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The Political Resources of American Science

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In the light of the traditional ethos of science, and particularly its emphasis on a complete separation between science and politics, a discussion of the political resources of science is bound to appear somewhat perverse, if not entirely heretical. Yet, while the idea of the separation of science and politics may still be consistent with feelings and wishes prevalent among scientists, it seems increasingly inadequate as a statement about reality. The tendency to confuse the question of what the social status of science *is* with what it *ought to be* continues to interfere with the development of a fruitful theoretical discourse about the social and political aspects of science.

Attempts to call attention to the links of science with its political environment have usually stimulated in scientists such associations as the Marxist approach to the sociology and history of science, which views scientific theories and institutions as the outgrowth of specific social and economic conditions. While some scientists have been attracted by this analysis, most have strongly rejected this type of approach, on the grounds that the description of science as derivative from its social context destroys its claim to be politically neutral and its right to be free from external control. It has suggested to them the dangers of censorship and political interference, and aggravated their fear of the consequences of linking science and politics. By the same token, scientists have tended to be much more sympathetic to those theories in the sociology and history of science which perceived scientists as obeying the inherent imperatives of scientific ideas and the logic of inquiry. The theory that scientists follow only the internal rules of science would seem to reinforce their effort to prevent the subordination of their work to standards extrinsic to science and to protect themselves from external political interference. Such autonomist social theories of science, as formulated by Polanyi, Hagstrom and Storer, provide, however, a more adequate description of the social reality of science as it was when science was still

The author, who has worked in Jerusalem since November 1970, recently completed his PhD in Government at Harvard, where this paper was written for presentation to the 136th meeting of the American Association for the Advancement of Science on 29 December 1969.

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a relatively small enterprise, largely insulated from the mainstream of economic needs and political forces. Even then, much like classical economic theories of the free market system, the autonomist model of science could never substantiate the existence of a perfectly self-regulatory and independent market system of scientific ideas. But the fact is that scientific, like economic, activity was sufficiently differentiated from other social and political activities to have rendered such a theoretical perspective quite fruitful.

Yet, in the light of the increasing interpenetration between science and politics in the years after the Second World War, an autonomist social theory of science has consistently failed to account for some of the most dramatic developments in the interrelations between science and society. By overlooking or dismissing the links between science and politics, such a theory was unable to explain the logic behind the growth and development of such bodies as the National Science Foundation (NSF), the President's Science Advisory Committee (PSAC), and the National Academy of Science Committee on Science and Public Policy (NAS–COSPUP); or the increasingly influential role of the growing group of scientist-statesmen such as Vannevar Bush, Killian, Kistiakowsky, Wiesner and Brooks. To overlook such developments on the grounds that the mixing of science and politics is undesirable is, of course, to accept the unscientific practice of rejecting a statement about reality, not because it is proven false, but because it does not correspond with one's wishes. It is equivalent for example, to the suggestion that economic theory should not have readapted its conceptual apparatus to account for economic behaviour in which the government plays a growing role, because such political interference conflicts with the true values of *laissez-faire* economy.

Without the fallacy of mistaking the insular ethos of science for a theory about the actual place of science in society, it becomes easier to recognize that contemporary American science is not a socially autonomous enterprise, nor is it insulated from politics. On the contrary, the unprecedented degree to which science in America is dependent upon external material and political support in order to exist has compelled American scientists to engage actively and continually in competition with other social groups for their share of public resources and political support. The new political condition of science has meant that the ability of science to grow and flourish depends no longer merely on the free and successful use of intellectual resources, but also on its adaptability to political action and its capacity to convert its unique resources into effective means of political influence.

