

Robert K.
Merton

Edited and
with an Introduction by
Norman W. Storer

**The
Sociology
of
Science**
Theoretical and
Empirical
Investigations

By the Same Author

Science, Technology, and Society in Seventeenth-Century England

Mass Persuasion [with Marjorie Fiske and Alberta Curtis]

Social Theory and Social Structure

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On the Shoulders of Giants

On Theoretical Sociology

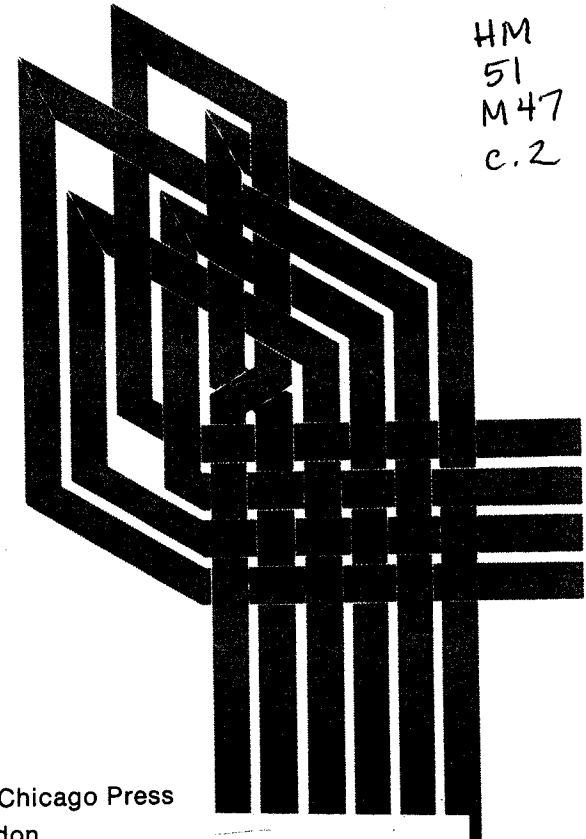
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[1973]

To my teachers

Pitirim A. Sorokin
Talcott Parsons
George Sarton
L. J. Henderson
A. N. Whitehead

who together formed
my interest in the
sociological study of
science

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Author's Preface

After a long gestation, the sociology of science has finally emerged as a distinct sociological specialty. Having evolved a cognitive identity in the form of intellectual orientations, paradigms, problematics and tools of inquiry, it has begun to develop a professional identity as well, in the form of institutionalized arrangements for research and training, journals given over to the subject in part or whole, and invisible colleges of specialists engaged in mutually related inquiry and not infrequent controversy. In these as in its other aspects, the sociology of science exhibits a strongly self-exemplifying character: its own behavior as a discipline exemplifies current ideas and findings about the emergence of scientific specialties.

In the light of this development, there is now more point than before in taking up the suggestion of Michael Aronson of the University of Chicago Press to bring together some of my papers in the sociology of science which are presently scattered in various journals, symposia, and other books. Still, like Alfred Schutz facing a similar decision, I must recognize that few of us can bring to our own work the distance and hopefully exacting judgment of an informed editor. I am therefore indebted to Professor Norman W. Storer for agreeing to select and arrange the papers, to provide the general introduction and prefatory notes, and to eliminate repetition except when, in his opinion, it provides redundancy useful for highlighting continuities of theme and idea. Having contributed to the field for more than a decade, Professor Storer is thoroughly at home in it and able to put these perspectives on the sociological study of science into historical and intellectual context.

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Science and the Social Order

1938

About the turn of the century, Max Weber observed that "the belief in the value of scientific truth is not derived from nature but is a product of definite cultures."¹ We may now add: and this belief is readily transmuted into doubt or disbelief. The persistent development of science occurs only in societies of a certain order, subject to a peculiar complex of tacit presuppositions and institutional constraints. What is for us a normal phenomenon which demands no explanation and secures many self-evident cultural values, has been in other times and still is in many places abnormal and infrequent. The continuity of science requires the active participation of interested and capable persons in scientific pursuits. But this support of science is assured only by appropriate cultural conditions. It is, then, important to examine the controls that motivate scientific careers, that select and give prestige to certain scientific disciplines and reject or blur others. It will become evident that changes in institutional structure may curtail, modify, or possibly prevent the pursuit of science.²

Sources of Hostility toward Science

Hostility toward science may arise under at least two sets of conditions, although the concrete systems of values—humanitarian, economic, politi-

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1. Max Weber, *Gesammelte Aufsätze zur Wissenschaftslehre* (Tübingen: J. C. B. Mohr, 1922), p. 213; cf. Pitirim A. Sorokin, *Social and Cultural Dynamics*, 4 vols. (New York: American Book Company, 1937), esp. vol. 2, chap. 2.

2. Cf. Robert K. Merton, *Science, Technology and Society in Seventeenth-Century England*, chap. 11.

cal, religious—upon which it is based may vary considerably. The first involves the logical, though not necessarily empirically sound, conclusion that the results or methods of science are inimical to the satisfaction of important values. The second consists largely of nonlogical elements. It rests upon the feeling of incompatibility between the sentiments embodied in the scientific ethos and those found in other institutions. Whenever this feeling is challenged, it is rationalized. Both sets of conditions underlie, in varying degrees, current revolts against science. It might be added that such logical and affective responses are also involved in the social approval of science. But in these instances science is thought to facilitate the achievement of approved ends and basic cultural values are felt to be congruent with those of science rather than emotionally inconsistent with them. The position of science in the modern world may be analyzed, then, as a resultant of two sets of conflicting forces, approving and opposing science as a large-scale social activity.

We restrict our examination to a few conspicuous instances of hostile reevaluation of the social role of science, without implying that the anti-science movement is in any sense thus localized. Much of what is said here can probably be applied to the cases of other times and places.³

The situation in Nazi Germany since 1933 illustrates the ways in which logical and nonlogical processes converge to modify or curtail scientific activity. In part, the hampering of science is an unintended by-product of changes in political structure and nationalistic credo. In accordance with the dogma of race purity, practically all persons who do not meet the politically imposed criteria of "Aryan" ancestry and of avowed sympathy with Nazi aims have been eliminated from universities and scientific institutes.⁴ Since these outcasts include a considerable number of eminent scientists, one indirect consequence of the racialist purge is the weakening of science in Germany.

Implicit in this racialism is a belief in race defilement through actual or symbolic contact.⁵ Scientific research by those of unimpeachable "Aryan" ancestry who collaborate with non-Aryans or who even accept their scientific theories is either restricted or proscribed. A new racial-political category has been introduced to include these incorrigible scientists who were once declared to be *echt-arisich*: the category of "White Jews." A

3. The premature death of E. Y. Hartshorne halted a proposed study of science in the modern world in terms of the analysis introduced in this chapter.

4. See chap. 3 of E. Y. Hartshorne, *The German Universities and National Socialism* (Cambridge, Mass.: Harvard University Press, 1937), on the purge of the universities; cf. *Volk und Werden* 5 (1937): 320–21, which refers to some of the new requirements for the doctorate.

