ADVENTURES
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43.

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

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that world. But science also has a mytho- poetic function; that is, it generates an immanent teleology and irreducibly and provides some of the meta- physical foundations for the rational struc- tures of our ideology.

As a consequence of this, the methods of argu- ment of science, its conceptions and its models, permeate first the intellectual life of the time, then the tenets and usages of everyday life. Our language of ideas, for example, owes a debt to the science of statics and hydraulics and the model of the chain of equations that are used in the construction of powerful analogues in many fields of study. Guiding ideas—such as conditions of equilibrium, centrifugal forces, con- servation laws and the balance of energy or power, feedback, invariance, complementarity—enrich the general arsenal of imaginative resources at our disposal. All philo- sophies 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 other two referring to theoreti- cal 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 a lonely, isolated, divorced from life and beneficent action in the larger sense.

In some extent science was rushed in this Hamletian scenario of the high ten- dency of some philosophers to pedagogize and to set 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 causes could have had so powerful effects on move- ments in the solar systems. . . . This most beautiful system of the suns cannot possibly be due to chance." The philosopher could only proceed from the caustic ‘admonition of an intelligent and powerful Being.’

The same attitude governed thought concerning science and its formation before the theory of geological evolution, the doctrine of the theory of biol- ogical evolution, and the origin of our galaxy before modern cosmology. This aspect of the conflict between sci- ence and religion results largely from a misinterpretation of the fact of the non- existence. To base one’s religious belief on an empirical evidence, is to mix the two of them as is fooleth in a bladder. The re- sult is a pseudo-science. Rejection of science, is equally precarious, for scientis- tical knowledge continually grows, super- naturalism has no secure foundation for religious belief, as all supernatural things that have taught, is neither the capacity nor the failure of man, but rather the nearness or the limits of his science—but fact.

Today political overlays make a wider understanding of science’s formation before the urgent and more difficult. "Religious propaganda," a recent dispatch in Irish Curteen is advised, must be coun- teracted by "scientific authentic propaganda" by local societies for "the dissemination of political and scienti- fic culture in the world.

The iconoclastic image of science has, however, another side, neither the pow- erable to an elementary misunderstanding of its functions. For example, the his- torian Arnold Toynbee charges science and technology with usurping the place of Christianity as the primary source of content of science with the technology of super- weapons. The missile is taking the role of the microscope as a symbol of modern science. All efforts to convince people that science itself can only give knowledge about himself and his environment, and occasionally a choice of action, and thus has been vanishing. The scientist as scien- tifician can take little credit or responsibility either for the facts he discovers—nor for the uses made of his discoveries, for his general is neither permitted nor specially fitted to make the decision of what should be done. 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 SCIENCE’S APOSTLES. The two last views held that man is inherently good toward, his new knowledge 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 has lacked sufficient and secure weapons; now he can immobilize his world.

Secondly, science cannot be considered for this new power, is here considered ethically neutral. But, like the scientist’s apostle, man can neither understand this tool nor control it. Unavoidably he will bring upon himself catastrophe, partly through his natural sinfulness and partly through his own power, of the knowledge is a manifestation. The fear in- spired by this image also motivates the represented demand for a continued pursuit of science. The most famous formu- lation was that of an American of Chapter at the meeting of the British Association for the Advancement of Science. We should all be better off, he contended, if every physical and chemical laboratory were closed ten years, as if he were directed there were turning them toward the establishment of the modern slide.

This suggestion is based on two mis- understandings. First, science is not an occupation that one can pursue or change at short notice, like working on an assem- bly line. The creative scientist does not have a free choice of action. He does not advance science, but science advances rather knowledge advances toward him and overpowers him. Even a superficial glance at the work of a Kepler, a Darwin or a Pasteur shows that the driving power of creation is as strong as the fire which seduced the scientist for the as artist.

Also, science cannot be considered for this reward for ignorance. To survive and progress, man cannot know too much about his environment. The real prize of knowledge is the obligation known ignorance imposes on us to assume responsibility for ourselves.

If in the future, technological, that science will help to compel us at last to curb the arrogant phrases from which past generations exonerated themselves. The science now has so sharpened the knife edges which civilization has so oblig- ated that the main antagonists join themselves recognize the enormity of the threat.

