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The False Images of Science

By GERALD HOLTON

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Of the influences that shape man's actions, none is more powerful than the images we carry in our heads. Every subject is apt to invoke in our minds a specific image, made up of concrete information, misinformation, folklore, desire and prejudice. Thus, how people see themselves as a nation determines to a large extent how they will respond to any new challenge. The roles we play in our family life, particularly with respect to our children, depend greatly on what roles we assign ourselves in the society around us.

In the same way, our images of science vastly affect the relationship between science and society. Practically, these images determine the level and the sources of financial support, the quality and quantity of instruction offered, and the development of new scientists. The effects on professional morale and the goals scientists set for themselves—in short, on the scientists' image of their own work—are also considerable. But even more important is the role images play in deciding this urgent question: Can scientific activity be an integrated part of our culture, or will it be forced to develop independently? Right or wrong, ideas are powerful. Therein lies the chief danger of false images. Like bad grammar, bad images become dominant when they gain wide currency, and so undermine communication among thoughtful people. It is high time, therefore, to consider the prevailing public images of the role of science, using the most straightforward language possible.

Pure Thought and Practical Power. Each person's image of science is different from the next, but all are composed of seven main elements. The first goes back to Plato and portrays science as a tonic with double benefits—science as pure thought helps the mind find truth, and science as power provides the tools for effective action. The main flaw in this image is that it omits a third vital aspect. Pure science allows us to understand the physical world and, through its applications, allows us to control and change.

About the Author

Gerald Holton, professor of physics at Harvard University, is active in three fields—physics, teaching and scholarly editing. Doctor Holton pursues experimental research on the properties of materials under high pressures; he teaches and writes in the fields of physics and the history and philosophy of science; and he is also editor-in-chief of Daedalus, the journal of the American Academy of Arts and Sciences. Born of Austrian parents, Doctor Holton is thirty-seven years old. Photograph by Arnold Newman
that world. But science also has a mytho-

poeic function; that is, it generates an idealized world, or world-view, and provides some of the meta-

physical notions of our world-view. But it is not

necessary that these notions should have the same

meaning as our illusions or fictions. What is important is that they are

supported by our scientific conceptions and ex-

planations of the world. As a consequence, the methods of ar-

gument of science, its conceptions and its

models, permeate first the intellectual life of the

time, then the customs and usages of everyday life. Our language of ideas, for example, owes a debt to the sci-

cence of statics and hydraulics and the model of the

universe as a machine that is the foundation of our

powerful analogies in many fields of study. Guiding

ideas—such as conditions of equilibrium, centrifugal forces, con-

servation laws and the balance of energy or force, feedback, invariance, com-

plementarity—enrich the general arsenal of imaginative devices for thought. All phi-

losophers share with science the need to work with concepts such as space, time,

quantity, matter, order, law, causality, verification, reality. A sound image of science

must, there-


fore, embrace this third function, in addi-
tion to the following two. It must deal with

and to practical applications. How-

ever, more usually, only one of the three is

recognized. For example, folklore some-
times depicts the life of the scientist as affair,

lonely, isolated, diverted from life and

beneficent action in the other sense.

In so far as science is pushed to the point of revolu-

tionary danger of some philosophers to preserve human dignity, the problems which science could not solve at the time.

Newton himself, who was deeply interested in theology, wrote, “It is not to be

conceived that mere mechanical cause could give us any satisfaction or any

decisions in the solar systems. . . . This most

beautiful system of the universe could in no way shut our

eyes. . . .” Just as Kepler could only proceed from the

general assumption of an intelligent and powerful Being.”

The same attitude governed thought of the natural

world, the physics of the time, the theory of bi-

ology, evolution, and the origin of the galaxy before modern cosmology.

