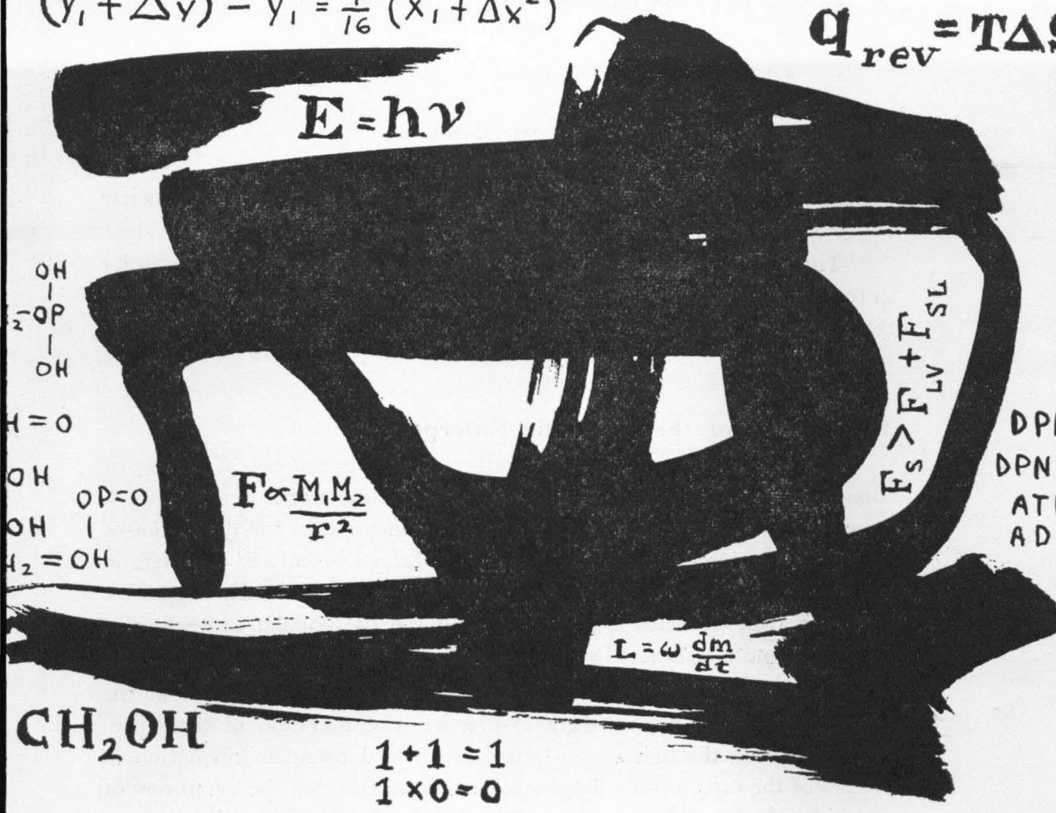

Science and Its Impact On Society

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"We live in an age of science"—so often expressed in so many variant forms, this has become a trite and empty platitude. It would be futile to attempt to build any worthwhile discussion on so fragile a foundation. But the expression can serve a useful purpose and give rise to fruitful debate—not in itself, but in its implications. Though we live in an age of science, how many men—scientists even—truly understand the nature of the scientific enterprise? If we live in a world of science, what place is left for more traditional world-outlooks and their associated intellectual and scholarly pursuits? What is the relation of science to the humanities, to the arts, or even to morals and religion? Finally, what is the practical effect on society of a scientific and technological world? Is it a force for good or ill?

These are some of the questions raised by a world of science. In order to cover so large a number of topics, they will be centered around the one theme that science is, in its essence, a pattern of thinking, a habit of the mind.

The Nature of the Scientific Enterprise

This fact—that science is basically a thinking process, a process of coming to *know* the world we live in—is one we sometimes tend to forget. However, it is a most important fact to keep in mind in any discussion of the true nature of science. Such a discussion cannot be entered into here in full, of course, but the main lines of the debate can be briefly suggested. The basic issue, it seems to me, is one between the popular contemporary positivism and a traditional realist interpretation of science.