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However, the ability of scientists to form a disciplined group for effective political action in the public arena has been seriously constrained by the internal division of the scientific community into a multiplicity of specialized scientific groups.[1] If modern science had had a grand theory which unified all its parts into a single conceptual scheme, it would have probably been easier for the scientific community to organize itself politically and to discipline its parts in the name of an agreed concept of scientific priorities. But even though in the past the unity of all the sciences was widely considered a real theoretical possibility, it has remained primarily an ideal or a theoretical postulate. There have, to be sure, always been agreed criteria for the evaluation of the relative merits of scientific theories, such as their scope of explanation, predictive value, quantifiability and accuracy. But there has been no clear theoretical basis for a scientific order of priorities or status among scientific fields. In the absence of such internal standards that would be binding on scientists in different areas of science, each specialized scientific group would naturally be tempted to attach greater importance to its own theoretical objectives and methodologies than to the others. Nevertheless, as long as the internal process of science was socially autonomous and invisible to the public eye, the ability of any particular scientific area to grow and develop usually depended on the success with which it could demonstrate its scientific merits to scientists from different fields, and so acquire recognition within the scientific community generally. But when the once subtle and publicly invisible process of allocating intellectual and material resources among scientific fields became publicly visible and politically exposed, the intellectual justification of a scientific choice among scientists became inseparable from the political justification of that choice to the public. It is possible to argue that the success of any given field to mobilize material resources and social support has come to depend not merely on scientists' recognition of its intellectual merit, but also on its political, economic or moral appeal to laymen. Since the domain of politics is governed not by the attitudes and opinions of scientists but rather by the attitudes and opinions of the lay public, the resources of political influence available to any given scientific field depend less on what scientists think about it than upon how it is perceived by nonscientists. Though such lay perceptions of science may be regarded by scientists as inaccurate or utterly fallacious, they are political facts which have a great role in influencing the

[1] Don K. Price has pointed out that this handicap is one of the reasons why society has very little cause to fear the rise of scientific oligarchy. See his *The Scientific Estate* (Cambridge, Mass., 1965), 101–19.

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political resonance of science. In fact, recurrent myths and misconceptions associated by the lay public with science as a whole, or with any particular field of science, are important constituents of the social and political environment of science.

In view of the growing role of political factors in the development of modern science, the study of the particular ways in which science is perceived by the lay public and of the comparative public images of different scientific fields is pertinent not merely to the understanding of the interaction between science and society, but also to the understanding of the structure and direction of the internal development of many scientific fields.

In venturing into such a study, I would like to suggest that we distinguish within the different dimensions of science which are visible to the lay public and have political consequences for science, the following four categories of what may be called 'political visibility':

1. The relation and relevance of scientific pictures of reality or images of nature to prevailing social, political and religious beliefs.
2. The relation of technologies generated by different fields of science to prevailing social values and concerns.
3. The degree of accessibility of a given science to the public.
4. The degree of peer consensus among the scientists of any given field.

These categories of political visibility refer to the publicly perceived features of science which affect lay attitudes towards science; they do not, however, in themselves indicate whether these attitudes are positive or negative. Of course only the publicly visible traits of science which evoke in the lay public a sense of harmony between science and prevailing social beliefs can be regarded as political resources of science, whereas those visible traits which suggest a conflict between science and popular beliefs are its political liabilities. The political skill of scientists should therefore consist largely of the ability to exploit relevant social beliefs and attitudes in order to manage the public images of science so as to improve its positive political visibility and its capacity to evoke public support.

With respect to the first category, the pictures of reality or images of nature associated with particular sciences are not analysed here from the point of view of their explanatory or heuristic function inside science, but from the point of view of their external relations to prevailing beliefs. The social history of science provides some dramatic examples of the negative political consequences of the conflict between scientific pictures of the universe, such as the Copernican and the Darwinian, and deep religious and

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ethical beliefs. Pictures of the universe presented by physics and biology were similarly consequential for social attitudes towards these two sciences in different ages. Charles Gillispie has pointed out that, to the Romantics, 'nature was the seat of virtue and Newton's laws were morally unedifying. . .'.[2] They revolted against the quantitative abstractions of physics which they linked to the objectification of nature and the cosmic alienation of man. In their attempts to make a scientific picture of the universe more congruent with their concept of man, they turned to the qualitative sciences; and they later attempted to substitute biology for physics as the queen of science.

With respect to the social sciences, perhaps the best known example is the socialist objection to the concept of 'economic man' postulated by classical economic theory. Again, regardless of the strictly scientific utility of this concept in statistical and predictive operations, the notion that man is a calculating egotist, while consistent with the norms of liberal democracy, was largely unacceptable and therefore detrimental to the growth of economic sciences in some Communist countries.

A curious example of political taboo in the area of population statistics can be found in Lebanon, whose political system is based on the principle of a delicate balance between the Christian and the Moslem populations. Here a population census has been frozen for decades, since the lending of scientific certification to a picture of social reality incompatible with the fiction of balance between religious sects might have disruptive repercussions for the political system.