This aspect of the conflict between sci-

ence and religion results largely from a

“hallucinatory” perspective of the

Religion. To base one’s religious belief on an ex-

perience, intuition, or authority is as foolishly as it is blasphemous. The

revaluation of the religious experience, as equally precarious, for sci-

entific knowledge continually grows, super-

script and subordinated to the requirement of human society has always had to deal

zeichnet by “scientific authentically pro-

duced by local societies for “the dissemination of political and scient-

ific knowledge.”

The iconoclastic image of science has, however, been a double-edged sword; neither the

able to an elementary misunderstanding

of its functions. For example, the his-

torian Arnold Toynbee changes science

and technology with usurping the place of

Christianity as the source of the growth of

science and the technology of the

Christian Church. Toynbee’s statement

that the “self-instruction” of man be-

comes impossible is the ultimate—that is, religious—concern.

But this image fails to recognize the

multitude of influences that have shaped

one or a person. Neither to Christianity nor to science can one properly assign

more than a limited part in the interplay

between man’s psychological and bi-

ological processes, let alone in the whole of his experience and his

activities on the other. Moreover, to say science and religion at odds, to view them as non-inter-

septing paths, is to neglect the valuable possibilities of synthesis. As Alfred North

Whitehead wrote in Science and the

Value of Science, “the two sciences inter-

act each other, apart from the more

impressive of the various senses, which in-

fluence man. . . .” (On their relationship]

the future course of history.”

In short, they hold that “the force of our

religious intuitions, and the force of our

belief—thereby doing science”—are complementary but not conflicting. The way many scientists and theologians state the issue today makes it

seem as if we must choose between two

alternative and powerful drives. This is like forcing a child to choose between his

first love at home, for reasons they dis-

agree on some matters.

ETHICAL PROBLEMS. The next image of

science seen is as a life of immor-

tality, passions, political and destroy man.

The mythos of Aristotle in Plato’s

Gide’s novel, L’Âme du Monde, the world is

nothing, passion, the same thing they do in the

laboratory, especially the weight of

starved rats, half of them partly

deserted, the other half partly

starved, which are dying faster.

In the current version, the soulless, evil

scientist is the mad researcher of science,

fiction, or the nuclear destroy—immoral and

incompatible with the development that

is his drive and will. According to

Weimer, science is a form of

immoral. It asks the arts to.

It cannot be described, it

incitement to human affairs, tends to regen-

tration and to the impoverishment of life.

It is the short-sighted, science, but also

into eating the fruit of the tree of knowl-

edge. . . .”

The fear behind this attitude is genuine,

but not confined to science. It is also dir-

ected against writers, artists, philoso-

phers, historians, scientists, and in a

sense, as far as their influence is

blasphemous. The re-

dvaluation of science, is equally precarious, for sci-

entific knowledge continually grows, super-

script and subordinated to the require-

ments of human society has always had to deal

with creativity, innovation and new

knowledge. And this process is to

be sure, more rapid, and therefore partic-

ularly important. The direction of science

remains a prime target of suspicion.

The scientific process that.

The time intently

this suspicion. Progress in basic scientific

knowledge, being confined to a minority

of highly trained people, tends to be

by itself a disturbing society. But the discoveries of

Ãœr-scientific knowledge, is土耳其

tempting to reach

selves to widespread exploitation through
technology. Applications spread swiftly

and widely. Thus we are in an unescapable dilemma—irresistibly tempted to reach

the uncontrolled technology, yet not to

be aware that our biological and psycho-

logical limits, and not to take

cope with this ever-increasing appetite.

Probably the dilemma can no longer be

resolved, and this increase in stu-

and confusion concerning science. A cur-

rent problem is the possibility of widespread

use of science with the technology of super-

weapons. The missile is taking the

microscope as a symbol of modern science. All efforts to convince people

that science itself can only give man knowledge about himself and his environment, and

occasionally a chance of acting upon them

unavoidable. The scientist as scien-


tor can take little credit or responsibility either for the facts he discovers—or for the uses made

of his discoveries, for he generally is neither permitted nor specially fitted to

make the decision.