The facts at issue in the discussion are the actual *procedures* of the various sciences, as we see them in practice. Consideration of these procedures has run through a crisis-phase since the Einsteinian revolution in physics of the early 1900's. In general, it can be said that the overthrow of a confident classical determinism reintroduced a healthy dose of skepticism into the interpretation of science.

The nature of scientific thinking can be summed up in terms of its method, the argumentation it uses, its concepts and results. The method, for the sake of brevity, can be reduced to the formulation of hypotheses to explain data, and experimentation to test the hypotheses. Though the variety of arguments useful within hypotheses is well nigh endless, the range includes deductive, probabilistic, functional or teleological, and genetic explanations.[1] Concepts used must be of the kind called "operational,"[2] and the results, in the usual interpretation, can be no more than theoretical laws of a high degree of probability.

This analysis can be presented in a purely positivistic way, from the openly nominalistic positivism of Pap,[3] through the currently popular ver-

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[1] Nagel: *The Structure of Science* (New York: Harcourt, Brace, and World, 1961), pp. 21-26.

[2] Holton and Roller: *Foundations of Modern Physical Science* (Reading, Mass.: Addison-Wesley, 1958), pp. 218-20.

[3] Pap: *An Introduction to the Philosophy of Science* (New York: Free Press of Glencoe, 1962).

sion of Nagel,[4] to more tempered versions in close contact with the actual sciences, such as those of Hanson[5] and Nash.[6] The analysis can also be interpreted in the light of traditional realism: in this case the view might be either that traditional natural philosophy remains valid independently of constant fluctuations in science,[7] or else that the conception of science as incapable of certitude is too restrictive.[8] In any case, it is obvious that science leaves serious questions for the philosophers to debate, *even within the matter proper to science itself.*

Statements are often made about the complementarity of science and the humanities,[9] but the mode of complementarity is seldom spelled out. What is more, it is often implied that the science-half of the complementarity alone gives genuine and objective knowledge. To the poet, science is not quite so clearly superior—or even so much more universally appreciated. To the realist philosopher viewing the matter from the standpoint of complementary patterns of thinking, the deprecation implied is even more objectionable.

In sum, there are at least three different approaches to the world of nature—the poetic, the philosophical, and the scientific—and any attempt to elevate one above the others, or to insist on one to the exclusion of the others, would seem to constitute a naive failure to appreciate the value of thinking patterns different from one's own.

The Impact of Science on Society

Do ideas have consequences? Can science, as a pattern of thinking, affect the world in which we live? Unquestionably, and we turn now to a consideration of the impact of science on society. This impact has been tremendous—how tremendous we will attempt to show by indicatng something of the full sweep of science's influence on our world. The areas chosen for this are: the influence of technology on society at large, the possible threat to culture of an exclusively scientific mentality, and the respective roles of science and the humanities in education. Obviously, under the circumstances, no substantive consideration can be given to specific

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[4] Nagel, *op. cit.*

[5] Hanson: *Patterns of Discovery* (Cambridge: The University Press, 1958).

[6] Nash: *The Nature of the Natural Sciences* (Boston: Little, Brown, 1963).

[7] Foley: Cosmology, *Philosophical and Scientific* (Milwaukee: Bruce, 1962).

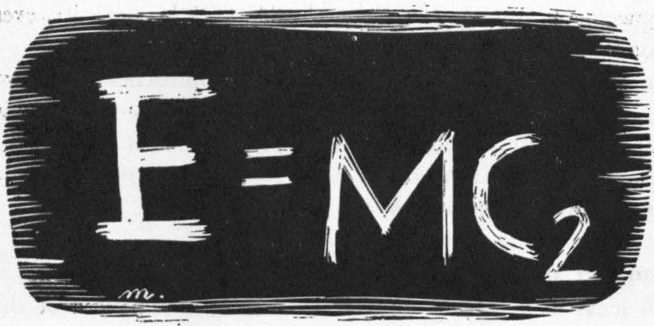
[8] Wallace: *Einstein, Galileo, and Aquinas* (Washington: Thomist Press, 1963).

[9] Holton and Roller, *op. cit.*, p. 215; Boas: "The Humanities and the Sciences," in Obler and Estrin (eds.): *The New Scientist* (Garden City, N. Y.: Doubleday Anchor, 1962), p. 184.

problems in each area, but the theme of patterns of thinking can continue to be a central point of focus in an effort to indicate the correct approach when substantive answers are sought.