In as much as American pluralist democracy has not been a fertile soil for the growth of well articulated comprehensive ideologies, the impact of scientific pictures of the universe on public attitudes towards science has been less focused and more subtle, though by no means less consequential than in Europe. On the other hand, the unique American tendency—noticed by many students of American culture—to direct and judge human conduct in the light of empirical facts has rendered the capacity of science to authorize and certify facts and pictures of reality a potent source of political influence. Don K. Price pointed out, in his pioneering study of science and government sixteen years ago, that in the American political system the 'unwillingness to take the answer from established authority leads to a tremendous use of research as a basis of decisions at all levels'.[3] This clearly suggests that in America the reliance on scientifically 'certified facts' has been a matter of determining not merely the content of decisions but also

[2] Charles C. Gillispie, *The Edge of Objectivity* (Princeton, 1960), 198–9.
[3] Don K. Price, *Government and Science* (New York, 1962), 27.

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their public credibility and legitimacy. In societies where social goals and policies are guided by concepts of transcendental authority, or are provided by revered aristocracies, the pronouncements of science about the universe, if allowed to be made public at all, would not usually have direct repercussions on human behaviour.[4] But in a society which has rejected such models of hierarchical or elitist authority, almost any visible conflict between the premises of public policy and what are accepted as the objective and impersonal facts of reality smacks of arbitrary and abusive use of political authority. It is no wonder that the justification of decisions by reference to research or investigation committees has acquired in America a symbolic-ritualistic function similar to the medieval practice of linking important decisions to precedents and predictions from Holy Scripture.

The links between the authority of scientific certifications, and the public evaluations of government policy, have opened up great opportunities, as well as great dangers, for science in America. The newly found power of American scientists to determine the timing and the context of public scientific pronouncements about certain facts could have major political consequences—as the controversies over nuclear fallout, anti-ballistic missiles (ABM), food additives and the biological basis of racial differences can illustrate.

The recent controversy about the sources of differences in IQ distribution among different ethnic and racial groups is particularly instructive.[5] The environmentalist perspective on man and society has always been more compatible with the traditional American belief in egalitarianism than the hereditary approach. If differences in IQ performance among human groups are believed to be not hereditary but rather the function of environmental conditioning, visible inequalities can be accepted as a tolerable passing phase,

[4] It has been reported, for instance, that in Indian villages the sheer distribution of scientific information about modern agricultural techniques through television broadcasts failed to have a serious impact on the practices of the villagers. But when the new techniques were legitimated by the authority of the village chiefs in social forums following the broadcasts, they were more widely adopted. See J. C. Mathur and Paul Neurath, *An Indian Experiment in Farm Radio Forums*, UNESCO Series (Paris, 1959), 61–111.

[5] For samples of the public record of this controversy see Arthur Jensen, 'How Much can we Boost IQ and Scholastic Achievement?' and the rebuttals in *Environment, Heredity and Intelligence*, Harvard Education Review Reprint Series, no. 2 (June 1969); *Congressional Records* (12 August 1969), E 6844; *ibid.* (5 November 1969), E 9348; *ibid.* (20 December 1969), E 10910; 'A Scientist's Variations of a Disturbing Racial Theme', *Life* (12 June 1970); 'Jensenism, the Theory that IQ is Largely Determined by the Genes', *New York Times Magazine* (21 September 1969); and the exchanges in *Bull. At. Sci.*, **26**, no. 3 (March 1970), 2–8, and no. 5 (May 1970), 17–26. See also my article in *Public Policy* (forthcoming), and Walter F. Bodmer and Luigi Luca Cavalli-Sforza, 'Intelligence and Race: it seems fruitless to inquire if differences in IQ have a genetic basis', *Scientific American*, **223**, no. 3 (Oct. 1970), 19–29.

