers who can tell who invented them. Likewise biology and medical science would not have gotten very far without the microscope; in our own day the revolutionary knowledge of the structure of complex proteins and the mechanisms of heredity owes much to the X-ray diffractometer and the computer. Science and technology always have gone forward hand in hand. It has been said that "the steam engine did more for science than science did for the steam engine."[2]

In discussing our knowledge of the world it is always salutary to remember that such knowledge often is initiated and always limited by our present tools of observation. It is true that theories often precede and suggest observations, but in the long run all theories must be consistent with observations if they are to survive.

## Science and Values

Our conventional description says that science is based on the impersonal analysis of observational data. This leads to the question of how much of our scientific picture is impersonal and how much it reflects our own values. Any student of history knows part of the answer. Science is a social activity, and as such its history cannot be separated from the history of anything else.

Quite clearly the choice of the topics of science is influenced strongly by our current interests and values. As one would expect, at any given time our scientific picture shows some aspects of nature in much greater detail than others because they are of greater current interest; they perhaps may be relevant to industry or war. In the fifteenth and sixteenth centuries, for example, when the world was being explored and opened up to trade there was a strong mercantile interest in developing navigation, which necessarily involved quite abstruse and fundamental studies of the motion of the moon and the distance of the sun.

In our own times we do not have to look any farther than space research to see the connection between our detailed knowledge of the surface of the moon and military interests. In the civil field only a small fraction of the world's research and development is concerned directly with the needs of the poorest but relatively large fraction of the world's population.

There is, I think, no need to pursue this obvious connection between the topics of science and the values of society any further; but before we leave it I would like to draw attention to an interesting and less obvious paradox in the pursuit of relevance. The demand that science should be more relevant to the things which society values and that scientists should be more socially responsible is, I believe, usually justified and certainly to be expected as the cost of science to the community increases. There is, however, one problem which often is overlooked. The relevance of scientific work can be judged only on a short time scale; over long periods it is impossible. It takes roughly one generation for the results of new experimental science to reach application and much longer for new mathematics. Thus most of the recent ideas of modern physics depend upon mathematics which was invented, but not applied, in the previous century. I doubt whether many of the discoveries on which science rests, such as the discovery of the electron, would have been funded by agencies assessing their relevance. The farther scientific work is from application the more vulnerable it is to the demands of relevance. Paradoxically our interests are best served in the long run by research which is guided largely by its own internal logic and not by our immediate needs. Necessity is the mother of invention but not of discovery. We must seek to understand the world for its own sake, not just for ours.

It is also clear that our values influence what we accept as scientific knowledge. There are many examples of this, particularly in fields of science which are "immature" in the sense that their main principles have not been established. It may be that the available facts are not decisive, so that theory plays too large a part in the conclusions, or perhaps the conclusions themselves are very sensitive to the choice of the factors on which they are based. In these circumstances what we accept as science may well depend on our current prejudices and preoccupations. Thus the history of the theory of the heliocentric universe, from Nicholas Copernicus onward, reflects on one side a religious preference for a man-centered universe and on the other a mystical idea about the central importance of the sun coupled with a preference for conceptual economy. Nearer our time there is the opposition to the probabilistic ideas of quantum mechanics, for example by Einstein, on the grounds of a prejudice against a universe ruled by chance. In the comparatively immature but extremely complex science of genetics we can point to the well-worn example of the theories of environmental genetics advanced in the 1940s by the agronomist T. D. Lysenko, ideas which were accepted as science largely because they were politically and ideologically welcome. Judging from recent controversies in the United States, one finds it still difficult to get value-free science on analogous questions of heredity and environment.

In brief, at any given epoch the process and the product of science are both colored by the current values of society.

## THE NATURE OF REALITY

Let us now look more closely at what, in conventional description, is implied by discovering and understanding the world "as it really is."

Most of us know perfectly well what is meant by reality. A stone is real, not imaginary; it is a solid, inert lump which if thrown through our window will break the glass. And yet modern science tells us that the inside of this stone is mostly space, very peculiar space filled with vacuum fluctuations and "virtual" particles; and in this space there are protons, electrons, and so on, which sometimes behave as waves and sometimes as billiard balls and which themselves may be made up of other mysterious entities called quarks. To be sure, science agrees that our stone is inert, and if we want to throw it back we can predict its path precisely by Newton's laws of motion or, even more precisely, by Einstein's general theory of relativity. But if we inquire more closely we find that this apparently simple quality of inertia is itself a mystery; some scientists think that it depends upon the interaction of the stone with all the other bodies in the universe, and some do not.

