THE POLITICAL NON-POLITICS OF

U.S. SCIENCE POLICY

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William A. Blanpied and Rachelle D. Hollander*

In this chapter we sketch the origins and development of some of the tensions that currently exist in the United States between science and government, principal patron of basic research in universities—as well as principal arbiter of the country's extensive, if diffuse, research and development (R&D) enterprise. Those tensions, we believe, are intimately related to issues of autonomy and accountability. Because the policy framework for government support of scientific research emerged in the wake of World War II, our principal focus will be on the past forty years. We will demonstrate that the relationships were at that time, and continue to be, politically negotiated relationships. We will then argue that an appropriate balance between scientific autonomy and accountability may be better served by including a broader representation at the table where the negotiations between science and government take place.

Problems of balancing autonomy and accountability are not new, however. Indeed, they predate by more than three centuries the post-World War II compact that continues to provide the framework for negotiations between science and government. They are already evident in Francis

*The views expressed by the authors are their own and do not necessarily reflect the policies of the National Science Foundation.
Bacon's 17th century vision. Bacon, then Lord Chancellor of England, selected as the frontispiece of the 1620 edition of his Novum Organum, a woodcut of a ship bound on a voyage of discovery, and a prophecy from the Book of Daniel: "And many shall go forth, and knowledge shall increase."¹ So the metaphor of scientific progress as equivalent to a physical voyage into terra incognita was present in one of the first detailed articulations of science as an organized, group activity.

Both the substance and rhetoric of his vision indicate that, to Bacon, an increase in knowledge—what today would be called the progress of science—was a necessary prerequisite to social progress. A systematic program to increase knowledge would require the disciplined efforts of self-selected groups—the "many"—who would be granted autonomy by the larger society. In other words, they would have the right to conduct their activities according to their own established rules, on the expectation that those activities would, in fact, ultimately lead to social benefits. It was the expectation of such social progress that provided the principal rationale for seeking to increase knowledge.²

A secularized version of the Baconian vision of scientific progress persists into our own era. Scientific progress is inevitably linked with social progress, and autonomy for scientific communities is viewed as a necessary prerequisite to scientific progress. The persistence of this article of faith is strikingly illustrated in both the substance and rhetoric of Science—the Endless Frontier, a report which Vannevar Bush, President Franklin Roosevelt's wartime science adviser, submitted to President Harry Truman in July 1945, as a blueprint for a continuing, peacetime relationship between science and government.³ Bush's argument links scientific progress to social progress, arguing that "... without
scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world."^4 Genuine scientific progress requires autonomous, self-governing communities, since, "Scientific progress on a broad front results from the free play of free intellects, working on subjects of their own choice, in the manner dictated by the curiosity for exploration of the unknown. Freedom of inquiry must be preserved under any plan for Government support of science . . "^5

Most strikingly, perhaps, our Baconian cultural heritage is evident in Bush's invocation of the U.S. government's long-standing support for oceanic ventures to legitimize the concept of public support to open new frontiers of science. In rearticulating this metaphor and the traditional assumptions concerning the necessary autonomy and self-governance of science, Bush provided the rationale for policies established in the late 1940s to link non-governmental scientific institutions in the United States more closely with the federal government. ^6

Both of Bush's assumptions—that scientific progress leads inevitably to social progress, and that scientific progress requires the autonomy of scientific communities—can be questioned, however. The first assumption overlooks the negative effects that can arise within and as a result of scientific activity. The second overlooks the possibility that the values scientists themselves hold may limit their ability to select appropriate priorities for research, even basic research, in the best interests of the larger society. It also ignores the need for broad-based and informed support for research and for procedures by which appropriate research agendas can be selected. It is these deficiencies that underlie many of the historical and current strains in the relationships among science, government and society.
Precedents for Negotiations Between Science and Government

From the perspective of the current debate over accountability and autonomy, two explicit arguments set forth in *Science--the Endless Frontier* should be noted:

First, Bush argued that the innovative contract system created during World War II ought to be established on a permanent, peacetime basis. This system placed the capabilities of non-governmental scientific institutions at the disposal of government in order to help it fulfill specific mission-oriented objectives, such as military research and development. An essential feature of Bush's argument was that scientists should, to the greatest extent possible, conduct such mission-oriented activities in their home institutions--private industry and particularly universities--so that they could enjoy the maximum possible measure of autonomy even while conducting work for government.