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and education can be regarded as a grand equalizer. In the context of the growing controversy about the racial aspect of educational and welfare programmes, a study challenging this environmentalistic model could only be regarded, by both supporters and critics, as enormously explosive. No wonder that the impact of the now famous publication of Jensen's article in the *Harvard Educational Review* was reportedly viewed by Washington policy makers as a major threat. The *New York Times Magazine* of 2 November 1969, quoted Special Presidential Assistant Daniel P. Moynihan as saying that 'the winds of Jensen blow in this city at gale force', and admitting that the Jensen case was raised in a cabinet discussion. In the light of the great unpopularity of the hereditary approach to human intelligence and education, it is perhaps not a coincidence that the geneticists' community (and in fact, through the NAS, the scientific community as a whole) tried to dissociate itself from the linking of the genetic explanations for IQ distribution with educational policy.[6] The two most vigorous advocates of the implications of genetic factors in IQ distribution for educational policy were a physicist and a psychologist, while the majority of the geneticist community, which was motivated at least in part by anxiety about its public image and support, took great pains to criticize these efforts.[7]

The second category of public visibility of science concerns the relation of technologies generated by different fields of science to prevailing social values and concerns. The extent to which the links of science to specific technology constitute positive or negative political visibility depends on both the publicly perceived contributions of any given field to specific technology and the value attached to this technology by the public. The political visibility of science from the point of view of its links to technology would be relatively small in societies or cultures which reject the values of man's control over his natural environment or which do not recognize the links of technology to the conceptual dimension of science. It will also be reduced in societies where scarcity of financial resources limits the vision of technological possibilities. By comparison with those of other countries, the American system has been exceptionally prominent on both counts: first in its

[6] For an earlier version of this dispute within the American Association for the Advancement of Science (AAAS), see Price, *op. cit.*, note 1, 110–11, and his 'Science and the Race Problem', in *Science*, **142** (1 November 1963), 558–61. See also J. J. W. Baker and G. E. Allen, *Hypothesis, Prediction and Implication in Biology* (Reading, Mass., 1968), 100–43.

[7] These remarks refer to the *de facto* political repercussions of the 'heredity *vs.* environment' controversy; they are not intended to imply that the contending theoretical positions must necessarily entail the policy implications attributed to them by parties to the dispute.

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zest for the values of human control over the physical environment and the instrumental significance which it attaches to scientific conceptualization, and second in the availability of resources for the development of technologies. But the dynamism of American politics has rendered the political value of any specific links between science and technology vulnerable to frequent fluctuations in political orientations and public opinion. At the time and in the place where the climate of opinion was primarily that of conquest and development of nature, the links of science to industrial technology, through chemistry, entailed positive political visibility for the chemical community. But now that this climate of opinion has begun to give way to mounting concern over an 'ecological crisis', and growing support for conservationist values, the public perception of chemistry as an ally of the values of industrial development, and of its role in the production of food additives, constitutes a political liability for the chemists' community.[8] On the other hand, those sciences which appear to have links to the goals of restoring and maintaining a balanced and humanly acceptable ecological system have only gained from this trend in public opinion.

Another case in point is the major shift in the relative positions of the physical and the social sciences in the last few years. As Harvey Brooks has pointed out, in the period between the last World War and the beginning of the Sixties the physical sciences enjoyed positive political visibility because of their links to military technology. During that period the social sciences underwent a difficult struggle for public recognition and support. The physicists' community, which was clearly the leader and the most influential group of scientists in public affairs, by and large did not support the social sciences in this effort and often resisted them vigorously. In November 1945, a letter to the President of the United States signed by five thousand scientists in support of the Bush Report stated 'that it would be a serious mistake to include the social sciences' (in the proposed NSF). It was widely held among physical scientists that, because the social sciences were 'controversial', their inclusion would render the NSF vulnerable to political criticism and would weaken its capacity to mobilize support for the physical sciences.[9] Since the mid-sixties, however, in light of growing criticism of the

[8] For a criticism of the role of chemistry in the food industry, see Ralph Nader's student project on food protection and the Food and Drug Administration: James S. Turner, *The Chemical Feast* (New York, 1970).

[9] See *Technical Information for Congress*, Report to the Subcommittee on Science, Research, and Development of the Committee of Science and Astronautics, US House of Representatives 91st Congress, First Session, by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 25 April 1969 (Washington, DC, 1969), chapter 5.

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Vietnam war and the military, and signs of profound social unrest, the contributions of the physical sciences to military technology have begun to boomerang, while their remoteness from urgent social problems has become a serious disadvantage. Although the social sciences have not developed spectacular means to solve social problems, the preoccupation with such problems has been sufficient to give them a boost. Their status within the NSF, the NAS and the American Association for the Advancement of Science (AAAS) has visibly improved. Now that the competence of social scientists has become so relevant, and the social sciences are regarded as good company, the spokesmen of the physical sciences no longer seem ashamed to associate with the social sciences in public; and they even take the initiative in searching for common grounds with social science in coping with such environmental problems as pollution or the sonic boom. These examples clearly illustrate, I believe, the opportunities and the threats which are involved in the political visibility of the links between science and technology.