Scientific thinking, as practiced, is predominantly a *quantitative* approach to the world of nature. This implies mechanical thinking, and the step to machines is an easy one—many of the great scientists have in fact been mechanically gifted and inventive. Technology is thus the natural offspring of science; it is also the most obvious area of science's influence on society.

One of the most striking features of our world, as contrasted with that of earlier generations, is its mobility and what is usually termed its "smallness"—the fact that men anywhere in the world can communicate with one another almost instantaneously and can exchange ideas almost as



they are developed. Ours is the world of the jet airliner and *Telstar* communications. Only a generation ago our parents' age was that of the automobile and the telephone, as our grandparents' was that of horse and buggy and slow mails. Developments in these areas come principally from two fields of science, electronics and petroleum chemistry—together with the engineering required to make application of science to production.

A *second* area in which our world is almost immeasurably different from that of our elders is that of synthetics, particularly plastics and chemical fibres. If we pause to think a moment, most of us will recognize that perhaps the greatest single factor in providing us with the conveniences we have in modern day America is the plastics industry. And of course these conveniences are finding wider and wider markets all over the world, including the underdeveloped nations. Where past ages have been referred to as the Bronze or Iron Ages, ours could well be called the Plastics Age.

And once again this is all an application of scientific discoveries, particularly in polymer chemistry.[10]

A *third* sphere of scientific influence is subtler still, involving something like a whole new outlook on the world. This is our modern evolutionary mentality, and its widespread currency is as new as our own generation. Furthermore, its influence is traceable almost directly to recent developments in scientific thinking. Our grandparents showed a definite hostility toward even the mention of evolution; our parents, if they were broad-minded, might have been at least tolerant. Today it is a rare thinking man whose total view of the temporal process is not explicitly evolutionary—it is in our blood, so to speak. How did this come about? And especially how did it happen so suddenly? Largely through recent developments in genetics that have converted Darwin's "natural selection" from an attractive hypothesis into a workable mechanism, with statistical computations to show that the world has been around long enough for natural selection to have produced what we see today.

Another important aspect of technology is its possible impact on the advancement of the underdeveloped nations. If the full scope of technology is brought to bear on the problem—technology in agriculture, in production, in distribution, in communications and above all in educaton—then, for perhaps the first time in history, there would seem to be the long-range possibility of improving the lot of nearly every underdeveloped people on our planet.[11]

What are the moral, social, and political effects of these science-technology contributions? This is a controversial question,[12] one aspect of which will be raised further on, in relation to the "two cultures" issue. Some believe that the only enduring effect of technology is likely to be the destruction of culture, the enslavement of men to machines. My own view is much less pessimistic; I think there is evidence already of an expanded *and even deepened* culture as a result of technology. In any case, judgment must be made on the basis of a valid criterion, and once again the notion of patterns of thinking must be brought in.

No question is ever solved unless the appropriate pattern of thinking

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[10] Garrett: *Penguin Science Survey,* 1963-A (Baltimore: Penguin pb, 1963), "Synthetic Fibres" and "Plastics in Perspective."

[11] *Scientific American,* Vol. 209, No. 3 (September, 1963), "Technology and Economic Development."

[12] Philipson (ed.): *Automation* (New York: Random House, Vintage pb, 1962), articles (for instance) by Goldberg, Diebold, Wienar, Drucker, Reuther, and Berfamini.

is brought to bear on it—this is almost too obvious to need stating. Yet it is a fact that most judgments on the goodness or badness of technology are based either on scientific thinking (which sees only advance) or aesthetic thinking (which sees only regression) when in fact the question is an ethical and social one. The only pattern of thinking appropriate to the question is the moral, aided by statistics.

A similar situation exists relative to nuclear power and nuclear warmaking potential. A recent book by two outstanding scientific editors details all the efforts of scientists since the development of the atomic and hydrogen bombs to bring their monster under human control.[13] Commendable as these efforts have been, and much as they indicate that it is a *human* answer that must be sought, the question may still be asked whether scientists who speak out on nuclear warfare are equipped in terms of the moral and political patterns of thinking that alone can answer a moral and political question. It may be that they are at least as well equipped as anyone else. But one sometimes wonders!