Not only have ever war the worlds on both sides openly expressed fear of war. If man is inherently evil, Judgment Day is surely near. But if good exists, one can be more optimistic. The alterna- tive are as extreme and so obvious as to allow hope that the instinct of self-preservation will reinforce good sense and moral strength. Mankind has come to its ex- perimentation crisis.

ECOLOGICAL DISASTER. A change in the average temperature of the earth or the salinity of an ocean may cause a large number of plants and animals to die. One calls this possibility "disaster." The fifth prevalent image of science is that science is the only way—nor man may be inherently evil, the rise of science happened, as if by accident, to initiate an ecological change that now corrodes the once conceivable basis for a stable society. In the words of theologian Jacques Martin, the "deadly disease" scientific technology is a 'goal of the total ethical truth and eternal values.'

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 center of creation. Absolute power showed our planetary system to be heliocentric, and man toppled from his throne. Science replaced pre- vision with blind evolution, and discovered that such absolutes as space, time and certainty are meaningless. All a priori axioms, like those of Euclidean geometry, were discovered one by one to be con- venient but arbitrary. Modern psychology and cosmology showed us the in- acceptance of cultural relativism. Truth it- self and indeterministic statements.

Worst of all, the argument concludes, though science cannot help us distinguish between good and evil, it nevertheless makes science the creator of the destiny of good. Drawing large upon analogy with the science the- liberal philosophers have become increas- ingly the educated, or the nonsense or the possibility of postulating immutable values, and so have under- mined the old foundations of moral and social authority. For through doubt and uncertain scientific investigation, society cannot thrive as a whole society is for the sake of its own sake.

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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 ecologi-
cal disaster can be subjected to a more
surface critique. Regardless of science’s
correlation of absolute values, those who have really given us a safe
anchor? A priori absolutes and standards
over the globe in completely contradic-
tory vicissitudes. Most of the humanistic
theory have been carried out under the
banner of some absolute philosophy, from
the Artex massacre to the auto
da de fe of the Spanish Inquisition, from
the massacre of the Hispanic to the N-2
gas chambers. It is at best an optical il-
lusion which makes the fourteenth cen-
tury look so sincere and desirable to mod-
ern critics of the recent, “scientific”
periods, just as the life of the “noble sav-
ages,” so esteemed by eighteenth-century
philosophers, has been used by what is
to be based largely on dense and mo-

If, therefore, some of the new phi-
losophies, inspired rightly or wrongly by
science, reject earlier bases of authority
as faulty—the founders of this nation did
—if they point out that “abundance” is a
change and contradict another, sci-
ence cannot be blamed. The faults were
there all the time.

In looking for a new and sooner basis
on which our world is to be
able, we shall find science indispensable. We can hope to
search and study, that the resources of society to the needs and potentials of
people only if we know more about
the inner workings of man. Already science has much to say that is valuable and im-
portant, but not necessarily so to
problems. One must not be obsessed with the
problem of man's inner
psychology, to dietetics, from immunology
to meteorology, from city planning to
agricultural research, by far the largest
part of our total scientific and technical effor-
to meet these needs, relationships, health and
comfort. There are areas in which the
need is absolutely unavoidable.

The new science requires a new kind
of scientist. The unorthodox, withdrawn
individual, on whom most great scientist
have always come up as the past, does not
fit well into the new system. We must keep a special place in our new
science, not only to symbolize our commit-
to science itself rather than to the
new machinery, Society, on the other hand, will have to hold on to the
satisfying urge of each scientist to adopt
the patterns of organization of society to the demands of society, as
justified by the quality of creative results
in a specialized profession and the
method. Many non-scientists would
be likely to suspect a hoax if it were
announced that the creative chemical
lighter than hydrogen had been syn-
den, or that a man had beamed
Russia in a secret race to establish
an international platform at the
of the sun. Apparently anything
can happen these days; science has no
inherent limitations. Thus, the
image depicts science as magic, the
scientist as a wizard, and the
scientist, we tend to either fear him or
to accept him as physically everything.