We have defined the third politically visible dimension of science as the degree to which it is accessible to the public. The role of the public accessibility of scientific knowledge in influencing lay attitudes towards science is not, of course, new. Francis Bacon criticized Aristotelian scholasticism on the grounds that it was inaccessible to the public. He was sensitive to the fact that, in an era of increasing challenge to established authority and the rising strength of anti-hierarchical values, his presentation of modern science as a new and more accessible mode of knowledge—not filtered by the esoteric mastery of books and Latin but open to the senses and common experience—served to bestow greater public legitimacy upon it. The emergence of the lay public as a legitimate audience of science was clearly manifested in the decision of men of knowledge, such as Galileo and Descartes, 'to write their works in the vernacular rather than in Latin avowedly for the purpose of appealing against the learned world to an intelligent reading public'.[10] In pre-revolutionary France, the exceptional popularity of qualitative chemistry among French democratic circles was similarly related, as Gillispie has pointed out, to the perception of chemistry as an exoteric science, as against the esoteric mathematical abstractions of Newtonian physics.[11] No wonder that in such an atmosphere the Secretary of the Académie Française, Condorcet, believed that the enhancement of the

[10] Herbert Butterfield, *The Origins of Modern Science*, revised edition (paperback) (New York, 1966), 180–1.
[11] Gillispie, *op. cit.*, 184–6.

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accessibility and visibility of scientific truths to the public was a necessary condition for public recognition of the authority of science in society.

In early nineteenth-century America, the popularity and the accelerated growth of what were then known as the 'natural history' sciences were linked to their ability to provide the common man with a sense of participation in the wonders of nature. The idea that the principle of scientific knowledge is classification was associated with the idea that science is not the work of geniuses and that 'everybody can be a scientist at least in comprehension'.[12] As the experience of chemistry and natural history clearly shows, it is in its incipient stage that a science is most likely to appeal to the layman. When a science achieves a high level of conceptual development, it requires more elaborate skills and training, and thus becomes more professionalized and esoteric. In the context of the American populistic and egalitarian political values, the process of professionalization and specialization, though it may be a measure of success from the scientific point of view, involves considerable costs in terms of negative political visibility. There is in America a powerful political sentiment against any form of elitism or claim to exclusive authority or competence, whether political, religious or scholarly. Alexis de Tocqueville, observing the American system in the middle of the last century, noted that 'in a country where no signs of incontestable greatness or superiority are perceived in any one of [the citizens] they are constantly brought back to their own reason as the most obvious and proximate source of truth'.[13] Yet the most developed areas of science are usually the least accessible to the public and the most vulnerable to the charge of esoterism and remoteness. When a highly esoteric scientific field is also associated with a highly unpopular picture of reality or technology, the compounded negative political visibility may be particularly harmful. The fact that modern esoteric fields of science are often criticized on the same grounds on which the early propagandists of science criticized the exclusivity of the clergy suggests that, regardless of the content of knowledge, the modes of its social and organizational configurations influence the relation of the scholarly community to its socio-political environment.

Finally, the fourth politically visible feature of any specific science is the degree of consensus achieved by its member scientists. The political visibility of consensus was noticed long ago; Leibniz, for example, believed that controversies and conflicts of opinion among scientists reduced the social position of science, and he devised a demonstrative scientific encyclopedia in

[12] Perry Miller, *The Life of the Mind in America* (New York, 1965), 319.
[13] Alexis de Tocqueville, *Democracy in America* (New York, 1945), vol. 2, 4.

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order to eliminate them.[14] Because the lay public cannot evaluate scientific propositions directly, it has to rely on more visible indirect signs of scientific merit, such as peer consensus. In the absence of such consensus, the lay public cannot find in science the certainty and the support it seeks. The ability of any specialized scientific group to make an impact on public policy and its implementation no doubt depends much upon this capacity to generate a minimal degree of consensus on scientific standards, evidence and conclusions, and to articulate them in the social context with the full backing of the authority of science. This is especially apparent in controversies such as on the relations between smoking or food additives and health, the nature of UFOs and the like, where the public is very anxious to receive scientific guidance, while the insufficient state of scientific knowledge limits the possibility of unequivocal peer consensus. When scientists can appear on all sides of an issue, none can persuade his audience that he speaks for objective and impersonal facts. The social force of scientific considerations is obviously weakened, and with it the public standing of the field of science that is involved.