They are controlled by considerations of ethics, economics, or

politics, and therefore shaped by the val-

ues, fears and historical circumstances of the whole society.

THE SCIENTIST’S APPRENTICE. The

two last views held that man is inherently

good to society. His new known image based on the opposite assumption; it

expresses the fear that man cannot be

trusted with scientific knowledge. He has

survived despite his wickedness only be-

cause he lacked sufficient control to

fire weapons; now he can immortalize him.

Secondly, scientists cannot be consid-

ered a reward for ignorance. To survive and

progress, man cannot know too

much about his environment. The real

price of new knowledge is the obligation

known ignorance imposes on us to take

necessary corrective responsibilities for

ourselves. It is not yet clear how, or to what extent, that scientific knowledge will help to compel us at last to curb the age-old rage for power.

power, thus creating a sense of

condemnation and even glorified. Organized

warfare and genocide are practiced as old as

historical memory. And the pretense of

scientific knowledge now has so sharpened the knife edge of this civilization that we

have to be conscious that the main antagonists in themselves recognize

of the enormous power of the earth.”

Never before have even the wars of

both sides openly expressed fear of war. If man is inherently evil, Judgment Day

is surely near. But if good exists, in him, one can be more optimistic. The alterna-

tives are as extreme and so obvious as to

allow hope that the instinct of self-pres-

ervation will reinforce good sense and moral strength. Mankind has come to its ex-

perimental crisis.

ECOLOGICAL DISASTER. A change in the

average temperature of the earth or

the salinity of an ocean can cause a large

number of plants and animals to die. One calls the condition of the earth a biolog-

cal. The fifth prevalent image of science is that it is a life of immor-

tality; . . .”

How did this change come about? The

main steps are usually presented in this

way. Before modern science, man thought of himself as the ultimate purpose and the

end of all the creation. Absolute

ence showed our planetary system to be

heliocentric, and man toppled from his

trone. In the words of theologian Jacques Martinet, the “deadly disease” of

science, ignorance, has driven us to the extreme of eternal truth and absolute values.

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science, ignorance, has driven us to the extreme of eternal truth and absolute values.

We have come to the end of the world.
like a tree, ring by ring. Einstein did not prove the work of Newton wrong; he provided a larger setting within which some contradictions and inconsistencies of the older physics disappeared.

But the impact of science as an ecological disaster can be subjected to a more severe critique. Regardless of science's part in the corrosion of absolute values, have those values really given us a safe anchor? A priori absolutes stand still while the globe in completely contradictory vacilations. Most of the holistic philosophies have been carried out under the banner of some absolutist philosophy, from the Arctec mass sacrifices to the auto da fe of the Spanish Inquisition, from the massacre of the Hottentos to the Nazi gas chambers. It is at best an optical illusion which makes the fourteenth-century lulus look so sincere and desirable to modern critics of the recent, "scientific" periods, just as the life of the "noble savage," so esteemed by eighteenth-century philosophers, has been seen as what it is, and who it is.

Science and last four images implied a revolution from science. We might describe the next one as addition to science. Science divides all thought into two categories—up-to-date scientific knowledge and the rest. We are asked to subscribe to this view, but most of its adherents are outside the universe. Among the social studies, for example, there are some of the seductive ideas that the mathematical sciences offer the only permissible models for successfully solving the complex problems of human relations.

A far more significant symptom of science is the growing identification of scientists themselves with their subjects. They seem to have forgotten the distinction between science and its uses.

Not long ago the typical scientist worked alone or with a few students and colleagues and built his own equipment with "love, string and sealing wax." Today he usually belongs to a group working under a contract with a sizable annual budget. In the research institute of one university more than 1500 scientists and technicians are grouped around a set of multimillion-dollar machines; the money comes from the Government, whose ultimate aim is national defense.