Apart from this, there can be no questioning the effect that science has had on mankind by way of the atomic and hydrogen bombs. These effects are deep, and both social and psychological. Many factors contribute to making ours the Age of Anxiety, but fear of an atomic holocaust must be ranked among the first.

Is "Scientific Thinking" a Threat to Culture?

Scientism can be defined as an attitude of mind that makes science the *only* genuinely worthwhile knowledge and considers science to be the salvation of the world, man's one hope for the future. If this is what we mean by "scientific thinking," there is no question: it constitutes a grave threat to culture, and even to civilization itself—obviously the bugaboo George Orwell has in mind in *1984*.

Does the term "scientific thinking" have any precise meaning apart from the scientfic method itself? The expression, I think, has at least four meanings: (1) the scientific method itself, in the creative scientist; (2) the habit of mind of the professional but non-creative scientist—teacher, student, or practitioner of technology; (3) the applications of the amateur scientist; and (4) the misapplications, the pseudo-science, of the man who presumes to speak for science without any grasp of its true spirit.

[13] Grodzins and Rabinowitch (ed.): *The Atomic Age* (New York: Basic Books, 1963); handy summary in a review by Cowan, *Science* (24 January, 1964), pp. 341-45.

Of the various kinds of "scientific thinking" I would mention first the scientific popularizer. With very little of the humility of the genuine scientist, such men presume to speak in the name of science, making all sorts of exaggerated claims, usually in a language of superlatives; this is pseudoscience and pseudo-scientific thinking, and I believe it also constitutes a threat to culture and humanity. Fortunately, there are today increasing numbers of genuine scientists in their own right who have taken it upon themselves to popularize science in a worthwhile way, showing up the other sort of popularization for what it is.[14]

The critical, "show-me-the-facts," attitude of many of our high school and college students today is also sometimes blamed on our scientific age. However, this is certainly not an entirely wrong-headed attitude in the first place, and I should think the best teachers (in any field of rational knowledge) would be precisely those who foster such an attitude.

Another, possibly even amusing, aspect of the influence of "scientific thinking" on our age has been suggested in a recent book by the New York drama critic, Walter Kerr.[15] This is the problem (if you view it that way) of the availability of scientific knowledge to modern children—an availability that is a threat, at the very least, to the unwary and non-knowledgeable parent.[16] Children today do have at their fingertips a fantastic store of scientific data, as anyone can tell you who has ever questioned a child's claim that an airliner has been developed which can carry over a hundred and fifty passengers, or that rocket boosters can now achieve over a million pounds of thrust. But any "threat" to culture here lies chiefly in the responsibility, or irresponsibility, of parents and teachers. For the child these are merely tremendously interesting facts, and all depends on what is made of them.

Kerr's book can also serve to introduce a more fundamental danger: that men today may become victims of a veritable pandemic of abstract thinking. He has in mind principally the concrete calculatons of trade and business, but he explicitly includes the scientific along with them.[17] Such thinking, he believes, threatens to crowd out entirely the traditional notion of intuitive contemplation, so essential to true humanist values. Others at least imply the same thing, in their fears of what the scientist, with his

[14] Three that come to mind immediately are George Gamow, Fred Hoyle, and Isaac Asimov.

[15] *The Decline of Pleasure* (New York: Simon and Schuster, 1962).

[16] *Ibid.*, pp. 17-24.

[17] *Ibid.*, pp. 111-12; 137-39.

habit of abstract and "objective" thought, will do to mankind if allowed to control his future.

This is perhaps the most real of all the threats science poses for the humanities. Kerr cites an instructive passage from Darwin's *Recollections* in which the great naturalist admits in a particularly striking way that his scientific studies had dulled to the point of bluntness his earlier appreciation of poetry and drama.[18] With ever increasing numbers of our young people getting involved in science today, it is at least *possible* that a similar result in them could simply crowd humanities out of their minds, and thus out of existence. Such a prospect brings us immediately to our final area of concern, science and education.