The degree of consensus is obviously not uniform in each discipline with respect to all subjects. But there are differences in the theoretical basis of consensus among scientific disciplines. The physical sciences were notably more successful in this respect than the life sciences, and the latter more successful than the social sciences; and within the social sciences, economics showed the highest degree of peer consensus. A comparative, though admittedly impressionistic, look at the development and structure of the influence on public policy of the specialized scientific communities in these areas suggests most interesting correlations that have yet to be explored.[15]

The four categories of political visibility of science which I have just presented (that is to say, the political dimensions of scientific pictures of reality, the links of science to technology, the accessibility of science to the public, and the degree of peer consensus) are hybrid variables. By combining the internal features of science with the traits of its socio-cultural environment, they can be used to conceptualize about the political resources of science. If we view science through these four categories, it becomes apparent that, in any given social context, fields of science differ in the character of

[14] See on this subject Robert McRae, *The Problem of the Unity of the Sciences: Bacon to Kant* (Toronto, 1961), chapter 4.

[15] I am currently studying the relations between such factors as the degree of theoretical consensus or conceptual differentiation of a field of science and the extent to which it evolves a self-conscious group of professional workers with common perceptions of their relations to other fields of science and shared political resources and strategies for mobilizing the financial support and the legitimation of the public for their work.

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their political visibility and resources; and that the political visibility of the same fields will vary in different political or cultural systems and at different points of time in the same system. It also appears that the same scientific field could hardly achieve high positive political visibility in the four categories simultaneously, since high scores in some will usually entail low scores in others. There is, for instance, very frequently conflict between positive political resources in the first two categories. Scientific pictures of reality which seem least consistent with common sense and popular beliefs are often most successful in predictive potential and in generating technologies. The mechanistic picture of the universe was historically widely unpopular on ethical and humanistic grounds, yet it was much more successful in predictive and technological productivity than the more ethically and humanistically popular biological vitalistic construct of the universe. Similarly, the scientific construct of the economic man was widely rejected on ethical and political grounds while supporting at the same time the development of fruitfully predictive and computational economic models. In the case of the apparent conflict between the hereditary and the environmental concepts of human intelligence, while the environmental model has enjoyed highly positive political visibility as an image of man, the hereditary model, because of the connotation of biological determinism, has suffered from negative political visibility. No wonder, then, that the supporters of the hereditary model have attacked the environmental model in the weak points of its failure when applied in educational programmes, while publicly defending the hereditary model not as an image of man but as potentially more applicable.[16]

These examples may reflect a more basic conflict between the force of scientific reductionism in predicting and technologically exploiting natural phenomena, and its unpopular fragmentary effects on common sense constructs of reality. The tension, in other words, is between the role of science as a cognitive enterprise which is a source of certainty and an integrated world picture, and as a source of power or tool for manipulating the environment.

There are also noticeable trade-offs in positive political visibility in the third and fourth categories. Very often the scientific disciplines with the highest degree of internal peer consensus on scientific matters are areas of science which are most esoteric and least accessible to the public. The greater the professionalization of a field, the greater is the exclusion of the layman.

The fact that scientific fields cannot usually achieve equally high scores

[16] See the relevant sections in Jensen, *op. cit.*

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in all four categories simultaneously has naturally led each scientific field to concentrate on emphasizing and utilizing its points of strength.[17] In the absence of a unified theoretical framework for science which would oblige the various fields from within to conform to a scientific order of priorities, each scientific field has been tempted to use its unique political resources in attempting to mobilize public support for its particular endeavour. This freedom for independent political entrepreneurship has been particularly stimulated by the opportunities which have been opened to science during and since the Second World War. The method of free political initiative has, however, involved serious potential dangers to science from the point of view of both its internal functioning and its general social status. Because federal funds now make up an unprecedented proportion of the total material resources available to various fields, a system of uncontrolled competition for public support entails the possibility that the external test of political resourcefulness will dangerously outweigh the internal test of intellectual promise in determining the fate of different scientific fields.[18] The cumulative effects of the interpenetration of scientific and political criteria for the distribution of the scientific effort could cause serious imbalances and disorientation in the internal working of the scientific community. Such dangers are particularly acute because of the growing influence of the relative social images of scientific fields on the flow of young intellectual talent among them. The concern expressed by physicists, mathematicians and molecular biologists in 1969 and 1970 over indications of the declining student enrolment in these fields, compared with a rise in student enrolment in the 'rele-