5. This is one of the many phases of the introduction of a caste system in Germany. As R. M. MacIver has observed, "The idea of defilement is common in every caste system" (*Society* [New York: Farrar & Rinehart, 1937], p. 172).

prominent member of this new race is the Nobel Prize physicist, Werner Heisenberg, who has persisted in his declaration that Einstein's theory of relativity constitutes an "obvious basis for further research."⁶

In these instances, the sentiments of national and racial purity have prevailed over utilitarian rationality. The application of such criteria has led to a greater proportionate loss to the natural science and medical faculties in German universities than to the theological and juristic faculties, as E. Y. Hartshorne has found.⁷ In contrast, utilitarian considerations are foremost when it comes to official policies concerning the directions to be followed by scientific research. Scientific work which promises direct practical benefit to the Nazi party or the Third Reich is to be fostered above all, and research funds are to be reallocated in accordance with this policy.⁸ The rector of Heidelberg University announces that "the question of the scientific significance [*Wissenschaftlichkeit*] of any knowledge is of quite secondary importance when compared with the question of its utility."⁹

The general tone of anti-intellectualism, with its depreciation of the theorist and its glorification of the man of action,¹⁰ may have long-run

6. Cf. the official organ of the SS, the *Schwarze Korps*, 15 July 1937, p. 2. In this issue Johannes Stark, the president of the Physikalisch-Technischen Reichsanstalt, urges elimination of such collaborations which still continue and protests the appointment of three university professors who have been "disciples" of non-Aryans. See also Hartshorne, *The German Universities*, pp. 112-13; Alfred Rosenberg, *Wesen, Grundsätze und Ziele der Nationalsozialistischen Deutschen Arbeiterpartei* (Munich: E. Boepple, 1933), p. 45 ff.; J. Stark, "Philipp Lenard als deutscher Naturforscher," *Nationalsozialistische Monatshefte* 71 (1936): 106-11, where Heisenberg, Schrödinger, von Laue, and Planck are castigated for not having divorced themselves from the "Jewish physics" of Einstein. See also chapter 5 of this volume.

7. The data upon which this statement is based are from an unpublished study by E. Y. Hartshorne.

8. Cf. *Wissenschaft und Vierjahresplan*, Reden anlässlich der Kundgebung des NSD-Dozentenbundes, 18 January 1937; Hartshorne, *The German Universities*, p. 110 ff.; E. R. Jaensch, *Zur Neugestaltung des deutschen Studententums und der Hochschule* (Leipzig: J. A. Bart, 1937), esp. p. 57 ff. In the field of history, for example, Walter Frank, the director of the Reichsinstitut für Geschichte des neuen Deutschlands, "the first German scientific organization which has been created by the spirit of the national-socialistic revolution," testifies that he is the last person to forgo sympathy for the study of ancient history, "even that of foreign peoples," but also points out that the funds previously granted the Archaeological Institute must be reallocated to this new historical body which will "have the honor of writing the history of the National Socialist Revolution." See his *Zukunft und Nation* (Hamburg: Hanseatische Verlagsanstalt, 1935), esp. pp. 30 ff.

9. Ernst Krieck, *Nationalpolitische Erziehung* (Leipzig: Armanen Verlag, 1935), p. 8.

10. The Nazi theoretician, Alfred Baeumler, writes: "Wenn ein Student heute es ablehnt, sich der politischen Norm zu unterstellen, es z. B. ablehnt, an einem Arbeits- oder Wehrsportlager teilzunehmen, weil er damit Zeit für sein Studium versäume, dann zeigt er damit, dass er nichts von dem begriffen hat, was um ihn geschieht. Seine Zeit kann er nur bei einem abstrakten, richtungslosen Studium versäumen" (*Männerbund und Wissenschaft* [Berlin: Junker & Dünnhaupt, 1934], p. 153).

rather than immediate bearing upon the place of science in Germany. For should these attitudes become fixed, the most gifted elements of the population may be expected to shun those intellectual disciplines which have become disreputable. By the late thirties, effects of this anti-theoretical attitude could be detected in the allocation of academic interests in the German universities.¹¹

It would be misleading to suggest that the Nazi government has completely repudiated science and intellect. The official attitudes toward science are clearly ambivalent and unstable. (For this reason, any statements concerning science in Nazi Germany are made under correction.) On the one hand, the challenging skepticism of science interferes with the imposition of a new set of values which demand an unquestioning acquiescence. But the new dictatorships must recognize, as did Hobbes who also argued that the State must be all or nothing, that science is power. For military, economic, and political reasons, theoretical science—to say nothing of its more respectable sibling, technology—cannot be safely discarded. Experience has shown that the most esoteric researches have found important applications. Unless utility and rationality are dismissed beyond recall, it cannot be forgotten that Clerk Maxwell's speculations on the ether led Hertz to the discovery that culminated in the wireless. And indeed one Nazi spokesman remarks: "As the practice of today rests on the science of yesterday, so is the research of today the practice of tomorrow."¹² Emphasis on utility requires an unbanishable minimum of interest in science which can be enlisted in the service of the State and industry.¹³ At the same time, this emphasis leads to a limitation of research in pure science.

Social Pressures on Autonomy of Science

An analysis of the role of science in the Nazi state uncovers the following elements and processes. The spread of domination by one segment of the social structure—the State—involves a demand for primary loyalty to it. Scientists, as well as all others, are called upon to relinquish adherence to

11. Hartshorne, *The German Universities*, p. 106 ff.; cf. *Wissenschaft und Vierjahresplan*, pp. 25-26, where it is stated that the present "breathing-spell in scientific productivity" is partly due to the fact that a considerable number of those who might have received scientific training have been recruited by the army. Although this is a dubious explanation of that particular situation, a prolonged deflection of interest from theoretical science will probably produce a decline in scientific achievements.

12. Professor Thiessen in *Wissenschaft und Vierjahresplan*, p. 12.

13. For example, chemistry is highly prized because of its practical importance. As Hitler put it, "we will carry on because we have the fanatic will to help ourselves and because in Germany we have the chemists and inventors who will fulfil our needs." Quoted in *Wissenschaft und Vierjahresplan*, p. 6, and passim.

all institutional norms that, in the opinion of political authorities, conflict with those of the State.¹⁴ The norms of the scientific ethos must be sacrificed, insofar as they demand a repudiation of the politically imposed criteria of scientific validity or of scientific worth. The expansion of political control thus introduces conflicting loyalties. In this respect, the reactions of devout Catholics who resist the efforts of the political authority to redefine the social structure, to encroach upon the preserves which are traditionally those of religion, are of the same order as the resistance of the scientist. From the sociological point of view, the place of science in the totalitarian world is largely the same as that of all other institutions except the newly dominant State. The basic change consists in placing science in a new social context where it appears to compete at times with loyalty to the state. Thus, cooperation with non-Aryans is redefined as a symbol of political disloyalty. In a liberal order, the limitation of science does not arise in this fashion. For in such structures, a substantial sphere of autonomy—varying in extent, to be sure—is enjoyed by nonpolitical institutions.

The conflict between the totalitarian state and the scientist derives in part, then, from an incompatibility between the ethic of science and the new political code which is imposed upon all, irrespective of occupational creed. The ethos of science¹⁵ involves the functionally necessary demand that theories or generalizations be evaluated in terms of their logical consistency and consonance with facts. The political ethic would introduce the hitherto irrelevant criteria of the race or political creed of the theorist.¹⁶

14. This is clearly put by Reichswissenschaftsminister Bernhard Rust, *Das Nationalsozialistische Deutschland und die Wissenschaft* (Hamburg: Hanseatische Verlagsanstalt, 1936), pp. 1–22, esp. p. 21.

15. The ethos of science refers to an emotionally toned complex of rules, prescriptions, mores, beliefs, values, and presuppositions which are held to be binding upon the scientist. Some phases of this complex may be methodologically desirable, but observance of the rules is not dictated solely by methodological considerations. This ethos, as social codes generally, is sustained by the sentiments of those to whom it applies. Transgression is curbed by internalized prohibitions and by disapproving emotional reactions which are mobilized by the supporters of the ethos. Once given an effective ethos of this type, resentment, scorn, and other attitudes of antipathy operate almost automatically to stabilize the existing structure. This may be seen in the current resistance of some scientists in Germany to marked modifications in the content of this ethos. The ethos may be thought of as the “cultural” as distinct from the “civilizational” component of science. Cf. R. K. Merton, “Civilization and Culture,” *Sociology and Social Research* 21 (1936): 103–13.