Clearly our concept of a "real stone" is an abstraction from the wider properties of stones based on our experience of seeing and feeling stones. It is a metaphor which, in terms of our everyday experience, describes something more fundamental, more complicated, and essentially mysterious. Broadly speaking, we can think of the whole scientific picture of the world in the same way, as a metaphor which describes and relates the abstractions we make by observation from a more complex, possibly infinitely complex, reality. These abstractions are chosen and limited partly by our own theories and values and partly by our tools of observation, and so our picture of reality is necessarily incomplete and provisional. It can never claim to be absolute truth, but it is the best picture we have.

## "Reality" and the Structure of Our Minds

There is another more profound question which we can ask about the impersonal nature of scientific knowledge. I am reminded of Arthur S. Eddington's story of the ichthyologist who explored the life of the ocean with a net which had a two-inch mesh. He came to the conclusion that all fish are longer than two inches.[3] This little parable prompts us to ask to what extent scientific knowledge is shaped and limited by the structure of our minds.

Our experience of physics in this century has made us cautious of answering this question. We have found that all the phenomena of nature cannot be explained or described in terms of our familiar, commonsense concepts of space, time, causality, identity, and even locality. Common sense cannot interpret the behavior of objects which are very small, like atoms, or very large, like the universe, or moving with speeds approaching the velocity of light. To bring this behavior within the discipline of science we have had to learn to think in new ways. A good example is to be found in quantum mechanics, where we have had to exchange certainty for probability. We have reached the remarkable conclusion that it is fundamentally impossible to predict what an individual particle or proton certainly will do no matter how much we know about it. We can predict only what it probably will do by a calculus which involves waves of probability. These waves of probability cannot be detected by any physical observation; they exist, so to speak, only in our mathematical minds.

What, we may ask, must the world be like in order that man may know it? Shall we always be able to develop uncommonsensical concepts to relate and predict phenomena as yet undiscovered? It remains to be seen.

### The Observer and the Picture

There is yet another question which brings out the nature of scientific knowledge rather well. How does this knowledge depend upon the act of inquiry? Is the observer, so to speak, part of the picture? The commonsense answer is obviously "yes" when we are looking at living things, especially at ourselves, and I shall say no more about that; but it is "no" when we are looking at the inanimate world. In thinking about inanimate things we distinguish sharply between the observer and the observed, between *res cogitans* and *res extensa*. We think of stones as having objective existence which is quite independent of us. As Gertrude Stein might have said, "a stone is a stone is a stone."

One of the great surprises of the present century has been to learn from physics that this commonsense view of our relations with the inanimate world is wrong or, to be kinder, is only an approximation of the truth. As I have said, we now realize that our concept of a thing is based on a limited set of abstractions which we ourselves choose to make from a more complex reality. Thus the concept of a thing, together with the intrinsic properties which we ascribe to it, depends upon what particular set of abstractions we select; in other words, it depends on the particular class of observations which we choose to carry out and therefore also on the theory which guides our choice. One of the most common intellectual errors is to confuse a concept or symbol with reality and to use it outside its proper domain of validity; in religious terms this is the sin of idolatry.

In the present century physicists have come to realize that by making different abstractions from reality it is possible to arrive at quite different, even contradictory, concepts of the thing which is being observed. A familiar but not unique example of this remarkable fact is to be found in the theory of light. The modern theory of light accepts that light behaves either as an indubitable wave or as an indubitable particle depending on the type of observation we choose to make. We have given up trying to make common sense out of its properties, and if asked what light is really like we can answer only that "light is like light" and offer a mathematical theory which will predict its behavior in any given situation. The point is of course that light is neither a particle nor a wave but something infinitely more complicated, something we cannot visualize in terms of everyday experience. And yet these two concepts, the particle and the wave, are both valid within their own limited domain; physicists call them complementary.

Perhaps I should emphasize that because it is possible to arrive at two apparently contradictory images of the same thing—for example, light—it does not follow that scientific knowledge is subjective. Admittedly the observer does enter our picture of the world by selecting the particular set of abstractions on which the picture is based. Furthermore, these abstractions cannot be thought of as being intrinsic to the thing itself; they are interactions between the thing and the observer. Nevertheless the actual observations of these interactions, the data on which our picture is based, remain truly objective. They are independent of the particular observer and can be verified by anyone, even by a machine. In brief, they are public knowledge.