Second, and at the time more controversially, Bush argued that science had become so important to society that the public interest demanded maintenance of a strong scientific infrastructure. When the conduct of undirected, curiosity-driven research--that is, the quest for knowledge for its own sake, or basic research--drives the entire scientific enterprise, the support of basic research, particularly in universities, becomes a legitimate concern of government. Therefore, it had become essential for the federal government to provide direct support for non-mission oriented scientific research and education in universities. But since the concept of public support of university research was so novel in the United States, a new, comprehensive agency would have to be created to carry out that mission.
Although the idea that the United States government should provide direct support for research in universities may have been novel in 1945, negotiated links between science and government were certainly not. In 1660 a group of self-anointed Baconian amateurs banded together in London to establish The Royal Society of London with the objective of making "...faithful Records of all the Works of Nature, or Art, which can come within their reach." That event marked the first, tentative beginning of science as an organized group activity in the English speaking world. During its first hundred years, the Royal Society (and similar amateur scientific societies elsewhere) developed an internal governance system to further the objective of accumulating useful knowledge. In essence, this system was a "republican" or "town meeting" system in which authority was, in principle, shared equally among all members, but in practice was granted to those who made the most significant contributions to the Society's work.

Very early in its history, too, the Royal Society exhibited a tension, like that evident today, between the desire for autonomy from, and the need for acceptance by, the larger society and the political authorities that governed it. Mindful of the recent ordeal of Galileo, the society abjured any intention of probing matters "affecting Church and State," regarding that concession necessary to guarantee that the state would respect their internal autonomy. On the other hand, members of the Royal Society believed that their labors would inevitably benefit the larger society, and in 1660 they sought and obtained an official charter from King Charles II. As early as 1667 they were also lamenting that the king and his councillors did not regard their work with sufficient seriousness. One might argue that the Royal Society thus compromised its autonomy from the outset. Yet
such a compromise had to be made if the activities of the self-anointed Baconians were to have significant effects on the larger society, and the fellows of the society confidently believed they would.

Science as an organized activity first emerged in the American colonies in 1743 when Benjamin Franklin drafted a charter for the American Philosophical Society, the first self-anointed Baconian group in North America. His words expressed the self-assurance of what was soon to emerge as a new nation founded upon principles of scientific rationality. Franklin's new society proposed both to further science for its own sake and science as a means to socially beneficial ends, by cultivating "... all philosophical experiments that let light into the nature of things, tend to increase the power of man over matter, and multiply the conveniences and pleasures of life." Inevitably then, science in America, as in England, would have to negotiate with government over issues of autonomy and accountability.

In fact, pivotal negotiations took place at the Constitutional Convention in 1787, when several prominent delegates proposed to grant to the federal government broad powers to support and encourage scientific activity, including authority to "establish seminaries for the promotion of literature and the arts and sciences," to "grant charters of incorporation," to "grant patents for useful inventions," and to "establish public institutions, rewards and immunities for the promotion of agriculture, commerce, trades and manufactures." These and other provisions failed to be incorporated into the Constitution not because a majority of delegates opposed their legitimacy, but rather because they were coupled, in the thinking of the delegates, with other proposals that would have granted authority to the federal government to build roads and
canals, an authority which the smaller states were loath to concede. Had the advocates for science succeeded in their negotiations in 1787, there would have been no need for Vannevar Bush to argue, a century and a half later, that the federal government had implicit authority to provide direct support for scientific research and education in universities.

Negotiation of the Current Science-Government Relationship

In July 1945 Bush proposed, in *Science--the Endless Frontier*, the creation of a National Research Foundation as a means to provide direct support for basic research and education in universities. Negotiations about the nature of the federal government's role extended from then until May 1950, when President Truman signed a modified version of Bush's proposal into law and thus established the National Science Foundation. The character and outcome of these negotiations were influenced by the experiences of scientists and officials in both the executive and legislative branches of government in negotiating the issue of civilian vs. military control over the development of atomic energy during 1946.