16. Cf. Baeumler, *Männerbund und Wissenschaft*, p. 145. Also Kriek, *Nationalpolitische Erziehung*, who states: “Nicht alles, was den Anspruch auf Wissenschaftlichkeit erheben darf, liegt auf der gleichen Rang- und Wertebene; protestantische und katholische, französische und deutsche, germanische and jüdische, humanistische oder rassische Wissenschaft sind zunächst nur Möglichkeiten, noch nicht erfüllte oder gar gleichrangige Werte. Die Entscheidung über den Wert der Wissenschaft fällt aus ihrer ‘Gegenwärtigkeit,’ aus dem Grad ihrer Fruchtbarkeit, ihrer geschichtsbildenden Kraft.”

Modern science has considered the personal equation as a potential source of error and has evolved impersonal criteria for checking such error. It is now called upon to assert that certain scientists, because of their extra-scientific affiliations, are a priori incapable of anything but spurious and false theories. In some instances, scientists are required to accept the judgments of scientifically incompetent political leaders concerning *matters of science*. But such politically advisable tactics run counter to the institutionalized norms of science. These, however, are dismissed by the totalitarian state as “liberalistic” or “cosmopolitan” or “bourgeois” prejudices,¹⁷ inasmuch as they cannot be readily integrated with the campaign for an unquestioned political creed.

From a broader perspective, the conflict is a phase of institutional dynamics. Science, which has acquired a considerable degree of autonomy and has evolved an institutional complex that engages the allegiance of scientists, now has both its traditional autonomy and its rules of the game—its ethos, in short—challenged by an external authority. The sentiments embodied in the ethos of science—characterized by such terms as intellectual honesty, integrity, organized skepticism, disinterestedness, impersonality—are outraged by the set of new sentiments that the State would impose in the sphere of scientific research. With a shift from the previous structure where limited loci of power are vested in the several fields of human activity to a structure where there is one centralized locus of authority over all phases of behavior, the representatives of each sphere act to resist such changes and to preserve the original structure of pluralistic authority. Although it is customary to think of the scientist as a dispassionate, impersonal individual, it must be remembered that the scientist, in company with all other professional workers, has a large emotional investment in his way of life, defined by the institutional norms which govern his activity. In terms of that ethos, the social stability of science can be ensured only if adequate defenses are set up against changes imposed from outside the scientific fraternity itself.

This process of preserving institutional integrity and resisting new definitions of social structure which may interfere with the autonomy of science finds expression in yet another direction. It is a basic assumption of modern science that scientific propositions “are invariant with respect to the individual” and group.¹⁸ But in a completely politicized society—where as

17. Thus, says Ernst Kriek: “In the future, one will no more adopt the fiction of an enfeebled neutrality in science than in law, economy, the State or public life generally. The method of science is indeed only a reflection of the method of government” (*Nationalpolitische Erziehung*, p. 6). Cf. Baeumler, *Männerbund und Wissenschaft*, p. 152; Walter Frank, *Zukunft und Nation*, p. 10; and contrast with Max Weber’s “prejudice” that “Politik gehört nicht in den Hörsaal.”

18. H. Levy, *The Universe of Science* (New York: Century Co., 1933), p. 189.

one Nazi theorist put it, "the universal meaning of the political is recognized"¹⁹—this assumption is impugned. Scientific findings are held to be merely the expression of race or class or nation.²⁰ As such doctrines percolate to the laity, they invite a general distrust of science and a depreciation of the prestige of the scientist, whose discoveries appear arbitrary and fickle. This variety of anti-intellectualism which threatens his social position is characteristically enough resisted by the scientist. On the ideological front as well, totalitarianism entails a conflict with the traditional assumptions of modern Western science.

Functions of Norms of Pure Science

One sentiment which is assimilated by the scientist from the very outset of his training pertains to the purity of science. Science must not suffer itself to become the handmaiden of theology or economy or state. The function of this sentiment is to preserve the autonomy of science. For if such extrascientific criteria of the value of science as presumable consonance with religious doctrines or economic utility or political appropriateness are adopted, science becomes acceptable only insofar as it meets these criteria. In other words, as the pure science sentiment is eliminated, science becomes subject to the direct control of other institutional agencies and its place in society becomes increasingly uncertain. The persistent repudiation by scientists of the application of utilitarian norms to their work has as its chief function the avoidance of this danger, which is particularly marked at the present time. A tacit recognition of this function may be the source of that possibly apocryphal toast at a dinner for scientists in Cambridge: To pure mathematics, and may it never be of any use to anybody!

The exaltation of pure science is thus seen to be a defense against the invasion of norms that limit directions of potential advance and threaten the stability and continuance of scientific research as a valued social activity. Of course, the technological criterion of scientific achievement also has a social function for science. The increasing comforts and conveniences deriving from technology and ultimately from science invite the social support of scientific research. They also testify to the integrity of the scien-

tist, since abstract and difficult theories which cannot be understood or evaluated by the laity are presumably proved in a fashion which can be understood by all, that is, through their technological applications. Readiness to accept the authority of science rests, to a considerable extent, upon its daily demonstration of power. Were it not for such indirect demonstrations, the continued social support of that science which is intellectually incomprehensible to the public would hardly be nourished on faith alone.

At the same time, this stress upon the purity of science has had other consequences that threaten rather than preserve the social esteem of science. It is repeatedly urged that scientists should in their research ignore all considerations other than the advance of knowledge.²¹ Attention is to be focused exclusively on the scientific significance of their work with no concern for the practical uses to which it may be put or for its social repercussions generally. The customary justification of this tenet—which is partly rooted in circumstance²² and which, in any event, has definite social functions, as we have just seen—holds that failure to adhere to this injunction will encumber research by increasing the possibility of bias and error. But this *methodological* view overlooks the *social* results of such an attitude. The objective consequences of this attitude have furnished a further basis of revolt against science; an incipient revolt that is found in virtually every society where science has reached a high stage of development. Since the scientist does not or cannot control the direction in which his discoveries are applied, he becomes the subject of reproach and of more violent reactions insofar as these applications are disapproved by the agents of authority or by pressure groups. The antipathy toward the technological products is projected toward science itself. Thus, when newly discovered gases or explosives are applied as military instruments, chemistry as a whole is censured by those whose humanitarian sentiments are outraged. Science is held largely responsible for endowing those engines of human

19. Baeumler, *Männerbund und Wissenschaft*, p. 152.

20. It is of considerable interest that totalitarian theorists have adopted the radical relativistic doctrines of *Wissensoziologie* as a political expedient for discrediting "liberal" or "bourgeois" or "non-Aryan" science. An exit from this cul-de-sac is provided by positing an Archimedean point: the infallibility of *der Führer* and his *Volk*. Cf. General Hermann Goering, *Germany Reborn* (London: Matthews & Marrot, 1934), p. 79. Politically effective variations of the "relationism" of Karl Mannheim (for example, *Ideology and Utopia*) have been used for propagandistic purposes by such Nazi theorists as Walter Frank, Krieck, Rust, and Rosenberg.

21. For example, Pareto writes: "The quest for experimental uniformities is an end in itself." See a typical statement by George A. Lundberg. "It is not the business of a chemist who invents a high explosive to be influenced in his task by considerations as to whether his product will be used to blow up cathedrals or to build tunnels through the mountains. Nor is it the business of the social scientist in arriving at laws of group behavior to permit himself to be influenced by considerations of how his conclusions will coincide with existing notions, or what the effect of his findings on the social order will be" (*Trends in American Sociology*, ed. G. A. Lundberg, R. Bain, and N. Anderson [New York: Harper, 1929], pp. 404-5). Compare the remarks of Read Bain on the "Scientist as Citizen," *Social Forces* 11 (1933): 412-15.