[17] This fact also helps to explain some of the patterns of relative rise and decline of the political fortunes of various scientific fields. Harvey Brooks, in comments on this paper, has pointed out that the decline of the political fortunes of physics and chemistry was not proportional to the rise in the fortunes of the social sciences and ecology, since, while physics and chemistry have been declining with respect to category 2, they have maintained their usually high scores in category 4; whereas social sciences and ecology, though they have gained with respect to 2, have remained at their usual low with respect to category 4. Indeed, the areas of the social sciences which have attracted growing support in Congress and the executive and improved their status in the NSF, NAS, PSAC, etc., have been precisely those areas of the quantitative social sciences with relatively high scores in peer consensus (4).

Perhaps we should add the observation that, since, of the four categories of political visibility, gains in 4 often indicate progress also in terms of the internal theoretical development of science, and since scientists who are laymen with respect to areas of science outside their own expertise are nevertheless likely to be more sensitive than the public to the internal norms of scientific achievements, high scores in 4 are of particular significance for the endorsements of scientific fields by the larger scientific community, as represented by the NSF, NAS and PSAC.

[18] Important circles of the American scientific community believe, for instance, that the space programme is a case of investment in a programme out of all proportion to its intellectual promise.

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vant' sciences such as psychology, sociology and ecology, reflects these links.

From the point of view of the social status of science as a whole, such political *laissez-faire* entails the risk that scientists, by confronting the public with competing and conflicting claims, may erode the public credibility and authority of science as a whole. The public expects scientists to be unanimous, and is not inclined to accept the privileged authority of science when there is no socially visible consensus. The rationale behind Leibniz's concern is in this sense timeless. In the American context, the perennial need to justify claims for support before the public forums of Congress has, predictably, dramatized the political futility of a process in which representatives of competing scientific fields use all the arguments they have in store to present the relative importance of their own activities.

However, neither the internal nor the external deficiencies incurred by the practice of unrestrained political entrepreneurship were clearly detectable during the years (particularly after Sputnik) in which continually high public support allowed most scientific fields to grow at an unprecedented rate. But when this trend levelled off during the latter years of the Johnson Administration, and science was increasingly threatened by cuts of federal funds and deteriorating public support, the strategy of free and uncoordinated political competition began to show its weaknesses. It has now become increasingly clear that, politically and economically speaking, the resources mobilized by each field affect the reservoir of resources left for the others, and that the political tactics used by some fields affect the political options open to others. This is particularly true in areas of science remote from social concerns and government missions. Thus the fate of sciences with little political appeal may reach a crisis unless the political resources of relatively wealthy and publicly strong fields, as well as of the scientific community as a whole, are employed with greater economy and consideration for the overall state of science. Even though the NSF was specifically designated to be a sort of 'balance-wheel' which diverts federal funds to underfunded yet scientifically worthy fields, there was little that it could do to offset imbalances in cases where the meagre political appeal of scientific fields was greatly out of proportion to the size of the funds they required. Despite its specific efforts to enhance the weight of internal scientific considerations, the NSF has largely reflected the 'balance of power' among fields, rather than helping to modify it. The need to mobilize support for programmes from the lay public and its elected or appointed representatives, has forced the NSF to respond to the demands of effective political strategy

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and make concessions to extra-scientific preferences and criteria at the expense of more purely scientific considerations.[19]

In the light of the growing difficulties of the last few years, the feeling that a new political strategy is needed for science has gained considerable strength. These feelings have not led, of course, to a conscious planned shift, but they have produced some significant changes in attitudes and institutions, the full meaning of which cannot yet be evaluated. What seems to be emerging is a turn from the former system of basically free political competition to a moderately controlled competition in which each science is bound to use its political resources economically and in coordination with the interests of other sciences and the state of science as a whole. Some of the principles of this new strategy were echoed in the address of Professor Seitz, ex-President of the NAS, before the American Physical Society in November 1964. Seitz reminded his audience 'of the way in which the competition among the nations of Western Europe in the last century has had the effect of decreasing the collective strength of all. Wisdom would seem to indicate that the family of High Energy Physics must somehow learn to resolve its differences and speak with a unified voice.'