From the perspective of the present analysis, the atomic energy debate was notable because it witnessed the emergence of a group of atomic scientists as an effective lobby. These atomic scientists were willing and able, not only to take their case for civilian control to the public, but also to seek and forge alliances on specific issues within the political system itself. They forged such an alliance with liberal elements in the Congress by convincing them that military control would impede the development of atomic energy for peaceful purposes. In contrast, they argued, civilian control would assure that Congress could maintain greater oversight authority, while vesting more autonomy for determining scientific
priorities with research scientists. The atomic scientists also forged an alliance with the Bureau of the Budget (which had the president's mandate to weld the federal bureaucracy into an instrument to carry out his policies) by persuading the Bureau that a presidentially-appointed Atomic Energy Commission of five civilian members would be more accountable to the president than the mammoth, difficult to manage Department of Defense.

Why were five years required to establish a National Science Foundation for the support of basic research and education, in contrast with the intense but relatively brief period of negotiation over the control of atomic energy development? First, of course, there was the post-war desire to harness "evil" for "good" and to demilitarize. Also, the atomic energy case could be regarded as an extension of the wartime emergency contract system on a continuing, peacetime basis. In contrast, the idea of direct federal support for non-mission oriented basic research in universities was, in the United States, completely novel. Thus the debate over the terms through which government could provide and universities could accept such support on behalf of their scientists challenged deeply held beliefs in both science and government about issues of governance, accountability, autonomy, as well as the proper definition and defense of public interests. Several troublesome questions were not completely resolved at the time and remain unresolved today, including, What constitute the public interests that presumably are to be served by closer links between science and government? Who should define those interests, and how should they be advanced and guarded? What constitutes an unwarranted intrusion into scientific autonomy and under what conditions? and Who should control the detailed selection of priorities for scientific research and procedures for the conduct of that research?
Negotiations over the establishment of a policy framework for federal support of scientific research in non-governmental institutions involved two phases. Each phase centered on a different but related issue within the context of accountability and autonomy questions. During the first phase, extending from July 1945 through August 1947, the principal issue was, Who are the stakeholders who should have a voice in Congressional and executive determinations of priorities for federally-supported research? Should those stakeholders be limited to scientists and others in the institutional settings where research is conducted? A positive answer could be supported by invoking the three-century old autonomy model of the relationship between science and society. Or should other social groups be given a voice in determining research priorities? This set of issues was resolved in favor of the traditional, narrow, autonomy model of science within the larger society.

During the second phase of the debate, extending from August 1947 through May 1950, the principal issue was, How can the insistence of science on a large measure of autonomy be reconciled with the Constitutional requirement that elected officials of government are accountable for the expenditure of public funds, and the persistent view of the Bureau of the Budget that the president was more qualified to define public interests than any single federal agency or any external constituency group? The compromise that resolved this issue appeared, for a time, to grant science a sufficient degree of autonomy, while assuring accountability to the Congress, the president, and his Bureau of the Budget.

The first issue was joined in July 1945, a few days after the centerpiece of Science--the Endless Frontier--the proposal to establish a National Research Foundation--was introduced into the Congress by Senator
Warren Magnuson of Washington. The Magnuson Bill would have modeled the new agency on existing private philanthropic foundations by vesting ultimate management authority, as well as authority for determining priorities for dispersing funds, in an independent, part-time, presidentially-appointed board of distinguished scientists and educators. Bush and his Congressional supporters argued that such a National Science Foundation would guarantee a maximum degree of autonomy to science, and would insulate it almost completely from interest group or pork barrel politics. A relatively narrow spectrum of groups with direct interests in scientific research would set its agenda.

Within days, Senator Harley Kilgore of West Virginia, who had waited patiently since 1943 for the end of the war to implement his own vision of how government should support science, introduced a competitive bill for a National Science Foundation that also would have been administered by a presidentially-appointed, non-government board. But the Kilgore Bill would have broadened the range of interests represented on the board by defining it in decidedly New Deal terms. To be sure, the Kilgore board would have included distinguished scientists. But there would also have been representatives of small business, labor, and agriculture, for example, reflecting a mid-1945 liberal Democratic perspective about the social groups that best articulated public interests. It was a board representing those interests that, in a Kilgore-inspired National Science Foundation, would have determined priorities for the support of scientific research. Clearly, such a board would have been a threat to the traditional construct of autonomy for science.