22. A neurological justification of this view is to be found in E. D. Adrian's essay in *Factors Determining Human Behavior* (Cambridge, Mass.: Harvard Tercentenary Publications, 1937), p. 9. "For discriminative behavior . . . there must be some interest: yet if there is too much the behavior will cease to be discriminative. Under intense emotional stress the behavior tends to conform to one of several stereotyped patterns."

destruction which, it is said, may plunge our civilization into everlasting night and confusion. Or to take another prominent instance, the rapid development of science and related technology has led to an implicitly antisience movement by vested interests and by those whose sense of economic justice is offended. The eminent Sir Josiah Stamp and a host of less illustrious folk have proposed a moratorium on invention and discovery,²³ in order that man may have a breathing spell in which to adjust his social and economic structure to the constantly changing environment with which he is presented by the "embarrassing fecundity of technology." These proposals have received wide publicity in the press and have been urged with unslackened insistence before scientific bodies and governmental agencies.²⁴ The opposition comes particularly from those representatives of labor who fear the loss of investment in skills that become obsolete before the flood of new technologies. Although these proposals probably will not be translated into action within the immediate future, they constitute one possible nucleus about which a revolt against science in general may materialize. It is largely immaterial whether these opinions which make science ultimately responsible for undesirable situations are valid or not. W. I. Thomas's sociological theorem—"If men define situations as real, they are real in their consequences"—is much in point here.

23. Of course, this does not constitute a movement opposed to science as such. Moreover, the destruction of machinery by labor and the suppression of inventions by capital have also occurred in the past. Cf. R. K. Merton, "Fluctuations in the Rate of Industrial Inventions," *Quarterly Journal of Economics* 49 (1935): 464 ff. But this movement mobilizes the opinion that science is to be held strictly accountable for its social effects. Sir Josiah Stamp's suggestion may be found in his address to the British Association for the Advancement of Science, Aberdeen, 6 September 1934. Such moratoria have also been proposed by M. Caillaux (cf. John Strachey, *The Coming Struggle for Power* [New York, 1935], p. 183), by H. W. Summers in the U. S. House of Representatives, and by many others. In terms of current humanitarian, social, and economic criteria, some of the products of science are more pernicious than beneficial. This evaluation may destroy the rationale of scientific work. As one scientist pathetically put it: if the man of science must be apologetic for his work, I have wasted my life. Cf. *The Frustration of Science*, ed. F. Soddy (New York: Norton, 1935), p. 42, and passim.

24. English scientists have especially reacted against the "prostitution of scientific effort to war purposes." Presidential addresses at annual meetings of the British Association for the Advancement of Science and frequent editorials and letters in *Nature* attest to this movement for "a new awareness of social responsibility among the rising generation of scientific workers." Sir Frederick Gowland Hopkins, Sir John Orr, Professor F. Soddy, Sir Daniel Hall, Dr. Julian Huxley, J. B. S. Haldane, and Professor L. Hogben are among the leaders of the movement. See, for example, the letter signed by twenty-two scientists of Cambridge University urging a program for dissociating science from warfare (*Nature* 137 [1936]: 829). These attempts for concerted action by English scientists contrast sharply with the apathy of scientists in this country toward these questions. [This observation holds for the period prior to the development of atomic weapons.] The basis of this contrast might profitably be investigated.

In short, this basis for the revaluation of science derives from what I have called elsewhere the "imperious immediacy of interest."²⁵ Concern with the primary goal, the furtherance of knowledge, is coupled with a disregard of the consequences that lie outside the area of immediate interest, but these social results react so as to interfere with the original pursuits. Such behavior may be rational in the sense that it may be expected to lead to the satisfaction of the immediate interest. But it is irrational in the sense that it defeats other values which are not, at the moment, paramount but which are nonetheless an integral part of the social scale of values. Precisely because scientific research is not conducted in a social vacuum, its effects ramify into other spheres of value and interest. Insofar as these effects are deemed socially undesirable, science is charged with responsibility. The goods of science are no longer considered an unqualified blessing. Examined from this perspective, the tenet of pure science and disinterestedness has helped to prepare its own epitaph.

Battle lines are drawn in terms of the question: can a good tree bring forth evil fruit? Those who would cut down or stunt the tree of knowledge because of its accursed fruit are met with the claim that the evil fruit has been grafted on the good tree by the agents of state and economy. It may salve the conscience of the individual man of science to hold that an inadequate social structure has led to the perversion of his discoveries. But this will hardly satisfy an embittered opposition. Just as the *motives* of scientists may range from a passionate desire in the furtherance of knowledge to a profound interest in achieving personal fame and just as the *functions* of scientific research may vary from providing prestige-laden rationalizations of the existing order to enlarging our control of nature, so may other social *effects* of science be considered pernicious to society or result in the modification of the scientific ethos itself. There is a tendency for scientists to assume that the social effects of science *must* be beneficial in the long run. This article of faith performs the function of providing a rationale for scientific research, but it is manifestly not a statement of fact. It involves the confusion of truth and social utility which is characteristically found in the nonlogical penumbra of science.

Esoteric Science as Popular Mysticism

Another relevant phase of the connections between science and the social order has seldom been recognized. With the increasing complexity of scientific research, a long program of rigorous training is necessary to test or even to understand the new scientific findings. The modern scientist has

25. R. K. Merton, "The Unanticipated Consequences of Purposive Social Action," *American Sociological Review* 1 (1936): 894-904.

necessarily subscribed to a cult of unintelligibility. There results an increasing gap between the scientist and the laity. The layman must take on faith the publicized statements about relativity or quanta or other such esoteric subjects. This he has readily done inasmuch as he has been repeatedly assured that the technologic achievements from which he has presumably benefited ultimately derive from such research. Nonetheless, he retains a certain suspicion of these bizarre theories. Popularized and frequently garbled versions of the new science stress the theories that seem to run counter to common sense. To the public mind, science and esoteric terminology become indissolubly linked. The presumably scientific pronouncements of totalitarian spokesmen on race or economy or history are for the uninstructed laity of the same order as announcements concerning an expanding universe or wave mechanics. In both instances, the laity is in no position to understand these conceptions or to check their scientific validity and in both instances they may not be consistent with common sense. If anything, the myths of totalitarian theorists will seem more plausible and are certainly more comprehensible to the general public than accredited scientific theories, since they are closer to common-sense experience and cultural bias. Partly as a result of scientific advance, therefore, the population at large has become ripe for new mysticisms clothed in apparently scientific jargon. This promotes the success of propaganda generally. The borrowed authority of science becomes a powerful prestige symbol for unscientific doctrines.

Public Hostility toward Organized Skepticism

Another feature of the scientific attitude is organized skepticism, which becomes, often enough, iconoclasm.²⁶ Science may seem to challenge the "comfortable power assumptions" of other institutions,²⁷ simply by subjecting them to detached scrutiny. Organized skepticism involves a latent questioning of certain bases of established routine, authority, vested procedures, and the realm of the "sacred" generally. It is true that, *logically*, to establish the empirical genesis of beliefs and values is not to deny their validity, but this is often the psychological effect on the naïve mind. Institutionalized symbols and values demand attitudes of loyalty, adherence, and respect. Science, which asks questions of fact concerning every phase of nature and society, comes into psychological, not logical, conflict with

26. Frank H. Knight, "Economic Psychology and the Value Problem," *Quarterly Journal of Economics* 39 (1925): 372-409. The unsophisticated scientist, forgetting that skepticism is primarily a methodological canon, permits his skepticism to spill over into the area of value generally. The social functions of symbols are ignored and they are impugned as "untrue." Social utility and truth are once again confused.

