ADVENTURES OF THE MIND

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
imagination which underlies and sup-
plies some of the meta-
phorical phrases and ways of thinking
that form the basis of our ideology.

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 tenets and usages
of everyday life. Our language of ideas,
for example, owes a debt to the sciences
of statics and hydraulics and the model
of the machine that foresaw many of
their 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 power, feedback, invariance is com-
plementarily—enrich the general arsenal
of imaginative devices for the overall
thinking. In short, science has the
ability 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 first two, of representation
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, diverged from life and
beneficent action in the larger sense.

To some extent science was pushed in this direction because of a long-
terminating tendency of some philosophers to provide a panacea for the
problems which science could not solve at the time. Newton himself, who was deeply
interested in theology, wrote, "It is not to be
considered that mere mechanical causes
could be given to so many phenomena
in the cosmos. . . . This most beautiful
system of the suns cannot possibly be
maintained by a chance collision of
stars, half of them partially extinguished,
and the weight of the sun which are
flying faster.

In the current version, the souls of
sculptors, evil scientists is the mad researcher of science fiction, or
the nuclear destroyer—imperial and
powerful because they have his
management, develop, traitorous if he
refuses. Accord-
ingly, the mad
scientist is not
inherently negative. It causes the
arts to languish, it blights culture and, when
applied to human affairs, tends to regener-
tation and to the impoverishment of
life.

Finally, short, scientists are said to
be into eating the fruit of the tree of
knowledge—through their bodies.

The fear behind this attitude is genuine,
but not confined to science. It is also
directed against writers, artists, philo-
osophers, theologians, and even the
fact of science itself as it is foreshadowed
in our daily language. Science, equally precarious, for
scientific knowledge continually grows, super-
dimensions, and our confidence in it
should be a secure foundation for religious
belief, as it is for science. Nevertheless, there is neither the capacity nor the failure of man,
who is always near the limits of his
science but—faith.

Today political overtones make a wider
understanding of science's formation before it is urgent and more difficult. "Religious
propaganda," a recent dispatch in Iran
Curriculum adviser, ought to be
counteracted by "scientific authentic pro-
goal" societies for "the dissemination of political and scient-
ific knowledge," to quote Alain
Badiou. The iconicic image of science has,
according to Badiou, "defined, the need to
be an elementary misunderstanding of
its function. For example, the
historian Arnold Toynbee challenges the
and technology with usurping the place
of Christianity as the creative source of
change. Some orthodox theologians call
science the "self-estrangement" of man because it is the founding of the ultimate—which is religious—concerns
Well.

But this image fails to recognize the
millions of influences that have
affected—or a person. Neither to Christianity
or science can one properly assign more than a limited part in the interplay
between man's psychological and bi-
ological experience, the full". What are the
opportunities and accidents of his history
on the other. Moreover, to set science
against religion, to view them as competi-

ting paths, is to neglect the valuable possibilities of synthesis. As Alfred North
Whitehead wrote in Science and the
Future, "the two systems are not gen-
eral forces, apart from the mere
impulses of the various senses, which in-
fluence man. . . . On (their relationship) depends the future course of history."

In short, that "the force of our
religious intuitions, and the force of our
intellectual—thus deforming—is complementary rather than
conflicting. The way many scientists
and theologians state the issue today makes it
seem as if we must choose between two
trading, powerful forces. This is like
forcing a child to choose between his
favorite poems or his favorite

In the current version, the souls of
go to work for conducting for impurity and immoral, and the
same
case. Society always has to
deal with creativity, innovation and new
innovations. And this is where the work of
science must be appreciated in a particular way.

What is science knowledge? It remains a prime target of
suspicion.

Progress in basic scientific
knowledge, being confined to a minority
of the population, is, in the words of
Barbier. But the discoveries of
"pure" science now readily lend them-
selves to widespread exploitation through
technology. Applications spread swiftly
and widely. Thus we are in an inescapable
dilemma—irresistibly tempted to reach
the product of research, but at the same time, yet do not
be aware that our biological and psycholog-
ical knowledge is not the same as
cope with this ever-increasing appetite.

Probably the dilemma can no longer be
resolved, and this increased interest
and confusion concerning science. A cur-
rent theme is the problem of the future 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 also give knowledge
about himself and his environment, and
occasionally a choice of acting on un-
seen was unavailing. The scientist as scien-
tist can take little credit or responsibility
either for the effects he discovers—or for the uses made of
by his discoveries, for his generalist
is neither permitted nor specially fitted to make the moral good
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 apprentices. The
two last views held that man is inherently
good toward the new knowledge. An image based on the opposite assumption;
expresses the fear that man cannot be
trusted with scientific knowledge. He has
survived despite his wickedness only be-
cause he lacked sufficient power to
fire; he can now immaculate his world.

Secondly, scientists are not considered
a new power, is here considered essentially
neutral. But, like the scientist's apprentice,
man can neither understand this tool nor
control it. Unavoidably he will bring
upon himself extraneous, partly through
his natural selfishness and partly through
his power of creation. Of the pursuit
knowledge is a manifestation. The fear
inherited by this image also motivates the
response demands for a kind of control
over the pursuit of science. The most
formous formulism was that of the group of
Russe at a meeting of the British Association
for the Advancement of Science. We should
all be well off, he contended, if every
physical and chemical laboratory were
ajar out of ten years, and if a tax or
interest were being used to determine the

This suggestion is based on two
misunderstandings. First, science is not
an occupation that one can pursue or change at short notice, like working on an
assembly line. The creative scientist does not have a free choice of activity. He does not
advocate science because he
knows science
advances toward him and
overwhelms him. Even a superficial
motion of the world at a Kepler, a Darwin
or a Pasteur shows that the driving
power of science is too strong for
the scientist as for the artist.