Before we go any further, I want to draw attention to two important and unfamiliar ideas in this discussion of scientific knowledge. First, a particular concept of reality is valid only in a limited domain. Second, it is possible to arrive quite objectively at two contradictory but nevertheless complementary concepts of the same thing, both of which are valid within their own field. Truth indeed has many faces.

## Scientific Progress

I now must say something about the progress of science because to the working scientist one of the principal attractions of science is its sense of progress. Such a sense is of course not unique to science; nor has it always been like that. For example, Giorgio Vasari, writing in the sixteenth century, conveys the sense of progress in the art of that time toward the goal of more nearly perfect representation.[4] And yet there was then no sense of progress in science. It came later, in the next century, with the questioning of ancient authority and the rise of the experimental method. Since the seventeenth century, science and technology have become our major paradigms of progress, and astronomy has given us an almost unlimited future into which we can progress. Nowadays the idea—or should I say the ideal?—of progress is so pervasive that it is hard to realize how recent and vulnerable it is. It is, by the way, equally hard to realize how recent and vulnerable is our belief in the value of scientific truth.

The progress of science is not, as Francis Bacon tried to persuade us, a simple matter of adding detail to detail.[5] In pursuing the larger goals of science—the cause and cure of cancer or the structure of matter—the great art is to ask the right questions, to choose problems which are relevant and soluble from the vast reservoir of unsolved problems. As any scientist knows, this cannot always be done, and research sometimes grinds to a halt until it is rescued by a new insight or a happy accident. Now and again someone discovers something immensely useful, such as X-rays or penicillin, entirely by accident or illuminates a whole range of problems by discovering the structure of DNA. When this happens there is a step forward which usually leads to the discovery of new phenomena and to a wider understanding of the relations between phenomena which are already known.

Some historians, such as Thomas S. Kuhn, have pictured the progress of science as a proliferation of ever deeper and narrower specialties.[6] They agree that its progress is measured by the number of problems solved; but they see these problems as being set by the whims of scientists themselves, and they discern no overall movement toward some central truth. This is a view of science which I believe to be misleading. I see no reason to suppose that the progress of science must converge on some central truth. To borrow a phrase from J. B. Bury, the idea looks to me suspiciously like an "illusion of finality."[7] It is characteristic of all advances in science that they pose more new questions than they answer. As long as this continues to happen, science will progress. To take one example from many, in the present century advances in nuclear physics have solved the old important problems in astrophysics of how the stars get their energy and how the heavy elements were formed. And yet they have created more unsolved problems in astrophysics than there were before, among them the complicated problem of how these heavy elements came to form the complex molecules of living matter.

A more realistic view does not see the progress of science simply as a proliferation of new data and narrower specialties but as the development of more and more powerful generalizations—the laws of nature—which extend our ability to explain, relate, and predict the diverse phenomena marking the frontiers of science. Newton, for example, saw the connection between the fall of an apple and the motion of the moon. In that sense science is getting easier, not harder, to understand.

It is often argued that the progress of science is slowing down and that one day it will stop. Admittedly the rate at which significant new ideas are produced has not kept pace with the enormous expansion of science, but it is obvious why this should be so. It is not, as so often is suggested, due to exhaustion of the subject; the number of problems has increased. It is not due to an unmanageable mass of data; that problem is being solved by technological advances in data handling. It is due to the simple fact that each advance in science gets progressively harder to make, not only harder but more costly as well. Our tools of observation, on which progress depends, must be more powerful and elaborate, and in real terms they cost more. If anything other than a loss of will stops the progress of science it is most likely to be the sheer cost of new tools. But we have not gotten to that stage yet, and even if the rate of progress does slow down that is not necessarily a bad thing. Society needs more time to get used to new things and new ideas.

In brief, I believe with most scientists that science does progress in a worthwhile way and that in the long run distortions in our picture of the world due to errors or cultural influences fade with time leaving us with progressively truer images of the world. An important article of the creed of science is *veritas temporis filia est*—truth is the daughter of time.

## WHY SCIENCE?

Why should we bother about science? Most people, if asked that question, would talk, I guess, about the practical uses of science. They would point to the very real contributions which science and technology have made to our health and wealth. No doubt they also would point to some of the things they fear, such as pollution, nuclear power, genetic engineering, and so on. Some, perhaps rather few, would point to the contributions that science has made to our culture in the same way as music and painting. Science, they would say, is worthwhile for its own sake—*ars pro gratia artis*.