27. Charles E. Merriam, *Political Power* (New York: Whittlesey House, 1934), pp. 82-83.

other attitudes toward these same data which have been crystallized and frequently ritualized by other institutions. Most institutions demand unqualified faith; but the institution of science makes skepticism a virtue. Every institution involves, in this sense, a sacred area that is resistant to profane examination in terms of scientific observation and logic. The institution of science itself involves emotional adherence to certain values. But whether it be the sacred sphere of political convictions or religious faith or economic rights, the scientific investigator does not conduct himself in the prescribed uncritical and ritualistic fashion. He does not preserve the cleavage between the sacred and the profane, between that which requires uncritical respect and that which can be objectively analyzed.²⁸

It is this which in part lies at the root of revolts against the so-called intrusion of science into other spheres. In the past, this resistance has come for the most part from the church which restrains the scientific examination of sanctified doctrines. Textual criticism of the Bible is still suspect. This resistance on the part of organized religion has become less significant as the locus of social power has shifted to economic and political institutions which in their turn evidence an undisguised antagonism toward that generalized skepticism which is felt to challenge the bases of institutional stability. This opposition may exist quite apart from the introduction of scientific discoveries that appear to invalidate particular dogmas of church, economy, and state. It is rather a diffuse, frequently vague, recognition that skepticism threatens the status quo. It must be emphasized again that there is no logical necessity for a conflict between skepticism within the sphere of science and the emotional adherences demanded by other institutions. But as a psychological derivative, this conflict invariably appears whenever science extends its research to new fields toward which there are institutionalized attitudes or whenever other institutions extend their area of control. In the totalitarian society, the centralization of institutional control is the major source of opposition to science; in other structures, the extension of scientific research is of greater importance. Dictatorship organizes, centralizes, and hence intensifies sources of revolt against science that in a liberal structure remain unorganized, diffuse, and often latent.

In a liberal society, integration derives primarily from the body of cultural norms toward which human activity is oriented. In a dictatorial structure, integration is effected primarily by formal organization and centralization of social control. Readiness to accept this control is instilled by speeding up the process of infusing the body politic with new cultural values, by substituting high-pressure propaganda for the slower process of the diffuse inculcation of social standards. The differences in the mecha-

28. For a general discussion of the sacred in these terms, see Emile Durkheim, *The Elementary Forms of the Religious Life*, pp. 37 ff.

nisms through which integration is typically effected permit a greater latitude for self-determination and autonomy to various institutions, including science, in the liberal than in the totalitarian structure. Through such rigorous organization, the dictatorial state so intensifies its control over nonpolitical institutions as to lead to a situation that is different in kind as well as degree. For example, reprisals against science can more easily find expression in the Nazi state than in America, where interests are not so organized as to enforce limitations upon science, when these are deemed necessary. Incompatible sentiments must be insulated from one another or integrated with each other if there is to be social stability. But such insulation becomes virtually impossible when there exists centralized control under the aegis of any one sector of social life which imposes, and attempts to enforce, the obligation of adherence to its values and sentiments as a condition of continued existence. In liberal structures the absence of such centralization permits the necessary degree of insulation by guaranteeing to each sphere restricted rights of autonomy and thus enables the gradual integration of temporarily inconsistent elements.

Conclusions

The main conclusions of this paper can be briefly summarized. There exists a latent and active hostility toward science in many societies, although the extent of this antagonism cannot yet be established. The prestige which science has acquired within the last three centuries is so great that actions curtailing its scope or repudiating it in part are usually coupled with affirmation of the undisturbed integrity of science or "the rebirth of true science." These verbal respects to the pro-science sentiment are frequently at variance with the behavior of those who pay them. In part, the anti-science movement derives from the conflict between the ethos of science and of other social institutions. A corollary of this proposition is that contemporary revolts against science are *formally* similar to previous revolts, although the *concrete* sources are different. Conflict arises when the social effects of applying scientific knowledge are deemed undesirable, when the scientist's skepticism is directed toward the basic values of other institutions, when the expansion of political or religious or economic authority limits the autonomy of the scientist, when anti-intellectualism questions the value and integrity of science and when nonscientific criteria of eligibility for scientific research are introduced.

This paper does not present a program for action in order to withstand threats to the development and autonomy of science. It may be suggested, however, that as long as the locus of social power resides in any one institution other than science and as long as scientists themselves are uncertain of their primary loyalty, their position becomes tenuous and uncertain.

13

The Normative Structure of Science

1942

Science, like any other activity involving social collaboration, is subject to shifting fortunes. Difficult as the notion may appear to those reared in a culture that grants science a prominent if not a commanding place in the scheme of things, it is evident that science is not immune from attack, restraint, and repression. Writing a little while ago, Veblen could observe that the faith of western culture in science was unbounded, unquestioned, unrivaled. The revolt from science which then appeared so improbable as to concern only the timid academician who would ponder all contingencies, however remote, has now been forced upon the attention of scientist and layman alike. Local contagions of anti-intellectualism threaten to become epidemic.

Science and Society

Incipient and actual attacks upon the integrity of science have led *scientists to recognize their dependence on particular types of social structure*. Manifestos and pronouncements by associations of scientists are devoted to the relations of science and society. An institution under attack must reexamine its foundations, restate its objectives, seek out its rationale. Crisis invites self-appraisal. Now that they have been confronted with challenges to their way of life, scientists have been jarred into a state of acute self-consciousness: consciousness of self as an integral element of society with corre-

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sponding obligations and interests.¹ A tower of ivory becomes untenable when its walls are under prolonged assault. After a long period of relative security, during which the pursuit and diffusion of knowledge had risen to a leading place if indeed not to the first rank in the scale of cultural values, scientists are compelled to vindicate the ways of science to man. Thus they have come full circle to the point of the reemergence of science in the modern world. Three centuries ago, when the institution of science could claim little independent warrant for social support, natural philosophers were likewise led to justify science as a means to the culturally validated ends of economic utility and the glorification of God. The pursuit of science was then no self-evident value. With the unending flow of achievement, however, the instrumental was transformed into the terminal, the means into the end. Thus fortified, the scientist came to regard himself as independent of society and to consider science as a self-validating enterprise which was in society but not of it. A frontal assault on the autonomy of science was required to convert this sanguine isolationism into realistic participation in the revolutionary conflict of cultures. The joining of the issue has led to a clarification and reaffirmation of the ethos of modern science.

Science is a deceptively inclusive word which refers to a variety of distinct though interrelated items. It is commonly used to denote (1) a set of characteristic methods by means of which knowledge is certified; (2) a stock of accumulated knowledge stemming from the application of these methods; (3) a set of cultural values and mores governing the activities termed scientific; or (4) any combination of the foregoing. We are here concerned in a preliminary fashion with the cultural structure of science, that is, with one limited aspect of science as an institution. Thus, we shall consider, not the methods of science, but the mores with which they are hedged about. To be sure, methodological canons are often both technical expedients and moral compulsives, but it is solely the latter which is our concern here. This is an essay in the sociology of science, not an excursion in methodology. Similarly, we shall not deal with the substantive findings of sciences (hypotheses, uniformities, laws), except as these are pertinent to standardized social sentiments toward science. This is not an adventure in polymathy.

The Ethos of Science

The ethos of science is that affectively toned complex of values and

1. Since this was written in 1942, it is evident that the explosion at Hiroshima has jarred many more scientists into an awareness of the social consequences of their work.

norms which is held to be binding on the man of science.² The norms are expressed in the form of prescriptions, proscriptions, preferences, and permissions. They are legitimized in terms of institutional values. These imperatives, transmitted by precept and example and reenforced by sanctions are in varying degrees internalized by the scientist, thus fashioning his scientific conscience or, if one prefers the latter-day phrase, his super-ego. Although the ethos of science has not been codified,³ it can be inferred from the moral consensus of scientists as expressed in use and wont, in countless writings on the scientific spirit and in moral indignation directed toward contraventions of the ethos.