The rationale of the new strategy was expressed by Lee DuBridge before the NAS: 'we all know our own field is of great importance and we all know that our own field is grossly underfunded. Often we may be tempted to argue that certain fields are overfunded. I hope this temptation can be avoided, at least in our public statements. Our objective should be to increase the total support of basic science.' Since the specialized professional societies are organized around specific fields, it was only natural that the initiative for the strategy of restrained competition should originate in the comprehensive scientific institutions (NAS, NSF and PSAC), and among former Presidential advisers, all of whom enjoy a synoptical view of science as a whole as well as a profound knowledge of its political condition.[20] The new rationale has increasingly acquired the status of a collective political consciousness. Its central idea is that in the long run each scientific field will

[19] The NSF has, to be sure, helped some scientific fields handicapped by low political appeal, such as systematic biology and pure mathematics, but it has nevertheless supported—somewhat out of proportion to its resources—fields with fairly strong political appeal, such as atmospheric science and oceanography.

[20] This does not necessarily mean that these scientist-statesmen are easily recognizable by their political skills. Often the level of their political sophistication appears to be correlated with the degree in which they preserve the appearance of political innocence. They know very well that the authority and influence of scientists in politics largely depends, as Robert Wood once pointed out, on their ability to appear apolitical. They also know to distinguish between the political uses of 'political innocence' and the political costs of political insensitivity.

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be better off if most of the scientific community will endorse (or at least not criticize) the claims of some fields at given times than if all the sciences were to present their maximal claims all the time. The need to coordinate the strategy of each field with that of all the rest has naturally implied a growing role for such scientific bodies as the NAS, NSF and AAAS, which are capable of articulating the collective authority of science as against the particularistic and more parochial pronouncements of the specialized scientific associations. In this way, some of the authority and influence that such multi-disciplinary organizations of science had lost in the past, because of the fragmentation of the scientific community, seems to have been recovered. While their comprehensive overview of science has made these organizations particularly useful to the Congress and the Executive, their public status as spokesmen for science as a whole has in turn strengthened them *vis-à-vis* the specialized scientific associations and societies. This trend has, of course, the healthy effect of separating central political functions from the professional scientific functions of specialized societies, and has forced the individual scientific fields to build up considerable support among scientists of other fields before presenting their case in the open political arena. The NAS has devised COSPUP to be a central reference point in this process, both as a coordinator and a buffer between science and politics.

The NAS–COSPUP has set out to strengthen the political resources of those scientific fields whose intellectual merit is not matched by their political prowess, and to economize the political resources of science by designing selective and well-prepared exposure of various scientific fields. Paradoxically, the actions of COSPUP have amounted to the use of political techniques to protect the traditional autonomy of scientific norms from external political pressures. It reflects the growing consciousness within the scientific community of the political condition of science, of the relationships between the popular images of science, and of the welfare of the scientific enterprise. The Academy, together with other comprehensive scientific organizations and many informal groups of scientific influentials, has attempted to improve the positive political visibility of scientific fields by linking them to areas of public concern and popular technologies, by increasing their accessibility to the public, and by encouraging consensus in public forums. The astronomers, for instance, like the high energy physicists, were encouraged to close ranks within their respective communities before stating their case to the political authorities; the mathematical community and other scientific fields have been helped by NAS–COSPUP in producing field reports to describe their objectives and needs in common language; the

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physical sciences have been quietly helped to offset links with unpopular military technology by giving greater attention to social problems such as pollution; and fields like genetics have been backed in their efforts to withhold unqualified sanction to genetic facts or theories with highly explosive political connotations.

It is still too early to evaluate this new political orientation of American scientists, and the extent to which their responsiveness to external political opportunities and demands is consistent, in the long run, with the preservation of the internal sub-culture of science. But if growth is to be a measure of success, and the spectacular history of American science since the Second World War is to be its testimony, it would seem that it is no longer the political asceticism of scientists, but rather their conscious, adaptable and economic utilization of their political resources, which will best serve the advancement of science.

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