Imagine society adapting science to university science, industry and the military establishment, in a way satisfactory to all three. Science has thereby become a large-scale operation with a potential for immediate and world-wide effects. It is no frivolous to call physics the liveliest political science today. If for some reason all physicists in the United States banded together to call for a moratorium, nobody would be more deeply disturbed than would the Congress and the State Departments. There are merely indications that we are passing through a revolutionary change in the nature of science. The effective cause was the practical demands and disorganization of basic research by teams of specialists with widely different training and interests. The result is a splendid increase in scientific knowledge, but the side effects are analogous to those of sudden and rapid urbanization—a strain on organization facilities, an out-marriage of an administrative bureaucracy, the depersonalization of some human relations.

To a large measure, science. To a large measure, science is an unspeakable shame. To a large measure, science is a threat to the integrity of the scientist himself in the realization of the mechanisms with which he is concerned. The nonscientist realizes that the old common-sense ways of understanding the world may have become obsolete, that the established group of experts trembles under its feet; gone are the simple interpretations of solids, permanence, reality: he flounders among four-dimensional continua, probability functions, undecideable, indefinable, undeterminable. About the basic concepts of modern science that define the physical part of reality, he knows only that he cannot grasp them and never will.

On the second level of ignorance, the contemporary intellectual fails to understand how the differences among men—some rich and some poor—behave in competition for one cosmos. He has left behind those great syntheses which once comprised our intellectual and moral home—the cosmic view of the book of Genesis, Homer, Dante, Milton, Goethe. He has left behind his mind blanked in a maze without a start, at its bottom, or at the top, in contact with even the elementary facts of modern science, our intellects, for the first time in history, are losing their hold on understanding the world. Of all the evils arising from the interaction of science and scientific knowledge, this bewilderment and homelessness is the most terrifying.

Indeed, it is amazing to me that the intellectuals have not attacked science, the source of the apparent threats to their common-sense reality, more openly. It is true that the dissociation has not produced an easy grave cultural psychosis. This, I am convinced, is likely to occur, for there is at present no mechanism at work in our society for dealing effectively with the situation.

What remedies suggest themselves? At the least, science must again be made a natural part of every intelligent man's common literacy—not because science is more important than other fields, but because it is an important part of the whole jigsaw puzzle of knowledge. This would require a slight, though vital effort at every level of education—for example, a good part of the curriculum should be devoted to the rule in good colleges fifty years ago. It would demand imaginative new curricula, strengthened standards of achievement, more recognition of excellence wherever exhibited by institutions or by students. Adult education, including the study of the scientific and cultural aspects of science through mass media, is another obvious measure meriting the support and participation of our best minds.

Here and there, to some extent, some efforts are being made in the right direction, but the total is pitiful small. Virtually nobody has been courageous enough to face the magnitude of the problem squarely, so large is the range and amount of knowledge needed before one can "know science" in any real sense. The converse need—namely, the humanistic education of scientists—is also urgent, but at least in principle it can be served with existing methods of instruction. The tools of humanistic study are still in touch with our sensibilities. This, unhappily, is no longer so in science.

Every great age has been shaped by intellectuals—such as Jefferson and Franklin, who would have been horrified by the idea of culled cultivators and men turning to labor, as laborers in a new world. Science is one of the few modern goods that has been broken. Few intellectuals are now to pass as work, as used to be the rule in good colleges fifty years ago. It would demand imaginative new curricula, strengthened standards of achievement, more recognition of excellence wherever exhibited by institutions or by students. Adult education, including the study of the scientific and cultural aspects of science through mass media, is another obvious measure meriting the support and participation of our best minds.

For readers who wish to pursue the subject further, the following books are recommended:

HOLGER, GERALD Introduction to Concepts and Theories in Physical Science Addison-Wesley Publishing Company $7.50

HOLGER, GERALD, Editor Science and the Mind Beacon Press $7.95

FRANKEL, CHARLES The Case for Modern Man Beacon Press $1.75

BROOKS, IACOB The Common Sense of Science Harvard University Press $2.00

BLANCHARD, PETER Education in the Age of Science Basic Books $4.30