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 knowledge impinges on the social
dependable and even glorified. Organized
warfare and genocide are praciced as old
as recorded history. Therefore, the choice of
is science now has-so sharpened the knife
effects which civilizations have had
achieved that the main antagonist itself
recognizes the enormous power. Never
before have even the wars orders
the two 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 so extreme and so obvious as
to allow hope that the instinct of self-pres-
ervation will reinforce good sense and moral
tyranny. Mankind has come to its ex-

erimentation crisis.

ECOLOGICAL DISASTER. A change in the
temperature of the earth or the salinity
of an ocean can cause a large
number of plants and animals to die. One calls this change "ecological disas-
ter." The fifth prevalent image of science is the "scientist's curse"—
or man may be inherently evil, the rise of
science happened, as if by accident, to
initiate an ecological change that now
encodes the only conceivable basis for a
stable society. In the words of theologian
Jacques Maritain, the "deadly disease"
sceince is "the sad disease" science. It has
become the fruit of the tree of eternal
eternity and actual truth.

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 center of creation. Absolute
science showed our planetary system to be
holocentric, and man toppled from his
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With the, the, one to be by
possibly not a variant but
likely an incomplete transcription.

ll. "The Shaping of the Modern Mind," For the
global public, Einstein was not merely
the tribus of our time; he was
the man who stood for reality; for the
notion that things locked different to
observers at different places at
different times; that the observer
of the seeker of truth, that a man
standing outside is a different
thing quite differently from a man moving
at another rate, that, in short, there is
no such thing as space, but only relative
traits. It is this precisely how the
general public understands science. A
"work of history," the study of science
physics did not find that everything is relative. On the contrary, relativity theory
reformulated the laws of physics so that
they would hold good for every observer,
no matter how one were to observe. Indeed,
not everything depends on one's point
of view; rather, the most valued truths are
wholly independent of the point of view.

Ignorance of science is also the only
effort for adopting rapid changes within
science as models for antirevolutionary atti-
dutes in change in military. The field of
thought is more conservative than sci-
ence, but it may hold the key to the
preserves knowledge. Science grows
Not long ago the typical scientist worked alone or with a few students and colleagues and built his own equipment with "low, string, stretching and scaling." 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 professors and technicians are grouped around a set of multimillion-dollar machines; the money comes from a Government whose ultimate aim is national defense. Many large-scale reorganizations of university science, industry and the military establishment have been made in an attempt to satisfy 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 needed a call for a moratorium, nobody would be more deeply 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 effective cause was the perfection and dissemi- nation 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 the organization facilities, an outgrowth of an administrative bureaucracy, the depersonalization of some human relations in the research institutions. To a large degree, where a continuing stream of new ideas is necessary the road to suicide have forgotten about this aspect of science. They do not believe, as I do, that man has been given his mind in order that he can think about what is what he is, and who he is.

Science and the last four images implied a revolution from science. We might de- scribe the next one as addition to science. Science divides all thought into two categories—up-to-date scientific knowledge and non-scientific knowledge. To a large degree, what we mentioned so far is theory. Among the social studies, for example, there are some voices of the seductive idea that the mathematical sciences offer the only permissible models for success- fully understanding of our society.

A far more significant symptom of science is the growing identification of scientific work with the economic. The huge sums spent annually on science and technology—about $10,000,000,000 this year in the United States—are channeled into science only 8 per cent is devoted to real basic research. 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 be- cause it is an important part of the whole jigsaw puzzle of knowledge. This would require almost, though not at every level of education—for example, a good part of the curriculum in high school—to 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 by students. Adult education, including the community colleges, will be increasingly an important channel of 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 be sure, some efforts are being made in the right direction, but the total is pitifully small. Virtually nobody has been courageous enough to face the magnitude of the problem squarely, for large is the range and amount of knowl- edge 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 hu- manistic study are still in touch with our sensibilities. This, unhap-pily, is no longer so in science.

Every great age has been shaped by in- tellectuals such as Jefferson and Franklin, who would have been horrified by the idea of cultivated men and women turning to science. The great age that has been broken. Few intellectuals are now prepared to act as role models. And meanwhile science advances faster and faster every day, widening the rift between science and culture.

To restore to some kind of re- cognition the intellectuals need to understand how different the future will be from the old age of men—to bring science into an orbit about as strange in 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:

- HOLT, GERALD Introduction to Concepts and Theories in Physical Science Addison-Wesley Publishing Company $7.50
- HOLT, GERALD, Editor Science in Our World—A Mind Beacon Press $5.00
- FRANKEL, CHARLES The Case for Modern Man Beacon Press $1.75
- BRONOWSKI, JACOB The Common Sense of Science Harvard University Press $2.00
- BLANSHARD, PAUL, Editor Education in the Age of Science Basic Books $4.50