An examination of the ethos of modern science is only a limited introduction to a larger problem: the comparative study of the institutional structure of science. Although detailed monographs assembling the needed comparative materials are few and scattered, they provide some basis for the provisional assumption that "science is afforded opportunity for development in a democratic order which is integrated with the ethos of science." This is not to say that the pursuit of science is confined to democracies.⁴ The most diverse social structures have provided some measure of support to science. We have only to remember that the Accademia del Cimento was sponsored by two Medicis; that Charles II claims historical attention for his grant of a charter to the Royal Society of London and his sponsorship of the Greenwich Observatory; that the Académie des Sciences was founded under the auspices of Louis XIV, on the advice of Colbert; that urged into acquiescence by Leibniz, Frederick I endowed the Berlin Academy, and that the St. Petersburg Academy of Sciences was instituted by Peter the Great (to refute the view that Russians are barbarians). But such historical facts do not imply a random association of science and social structure. There is the further question of the ratio of scientific achievement to scientific potentialities. Science develops in various social

2. On the concept of ethos, see William Graham Sumner, *Folkways* (Boston: Ginn, 1906), pp. 36 ff.; Hans Speier, "The Social Determination of Ideas," *Social Research* 5 (1938): 196 ff.; Max Scheler, *Schriften aus dem Nachlass* (Berlin, 1933), 1:225-62. Albert Bayet, in his book on the subject, soon abandons description and analysis for homily; see his *La morale de la science* (Paris, 1931).

3. As Bayet remarks: "Cette morale [de la science] n'a pas eu ses théoriciens, mais elle a eu ses artisans. Elle n'a pas exprimé son idéal, mais elle l'a servi: il est impliqué dans l'existence même de la science" (*La morale de la science*, p. 43).

4. Tocqueville went further: "The future will prove whether these passions [for science], at once so rare and so productive, come into being and into growth as easily in the midst of democratic as in aristocratic communities. For myself, I confess that I am slow to believe it" (*Democracy in America* [New York, 1898], 2: 51). See another reading of the evidence: "It is impossible to establish a simple causal relationship between democracy and science and to state that democratic society alone can furnish the soil suited for the development of science. It cannot be a mere coincidence, however, that science actually has flourished in democratic periods" (Henry E. Sigerist, "Science and Democracy," *Science and Society* 2 [1938]: 291).

structures, to be sure, but which provide an institutional context for the fullest measure of development?

The institutional goal of science is the extension of certified knowledge. The technical methods employed toward this end provide the relevant definition of knowledge: empirically confirmed and logically consistent statements of regularities (which are, in effect, predictions). The institutional imperatives (mores) derive from the goal and the methods. The entire structure of technical and moral norms implements the final objective. The technical norm of empirical evidence, adequate and reliable, is a prerequisite for sustained true prediction; the technical norm of logical consistency, a prerequisite for systematic and valid prediction. The mores of science possess a methodologic rationale but they are binding, not only because they are procedurally efficient, but because they are believed right and good. They are moral as well as technical prescriptions.

Four sets of institutional imperatives—universalism, communism, disinterestedness, organized skepticism—are taken to comprise the ethos of modern science.

Universalism

Universalism⁵ finds immediate expression in the canon that truth-claims, whatever their source, are to be subjected to *preestablished impersonal criteria*: consonant with observation and with previously confirmed knowledge. The acceptance or rejection of claims entering the lists of science is not to depend on the personal or social attributes of their protagonist; his race, nationality, religion, class, and personal qualities are as such irrelevant. Objectivity precludes particularism. The circumstance that scientifically verified formulations refer in that specific sense to objective sequences and correlations militates against all efforts to impose particularistic criteria of validity. The Haber process cannot be invalidated by a Nuremberg decree nor can an Anglophobe repeal the law of gravitation. The chauvinist may expunge the names of alien scientists from historical textbooks but their formulations remain indispensable to science and technology. However *echt-deutsch* or hundred-percent American the final increment, some aliens are accessories before the fact of every new scientific advance. The imperative of universalism is rooted deep in the impersonal character of science.

5. For a basic analysis of universalism in social relations, see Talcott Parsons, *The Social System* (New York: Free Press, 1951). For an expression of the belief that "science is wholly independent of national boundaries and races and creeds," see the resolution of the Council of the American Association for the Advancement of Science, *Science* 87 (1938): 10; also, "The Advancement of Science and Society: Proposed World Association," *Nature* 141 (1938): 169.

However, the institution of science is part of a larger social structure with which it is not always integrated. When the larger culture opposes universalism, the ethos of science is subjected to serious strain. Ethnocentrism is not compatible with universalism. Particularly in times of international conflict, when the dominant definition of the situation is such as to emphasize national loyalties, the man of science is subjected to the conflicting imperatives of scientific universalism and of ethnocentric particularism.⁶ The structure of the situation in which he finds himself determines the social role that is called into play. The man of science may be converted into a man of war—and act accordingly. Thus, in 1914 the manifesto of ninety-three German scientists and scholars—among them, Baeyer, Brentano, Ehrlich, Haber, Eduard Meyer, Ostwald, Planck, Schmoller, and Wassermann—unloosed a polemic in which German, French, and English men arrayed their political selves in the garb of scientists. Dispassionate scientists impugned "enemy" contributions, charging nationalistic bias, log-rolling, intellectual dishonesty, incompetence, and lack of creative capacity.⁷ Yet this very deviation from the norm of universalism actually presupposed the legitimacy of the norm. For nationalistic bias is opprobrious only if judged in terms of the standard of universalism; within another institutional context, it is redefined as a virtue, patriotism. Thus in the process of condemning their violation, the mores are reaffirmed.

6. This stands as written in 1942. By 1948, the political leaders of Soviet Russia strengthened their emphasis on Russian nationalism and began to insist on the "national" character of science. Thus, in an editorial, "Against the Bourgeois Ideology of Cosmopolitanism," *Voprosy filosofii*, no. 2 (1948), as translated in the *Current Digest of the Soviet Press* 1, no. 1 (1 February 1949): 9: "Only a cosmopolitan without a homeland, profoundly insensible to the actual fortunes of science, could deny with contemptuous indifference the existence of the many-hued national forms in which science lives and develops. In place of the actual history of science and the concrete paths of its development, the cosmopolitan substitutes fabricated concepts of a kind of supernational, classless science, deprived, as it were, of all the wealth of national coloration, deprived of the living brilliance and specific character of a people's creative work, and transformed into a sort of disembodied spirit . . . Marxism-Leninism shatters into bits the cosmopolitan fictions concerning supra-class, non-national, 'universal' science, and definitely proves that science, like all culture in modern society, is national in form and class in content." This view confuses two distinct issues: first, the cultural context in any given nation or society may predispose scientists to focus on certain problems, to be sensitive to some and not other problems on the frontiers of science. This has long since been observed. But this is basically different from the second issue: the criteria of validity of claims to scientific knowledge are not matters of national taste and culture. Sooner or later, competing claims to validity are settled by universalistic criteria.

7. For an instructive collection of such documents, see Gabriel Pettit and Maurice Leudet, *Les allemands et la science* (Paris, 1916). Félix de Dantec, for example, discovers that both Ehrlich and Weismann have perpetrated typical German frauds upon the world of science. ("Le bluff de la science allemande.") Pierre Duhem concludes that the "geometric spirit" of German science stifled the "spirit of finesse": *La science allemande* (Paris 1915). Hermann Kellermann, *Der Krieg der Geister* (Weimar, 1915) is a spirited counterpart. The conflict persisted into the postwar period; see Karl Kherkhof, *Der Krieg gegen die Deutsche Wissenschaft* (Halle, 1933).

Even under counter-pressure, scientists of all nationalities adhered to the universalistic standard in more direct terms. The international, impersonal, virtually anonymous character of science was reaffirmed.⁸ (Pasteur: "Le savant a une patrie, la science n'en a pas.") Denial of the norm was conceived as a breach of faith.