Science and Education—Point of the "Two Cultures" Controversy

The central concern of this discussion has been the notion of scientific (and other) patterns of thinking. If there is such a danger of abstract and scientific thinking crowding out the humanities in an individual mind, a similar possibility seems, to some, built into our highly specialized system of higher education, thus threatening the elimination of the only force capable of controlling science and technology in our modern world. Highlighting this danger has been a chief merit of the recent "two cultures" controversy. This was an encounter, which took place in England, between a scientific educator, C. P. Snow,[19] and a leading literary figure, F. R. Leavis[20]— and encounter which has become justly famous.

The basic encounter was not a direct confrontation, but separate lectures, both delivered at Cambridge University. With no intention of reviving the controversy, I give only what I take to be the essentials of the debate. On his side, Snow maintains that there exists a vast gulf, or lack of communication, between scientists and non-scientists (called the "traditional culture," perhaps unfortunately), and this demands a broadening, a de-specializing, of university training; Leavis, for his part, acidly castigates Snow for his lack of appreciation of true literary tradition and promotes his own brand of de-specialization.

Thus, the central focus of the controversy is on the educational question of how to eliminate excessive specialization. Leavis thinks this must come through a greater individual "awareness" (even about the aims of

18 *Ibid.*, p. 67.

19 *The Two Cultures* (Cambridge: Cambridge Univ., 1959).

20 Leavis and Yudkin: *Two Cultures?* (New York: Pantheon, 1963).

science. He thus promotes the upgrading of a renovated English department. Snow's view takes the opposite tack. For him the lack might also be said to lie chiefly within the English (and other humanities) departments, but it is a lack chiefly of literary men in their knowledge and appreciation of science, a lack which makes them incapable of working with scientists for that broadened approach to education which is necessary to meet the challenges of the scientific revolution.

In the printed version of Leavis' lecture a third party is brought into the debate—Michael Yudkin, a scientist on Leavis' side. He questions Snow's basic premise, that something can be done about excessive specialization, at least as it affects non-scientists: "But it can only be a one-way bridge. For the non-scientist an understanding of science rests not on the acquisition of scientific knowledge, but on scientific habits of thought and method.[21] But the paradox is, he thinks, that these cannot be acquired *except* by acquiring scientific knowledge.

I agree with Yudkin that specialization cannot be overcome. It is inevitable, and it is a good thing. In the future there will be no excuse for lack of competence, genuine competence, in any field of knowledge (particularly in science), and there is no way to such except through the best specialized training available. But does this mean we must reconcile ourselves to the education of one-sided, compartmentalized men? I do not think so, and I disagree with Yudkin in his belief that scientific method cannot be learned except by the acquisition of true scientific knowledge. Here I would appeal to Aristotle, in a quotation as remarkable for its pointedness as for its having been written two thousand years ago:

> Every systematic science, the humblest and the noblest alike, seems to admit of two distinct kinds of proficiency; one of which may be properly called scientific knowledge of the subject, while the other is a kind of educational acquaintance with it. For an educated man should be able to form a fair offhand judgment as to the goodness or badness of the method used by a professor in his exposition—to be educated is in fact to be able to do this. (Aristotle, *On the Parts of Animals,* I, 1: 639al.)

Education. According to Aristotle in this quote, education means specialization in at least one field, appreciation of the method of other

[21] *Ibid.*, p. 55.

fields. I would maintain that, if properly carried out, even *extreme specialization* in a scientific field *could* be so geared to methodology and patterns of thinking that, if accompanied by similar (though general) introductions to other patterns of thought, it would lead to what Aristotle has in mind—the "educated man." This is idealistic, I admit. I also admit that it would require extraordinary teachers in the non-specialized courses, to give a "feel" for other patterns of thinking. But even an idealistic plan is better than despair over none at all.

Conclusion

Science, then, has had a tremendous influence on all our lives. It has its dangers, but in general it is a force for good. To sum up, I would say science will remain beneficial as long as, and to the extent that, it is appreciated as primarily a way of *knowing* the world we live in. If this is not appreciated, if science becomes the slave of technology, and is thus closed off forever from considerations of pure thought and openness to speculation, then science could well destroy the world, rather than aid man in his perpetual quest for self-betterment.

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