In my view these arguments for science are too shallow. Science is not just a modern cargo cult, an ornament of society, an intellectual pastime. Modern science is one of the greatest achievements of the mind and spirit of man; it is not to be treated simply as an instrument of social or political purpose. It is one of the main, indispensable pillars on which our civilization and our hopes for the future rest. I will point out some reasons why I believe this to be true.

### Science and Right Action

The simple equation of truth with goodness and of knowledge with right action was spelled out in the seventeenth and eighteenth centuries. It flourished when men came to look more toward perfectibility in the future than at perfection in the past. The progress of science, urged on by Bacon, played a significant part in this reorientation. We have inherited this precious belief in the possibility of progress, but we have learned that it demands not only knowledge but also vision and wisdom. To act rightly we always must be making value judgments in which we weigh profit and loss, freedom and justice, beauty and truth, and to do this we need all the science we can get. Most of the problems of the modern world involve detailed scientific knowledge, and it is the obvious responsibility of scientists to alert us to the social implications of scientific advances and to help us, in terms we can understand, to apply them wisely. William Blake wrote: "He who would do good to another must do it in Minute Particulars. General Good is the plea of the scoundrel, hypocrite and flatterer, for Art and Science cannot exist but in minutely organized Particulars."[8]

### Science and Weltanschauung

Let us now turn to the influence of science on our world view. One of the four main elements in the ethos of science, I mentioned, is organized skepticism—not the sort of quality to inspire devoted enthusiasm but nevertheless invaluable to society. We must remember that one of the dangers to any society, especially since the development of mass communications, is that it might become credulous. The antidote to credulity is skepticism.

Anyone who has studied the trial of Galileo, the controversy over evolution between Samuel Wilberforce and Thomas Henry Huxley, or the "monkey" trials in Dayton, Tennessee, will know that human institutions preserve ideas as a rock preserves fossils. One of the principal cultural functions of science is to prevent this from happening and to keep our ideas flexible and realistic by pointing continuously to the way the world—to the best of our current knowledge—actually is. In doing so science fulfills the classic role of destroying superstition.

Consider, for a moment, the profound changes in our world view brought about by Copernicus when he removed the earth from the center of the universe and by Newton when he developed the science of celestial mechanics. In the present century we have seen equally great changes. The earth is now a planet of a minor star in a galaxy of billions of other stars, and the galaxy itself is one among millions and millions of other galaxies which stretch away as far as our most powerful telescopes can see. The same sort of readjustment of perspective has taken place in time. Modern cosmology has given us an immense past and an equally immense future. Astrophysics has shown us how the heavy elements of which we are all made were evolved in stars from primeval hydrogen. Thus astronomy, geology, and biology have placed the evolution of the earth and of man in a vast tract of time. There are of course many questions which are unanswered, such as the origin of the planets or of living matter, but the general perspective of our place in time and space is now fairly clear. What effects this new perspective will have on our culture it is still too early to say; but what we now can see is that all modern science—the whole study of evolution from the big bang to man—points to an old and powerful idea, to the unity of man and his environment, and to his need to live in harmony with it. And there is more to come; what, for example, will be the effects on our society of understanding the mechanism of heredity, the mechanism of mind, or even perhaps communication with other worlds?

If our ideas about ourselves and the world we live in are to be flexible and realistic, as they must, then we shall have to keep an eye on the picture of the world presented by science. We must be prepared always to revise our ideas in the light of what we see; and this of course applies equally well to the teaching of the church. A static view of the world belongs to the Middle Ages.

### Science and Imagination

I now want to say a word about imagination because the prophets of the counterculture (e.g., Roszak) are always telling us that science is an enemy of the imagination, and I believe this to be profoundly untrue.[9] To be sure, wisdom and vision both need imagination, but history shows us clearly that imagination always must retain contact with "objective truth," the sort of truth which science offers. Beliefs and institutions guided by unrestrained imagination go stale and sooner or later turn into fantasy—and very nasty fantasies too. (E.g., consider the ritual human sacrifices practiced by the Aztecs). Not only does science keep imagination's feet on the ground, but it enriches it because, as J. Bronowski was fond of pointing out, "the strength of the imagination, its enriching power and excitement, lies in its interplay with reality—physical and emotional."[10] No one could foresee or imagine the beauty and the complexity of nature as revealed by science.