Universalism finds further expression in the demand that careers be open to talents. The rationale is provided by the institutional goal. To restrict scientific careers on grounds other than lack of competence is to prejudice the furtherance of knowledge. Free access to scientific pursuits is a functional imperative. Expediency and morality coincide. Hence the anomaly of a Charles II invoking the mores of science to reprove the Royal Society for their would-be exclusion of John Graunt, the political arithmetician, and his instructions that "if they found any more such tradesmen, they should be sure to admit them without further ado."

Here again the ethos of science may not be consistent with that of the larger society. Scientists may assimilate caste-standards and close their ranks to those of inferior status, irrespective of capacity or achievement. But this provokes an unstable situation. Elaborate ideologies are called forth to obscure the incompatibility of caste-mores and the institutional goal of science. Caste-inferiors must be shown to be inherently incapable of scientific work, or, at the very least, their contributions must be systematically devaluated. "It can be adduced from the history of science that the founders of research in physics, and the great discoverers from Galileo and Newton to the physical pioneers of our own time, were almost exclusively Aryans, predominantly of the Nordic race." The modifying phrase, "almost exclusively," is recognized as an insufficient basis for denying outcasts all claims to scientific achievement. Hence the ideology is rounded out by a conception of "good" and "bad" science: the realistic, pragmatic science of the Aryan is opposed to the dogmatic, formal science of the non-Aryan.⁹ Or, grounds for exclusion are sought in the extrascientific capacity of men of science as enemies of the state or church.¹⁰ Thus, the

8. See the profession of faith by Professor E. Gley (in Pettit and Leudet, *Les allemands et la science*, p. 181): "il ne peut y avoir une vérité allemande, anglaise, italienne ou japonaise pas plus qu'une française. Et parler de science allemande, anglaise ou française, c'est énoncer une proposition contradictoire à l'idée même de science." See also the affirmations of Grasset and Richet, *ibid*.

9. Johannes Stark, *Nature* 141 (1938): 772; "Philipp Lenard als deutscher Naturforscher," *Nationalsozialistische Monatshefte* 7 (1936): 106-12. This bears comparison with Duhem's contrast between "German" and "French" science.

10. "Wir haben sie [marxistischen Leugner] nicht entfernt als Vertreter der Wissenschaft, sondern als Parteigaenger einer politischen Lehre, die den Umsturz aller Ordnungen auf ihre Fahne geschrieben hatte. Und wir mussten hier um so entschlossener zugreifen, als ihnen die herrschende Ideologie einer wertfreien und voraussetzungslosen Wissenschaft ein willkommener Schutz fuer die Fortfuehrung ihrer Plaene zu sein schien. Nicht wir haben uns an der Wuerde der freien Wissenschaft vergangen. . ." Bernhard Rust, *Das nationalsozialistische Deutschland und die Wissenschaft* (Hamburg: Hanseatische Verlagsanstalt, 1936), p. 13.

exponents of a culture which abjures universalistic standards in general feel constrained to pay lip service to this value in the realm of science. Universalism is deviously affirmed in theory and suppressed in practice.

However inadequately it may be put into practice, the ethos of democracy includes universalism as a dominant guiding principle. Democratization is tantamount to the progressive elimination of restraints upon the exercise and development of socially valued capacities. Impersonal criteria of accomplishment and not fixation of status characterize the open democratic society. Insofar as such restraints do persist, they are viewed as obstacles in the path of full democratization. Thus, insofar as laissez-faire democracy permits the accumulation of differential advantages for certain segments of the population, differentials that are not bound up with demonstrated differences in capacity, the democratic process leads to increasing regulation by political authority. Under changing conditions, new technical forms of organization must be introduced to preserve and extend equality of opportunity. The political apparatus may be required to put democratic values into practice and to maintain universalistic standards.

"Communism"

"Communism," in the nontechnical and extended sense of common ownership of goods, is a second integral element of the scientific ethos. The substantive findings of science are a product of social collaboration and are assigned to the community. They constitute a common heritage in which the equity of the individual producer is severely limited. An eponymous law or theory does not enter into the exclusive possession of the discoverer and his heirs, nor do the mores bestow upon them special rights of use and disposition. Property rights in science are whittled down to a bare minimum by the rationale of the scientific ethic. The scientist's claim to "his" intellectual "property" is limited to that of recognition and esteem which, if the institution functions with a modicum of efficiency, is roughly commensurate with the significance of the increments brought to the common fund of knowledge. Eponymy—for example, the Copernican system, Boyle's law—is thus at once a mnemonic and a commemorative device.

Given such institutional emphasis upon recognition and esteem as the sole property right of the scientist in his discoveries, the concern with scientific priority becomes a "normal" response. Those controversies over priority which punctuate the history of modern science are generated by the institutional accent on originality.¹¹ There issues a competitive coopera-

11. Newton spoke from hard-won experience when he remarked that "[natural] philosophy is such an impertinently litigious Lady, that a man had as good be engaged in lawsuits, as have to do with her." Robert Hooke, a socially mobile individual whose rise in status rested solely on his scientific achievements, was notably "litigious."

tion. The products of competition are communized,¹² and esteem accrues to the producer. Nations take up claims to priority, and fresh entries into the commonwealth of science are tagged with the names of nationals: witness the controversy raging over the rival claims of Newton and Leibniz to the differential calculus. But all this does not challenge the status of scientific knowledge as common property.

The institutional conception of science as part of the public domain is linked with the imperative for communication of findings. Secrecy is the antithesis of this norm; full and open communication its enactment.¹³ The pressure for diffusion of results is reinforced by the institutional goal of advancing the boundaries of knowledge and by the incentive of recognition which is, of course, contingent upon publication. A scientist who does not communicate his important discoveries to the scientific fraternity—thus, a Henry Cavendish—becomes the target for ambivalent responses. He is esteemed for his talent and, perhaps, for his modesty. But, institutionally considered, his modesty is seriously misplaced, in view of the moral compulsive for sharing the wealth of science. Layman though he is, Aldous Huxley's comment on Cavendish is illuminating in this connection: "Our admiration of his genius is tempered by a certain disapproval; we feel that such a man is selfish and anti-social." The epithets are particularly instructive for they imply the violation of a definite institutional imperative. Even though it serves no ulterior motive, the suppression of scientific discovery is condemned.

The communal character of science is further reflected in the recognition by scientists of their dependence upon a cultural heritage to which they lay no differential claims. Newton's remark—"If I have seen farther it is

12. Marked by the commercialism of the wider society though it may be, a profession such as medicine accepts scientific knowledge as common property. See R. H. Shryock, "Freedom and Interference in Medicine," *The Annals* 200 (1938): 45. "The medical profession . . . has usually frowned upon patents taken out by medical men. . . . The regular profession has . . . maintained this stand against private monopolies ever since the advent of patent law in the seventeenth century." There arises an ambiguous situation in which the socialization of medical practice is rejected in circles where the socialization of knowledge goes unchallenged.

13. Cf. Bernal, who observes: "The growth of modern science coincided with a definite rejection of the ideal of secrecy." Bernal quotes a remarkable passage from Réaumur (*L'Art de convertir le forgé en acier*) in which the moral compulsion for publishing one's researches is explicitly related to other elements in the ethos of science. For example, "il y eût gens qui trouvèrent étrange que j'eusse publié des secrets, qui ne devoient pas être révélés . . . est-il bien sur que nos découvertes soient si fort à nous que le Public n'y ait pas droit, qu'elles ne lui appartiennent pas en quelque sorte? . . . resterait-il bien des circonstances, où nous soions absolument Maîtres de nos découvertes? . . . Nous nous devons premièrement à notre Patrie, mais nous nous devons aussi au rest du monde; ceux qui travaillent pour perfectionner les Sciences et les Arts, doivent même se regarder comme les citoyens du monde entier" (J. D. Bernal, *The Social Function of Science* [New York: Macmillan, 1939] pp. 150-51).

by standing on the shoulders of giants"—expresses at once a sense of indebtedness to the common heritage and a recognition of the essentially cooperative and selectively cumulative quality of scientific achievement.¹⁴ The humility of scientific genius is not simply culturally appropriate but results from the realization that scientific advance involves the collaboration of past and present generations. It was Carlyle, not Maxwell, who indulged in a mythopoeic conception of history.