Like the other false images of science, this one is partly an educational problem. All our various conclusions of tech-
tical devices, all our talk about science, and all the more need to
make developments cannot hide that most of us are content to remain completely ignorant
of science. In a recent nationwide survey, nearly 40 per cent of those who had
attended college confessed they took not a
single course in physical or biological

Not long ago the typical scientist worked alone or with a few students and
and colleagues and built his own equipment with
“few, string and sealing wax.”

Today he usually belongs to a group
under a contract with a sizable
annual budget. In the research institute of
one university more than 1500 students
and technicians are grouped around a set
of multimillion-dollar machines; the
money comes from a Government
whose ultimate aim is national defense.

But change society existing scientific
university science, industry and the mili-
tary establishment to a great extent, the satis-
faction of all three. Science has
thereby become a large-scale operation with a potential for immediate and world-
wide effects. It is not frivolous to call
physics the liveliest political science
today. If for some reason all physicists in
the United States headed a call for a non
peace movement, nobody would be more
deply disturbed than would the Congress and
the State Department.

These are merely indications that we are passing through a revolutionary
change in the nature of science. The effec-
tive cause was the proliferation and dis-
semination of basic research by teams of specialists with widely
different training and interests. The result is a splendid increase in scientific know-
ledge, but the side effects are analogous
to those of sudden and rapid urbanization—
a strain on organization facilities, a
challenge to an administrative bureaucracy, the
depersonalization of some human rela-
tionships. To a large extent, therefore, the
science of the future will be that of the
modern man, not of the polymath
with the mechanism of scientific research
can change the individual scientist, who
needs a feeding. The non-scientist realizes that the old
can be understood, but have become obstacles. People can
understand their lives better than their feet and furniture;
are the simple interpretations of solids, per-
formance, reality; he flounders among
the four-dimensional continua, probably
unrealizable, undiscernable, the
understandings. About the basic concepts of the modern science that defines the
part of reality, he knows only that he

On the second level of ignorance, the
contemporary intellectual fails to under-
thed that the difference exists between one
university and another and in the
individuals as different scientists
of one cosmos. He has left behind those
great syntheses which once comprised our in-
adequate and moral reality—the cosmic
view of the book of Genesis, Homer, Dante, Milton, Goethe;
the scientist is more
in a maze without a
The brutal fact is that the laptop scien-
testers with even the elementary facts
of science, our intellects, for the
first time in history, are losing their
contact with the whole of
the cosmos. All the evils arising from the incompleteness of
ience and scientific knowledge, this
blemish on physics are terrifying.

Indeed, it is amazing to me that the
intellectuals have not attacked science, the
source of the apparent threats to their
sensibility—sensually, morally, or cognitively—true that the
association has not produced any
shaping of the personality. This, I am
considered, is likely to occur, for there is
mechanism at work in our
sense of dealing effectively with the
costs.

What remedies suggest themselves? At
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 be-
cause it is an important part of the whole
igaming piece of knowledge. This would
require an overhaul of the educational system: for example, a
part of the curriculum should be
be the rule in good colleges fifty years
ago. It would demand imaginative new
curricula, strengthened standards of
achievement, more recognition of excel-
lence—whether exhibited by instructors
or students. Adult education, including
the study of the cultural bases of scien-
cultural aspects of science through mass
media, is another obvious measure merit-
ing the support and participation of
our best minds.

Here and there, to some, efforts are
being made in the right direction, but the
total is pitifully small. Virtually no-
body has been courageous enough to face
the magnitude of the problem squarely, so
large is the range and amount of knowl-
edge needed before one can "know sci-
ence" 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 hu-
manistic study are still in touch with our
sensibilities. This, unhappily, is no longer
true in science.

Every great age has been shaped by in-
tellectuals such as Jefferson and Franklin, who would have been horrified by the
time of self-governed, women and men turn-
ing their inner selves. Science, however, has been broken. Few intellectuals are now
time to pass an examination, let alone
the field of our common culture—that is the
great challenge before intellectuals to
day. And nothing better illustrates the
urgency and difficulty of this task than the
false images prevailing about science.

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

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

HOLTON, GERALD, Editor Science and the Mind
Beacon Press $7.35

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

BRONOWSKI, JACOB The Common Sense of Science
Harvard University Press $2.00

BLANKARD, PAUL, Editor Education in the Age of Science
Basic Books $4.30