SCIENCE AND FAITH

How in our own times can we make it easier for faith and science to work together as faith and art have done in previous centuries? Newton certainly thought that it could be done in his day, and so did the deists after him. But it did not take long for science and religion to become enemies—what went wrong? The fault, needless to say, lay on both sides. In their enthusiasm for celestial mechanics or for the theory of evolution many scientists, such as Pierre Simon Laplace, saw no need for God. The supporters of religion on the other hand confused the powerful symbolic ideas which they had inherited from the past with reality, and so they fought a losing battle with science. Thus Huxley won his battle about evolution with Wilberforce—no doubt he should have won but not, I think, so easily.

To this day there are people who carry on these old battles but fight under different banners and on different ground. Some, for example, tell us that the ideals of science have been so eroded by its alliance with power that it has little apart from material goods to offer us. This argument, I suspect, we have heard before in the context of the church. I suggest that it is no more valid a reason for turning away from the values of science than it is for turning away from the Christian faith. Others attack science because they say it removes the sense of mystery from the world and dehumanizes us by its emphasis on objectivity. Like Laplace's *systeme du monde*, the scientific "single vision" of the world has no place for the supernatural, no need for God.

This second view of science is, I suppose, still one of the main obstacles to a closer alliance with faith. There is of course no simple solution to this difficulty, but there are some ideas and attitudes which, I believe, are helpful.

First, I think that we must dispel the idea that science removes mystery from the world. It is true of course that science does remove minor mysteries, such as the mechanism of heredity, but in doing so it shows us where the major mysteries really are.

As I said earlier, our scientific knowledge is based on abstractions which we choose to make from a more complex, essentially mysterious, reality. All our ideas about the world, about time, space, fundamental particles, light, and so on are therefore symbolic entities which are themselves mysterious. As for the great mysteries which stand in the shadows of all human thought, such as the origin and purpose of the world, modern science cannot be accused of sweeping them away. The mystery of creation is intact, pushed back by twenty billion years, but nevertheless where it always was—in the beginning. Nor has science anything to say about the purpose of the world. It has told us a good deal about the scenario of the play but not about the plot. In brief, everything we know is bounded by mysteries. Science relates us to these mysteries impersonally through objective knowledge; art and religion relate us to them personally through beauty, meaning, and purpose. Thus in the domain of science, as the critics rightly point out, there is no room for the supernatural; what they overlook is that the natural is mysterious enough.

Second, I think we must accept that the scientific vision of the world is neither a rival nor an alternative to any other point of view. It is an essential part of learning to be at home in this mysterious universe and of making the best of it and of ourselves. At the same time we must recognize that this "public" vision of the world is not the only one. Modern physics has demonstrated for all to see the importance of complementarity in human understanding. It seems that there are many things, perhaps everything, which cannot be understood from one point of view. It is therefore essential to explore other points of view but, as science tells us, it is equally important to realize that every point of view has a limited domain of validity.

Third, I suggest that we accept the pursuit of science as a moral duty. To regard it as an enemy of faith is to live in the last century. Not only is it essential to making a better world, but also it is a dynamic revelation of the marvelous and mysterious world in which we live.

As Roszak says, "Unless the eye catch fire, / The God will not be seen, / Unless the ear catch fire, / The God will not be heard, / Unless the tongue catch fire, / The God will not be named, / Unless the heart catch fire, / The God will not be known."[11] Modern science, I believe, can help faith to set the mind on fire.

NOTES

1. Robert K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago: University of Chicago Press, 1973).

2. James Bryant Conant, *Science and Common Sense* (London: Oxford University Press, 1951), p. 39.

3. Arthur S. Eddington, *The Philosophy of Physical Science* (Cambridge: Cambridge University Press, 1938).

4. Giorgio Vasari, *Lives of the Most Eminent Painters, Sculptors, and Architects*, trans. Gaston DuC. DeVere and ed. Robert N. Linscott (New York: Modern Library, 1959).

5. Francis Bacon, *Novum Organum* 1.

6. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

7. J. B. Bury, *The Idea of Progress: An Inquiry into Its Origin and Growth* (New York: Macmillan Co., 1932).

8. William Blake, "Jerusalem," in *Complete Writings*, ed. G. Keynes (London: Oxford University Press, 1972), p. 687.

9. Theodore Roszak, *The Making of a Counter Culture: Reflections on Technocratic Society and Its Youthful Opposition* (London: Faber, 1970).

10. J. Bronowski, *A Sense of the Future*, ed. Piero Ariotti (Cambridge.: M.I.T. Press, 1977).
11. Theodore Roszak, *Where the Wasteland Ends: Politics and Transcendence in Postindustrial Society* (Garden City, N.Y.: Doubleday & Co., 1972), p. 296.