The communism of the scientific ethos is incompatible with the definition of technology as "private property" in a capitalistic economy. Current writings on the "frustration of science" reflect this conflict. Patents proclaim exclusive rights of use and, often, nonuse. The suppression of invention denies the rationale of scientific production and diffusion, as may be seen from the court's decision in the case of *U.S. v. American Bell Telephone Co.*: "The inventor is one who has discovered something of value. It is his absolute property. He may withhold the knowledge of it from the public."¹⁵ Responses to this conflict-situation have varied. As a defensive measure, some scientists have come to patent their work to ensure its being made available for public use. Einstein, Millikan, Compton, Langmuir have taken out patents.¹⁶ Scientists have been urged to become promoters of new economic enterprises.¹⁷ Others seek to resolve the conflict by advocating socialism.¹⁸ These proposals—both those which demand economic returns for scientific discoveries and those which demand a change in the social system to let science get on with the job—reflect discrepancies in the conception of intellectual property.

Disinterestedness

Science, as is the case with the professions in general, includes disinterestedness as a basic institutional element. Disinterestedness is not to be equated with altruism nor interested action with egoism. Such equivalences

14. It is of some interest that Newton's aphorism is a standardized phrase which had found repeated expression from at least the twelfth century. It would appear that the dependence of discovery and invention on the existing cultural base had been noted some time before the formulations of modern sociologists. See *Isis* 24 (1935): 107-9; 25 (1938): 451-52.

15. 167 U. S. 224 (1897), cited by B. J. Stern, "Restraints upon the Utilization of Inventions," *The Annals* 200 (1938): 21. For an extended discussion, cf. Stern's further studies cited therein, also Walton Hamilton, *Patents and Free Enterprise*, Temporary National Economic Committee Monograph no. 31 (1941).

16. Hamilton, *Patents and Free Enterprise*, p. 154; J. Robin, *L'oeuvre scientifique: sa protection-juridique* (Paris, 1928).

17. Vannevar Bush, "Trends in Engineering Research," *Sigma Xi Quarterly* 22 (1934): 49.

18. Bernal, *The Social Function of Science*, pp. 155 ff.

confuse institutional and motivational levels of analysis.¹⁹ A passion for knowledge, idle curiosity, altruistic concern with the benefit to humanity, and a host of other special motives have been attributed to the scientist. The quest for distinctive motives appears to have been misdirected. It is rather a distinctive pattern of institutional control of a wide range of motives which characterizes the behavior of scientists. For once the institution enjoins disinterested activity, it is to the interest of scientists to conform on pain of sanctions and, insofar as the norm has been internalized, on pain of psychological conflict.

The virtual absence of fraud in the annals of science, which appears exceptional when compared with the record of other spheres of activity, has at times been attributed to the personal qualities of scientists. By implication, scientists are recruited from the ranks of those who exhibit an unusual degree of moral integrity. There is, in fact, no satisfactory evidence that such is the case; a more plausible explanation may be found in certain distinctive characteristics of science itself. Involving as it does the verifiability of results, scientific research is under the exacting scrutiny of fellow experts. Otherwise put—and doubtless the observation can be interpreted as *lese majesty*—the activities of scientists are subject to rigorous policing, to a degree perhaps unparalleled in any other field of activity. The demand for disinterestedness has a firm basis in the public and testable character of science and this circumstance, it may be supposed, has contributed to the integrity of men of science. There is competition in the realm of science, competition that is intensified by the emphasis on priority as a criterion of achievement, and under competitive conditions there may well be generated incentives for eclipsing rivals by illicit means. But such impulses can find scant opportunity for expression in the field of scientific research. Cultism, informal cliques, prolific but trivial publications—these and other techniques may be used for self-aggrandizement.²⁰ But, in general, spurious claims appear to be negligible and ineffective. The translation of the norm of disinterestedness into practice is effectively supported by the ultimate accountability of scientists to their compeers. The dictates of socialized sentiment and of expediency largely coincide, a situation conducive to institutional stability.

In this connection, the field of science differs somewhat from that of other professions. The scientist does not stand *vis-à-vis* a lay clientele in the same fashion as do the physician and lawyer, for example. The possi-

19. Talcott Parsons, "The Professions and Social Structure," *Social Forces* 17 (1939): 458–59; cf. George Sarton, *The History of Science and the New Humanism* (New York, 1931), p. 130 ff. The distinction between institutional compulsives and motives is a key, though largely implicit, conception of Marxist sociology.

20. See the account of Logan Wilson, *The Academic Man* (New York: Oxford University Press, 1941), p. 201 ff.

bility of exploiting the credulity, ignorance, and dependence of the layman is thus considerably reduced. Fraud, chicane, and irresponsible claims (quackery) are even less likely than among the "service" professions. To the extent that the scientist-layman relation does become paramount, there develop incentives for evading the mores of science. The abuse of expert authority and the creation of pseudo-sciences are called into play when the structure of control exercised by qualified compeers is rendered ineffectual.²¹

It is probable that the reputability of science and its lofty ethical status in the estimate of the layman is in no small measure due to technological achievements.²² Every new technology bears witness to the integrity of the scientist. Science realizes its claims. However, its authority can be and is appropriated for interested purposes, precisely because the laity is often in no position to distinguish spurious from genuine claims to such authority. The presumably scientific pronouncements of totalitarian spokesmen on race or economy or history are for the uninstructed laity of the same order as newspaper reports of an expanding universe or wave mechanics. In both instances, they cannot be checked by the man-in-the-street and in both instances, they may run counter to common sense. If anything, the myths will seem more plausible and are certainly more comprehensible to the general public than accredited scientific theories, since they are closer to common-sense experience and to cultural bias. Partly as a result of scientific achievements, therefore, the population at large becomes susceptible to new mysticisms expressed in apparently scientific terms. The borrowed authority of science bestows prestige on the unscientific doctrine.

Organized Skepticism

As we have seen in the preceding chapter, organized skepticism is variously interrelated with the other elements of the scientific ethos. It is both a methodological and an institutional mandate. The temporary suspension of judgment and the detached scrutiny of beliefs in terms of empirical and logical criteria have periodically involved science in conflict with other institutions. Science which asks questions of fact, including potentialities, concerning every aspect of nature and society may come into conflict with other attitudes toward these same data which have been crystallized and often ritualized by other institutions. The scientific investigator does not preserve the cleavage between the sacred and the profane, between that

21. Cf. R. A. Brady, *The Spirit and Structure of German Fascism* (New York: Viking, 1937), chap. 2; Martin Gardner, *In the Name of Science* (New York: Putnam's, 1953).

22. Francis Bacon set forth one of the early and most succinct statements of this popular pragmatism: "Now these two directions—the one active, the other contemplative—are one and the same thing; and what in operation is most useful, that in knowledge is most true" (*Novum Organum*, book 2, aphorism 4).

which requires uncritical respect and that which can be objectively analyzed.

As we have noted, this appears to be the source of revolts against the so-called intrusion of science into other spheres. Such resistance on the part of organized religion has become less significant as compared with that of economic and political groups. The opposition may exist quite apart from the introduction of specific scientific discoveries which appear to invalidate particular dogmas of church, economy, or state. It is rather a diffuse, frequently vague, apprehension that skepticism threatens the current distribution of power. Conflict becomes accentuated whenever science extends its research to new areas toward which there are institutionalized attitudes or whenever other institutions extend their control over science. In modern totalitarian society, anti-rationalism and the centralization of institutional control both serve to limit the scope provided for scientific activity.

The Reward System of Science

Part

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