Ultimately, the more conservative Magnuson Bill, which accepted the Bush thesis that self-governing activities of science best served the public interest, prevailed in both Houses of Congress. It was, however,
vetoed in August 1947 by President Truman, acting on the advice of the Bureau of the Budget. Truman's veto message accepted with enthusiasm the legitimacy of public support of basic research in universities and the need for a reasonable level of scientific autonomy. But it emphatically rejected the claim that the president could delegate ultimate authority for the use of public funds to an independent, part-time board (representing the interests of those who would use those funds) and a director who would serve at the pleasure of the board, not the president.

Three years later, in May 1950, President Truman signed into law a compromise measure to create a National Science Foundation. That law reserves to the president (and to the Congress that appropriates funds for the agency) ultimate authority over the ways in which the National Science Foundation disperses its funds. For the law provides that the director of the agency is not appointed by the Foundation's National Science Board, but by the president, and is therefore responsible to the president. The law also vests overall policy guidance and responsibility for providing advice at the highest levels of government to the National Science Board, to be composed mostly of eminent scientists and people with "distinguished records of public service." 17

As time has passed, this requirement has meant that the board has come to be comprised of people from academic institutions, business, and industry with strong scientific and management backgrounds. The board has generally accepted the traditional assumption that scientists themselves are best qualified to determine the detailed research priorities that will best serve public interests. Since scientists and engineers have traditionally been employed by a relatively narrow spectrum of institutions, however, this formulation has meant that the board itself has
generally represented a narrow spectrum of societal interests. Such a
group may be predisposed to overlook value issues associated with
ostensibly scientific choices or questions raised by scientists' 
affiliations with institutions whose priorities may not always be purely 
scientific or emphasize public interests.

One consequence of the long debate over the creation of the National 
Science Foundation was that, when the agency was finally established, it 
could not aspire to become the comprehensive federal agency for the support 
of basic scientific research that Vannevar Bush had envisioned in 1945. 
During the three year interval between August 1947, when President Truman 
vetoed the Magnuson bill, and May 1950, when he signed the compromise act 
into law, several other agencies--most notably the Department of Defense, 
the Atomic Energy Commission, and the National Institutes of Health--had 
established themselves as supporters of basic research in universities in 
areas broadly related to their missions. Thus a pluralistic, decentralized 
system of basic research support in which individual investigators could 
seek funding from more than one agency began to evolve; and this result has 
often been taken as a positive outcome.

Additionally, the growth of basic research support within the 
so-called mission agencies encouraged the development of institutional 
links between the basic research conducted within university communities 
and the predominantly applied research and development programs of these 
agencies. This outcome has also been regarded as positive, since it 
facilitates the transfer of basic research results into tangible products 
and processes. On the other hand, it has also had some influence in 
blurring the boundaries between basic research and other types of science 
and engineering activities, which in turn strains the relationship between 
government and independent scientific institutions in the United States.
Renewal of the Debate

Given the unprecedented nature of the concept of a substantial, mutually-beneficial, continuing dependence of science and government on each other; and given the novelty and complexity of the issues associated with translating that concept into workable, institutionalized reality, it is remarkable that a viable set of policies for linking government and science managed to emerge at all. That agreement was reached on a compact that has provided a more or less satisfactory framework for the relationships between science and government for four decades was due both to the considerable political skill of the scientists who participated in those protracted negotiations, and to the conviction on the part of influential factions within both science and the executive and legislative branches of government that close working relationships had become essential.

Four sets of incompletely articulated assumptions or expectations underlay the post-World War II policy framework negotiated between science and government:

First, the expectation that specific problems associated with the differing stances on issues of accountability and autonomy could be resolved on a case-by-case basis by means of continued, good-faith negotiations between the interested parties.

Second, the tacit expectation that the interested parties in the evolving relationship would not change significantly, but rather that negotiations would continue to be managed primarily by an identifiable group of leaders of the U.S. basic research communities on the one hand, and on the other, by representatives of the federal R&D agencies, the
Bureau of the Budget, and a few members of Congress who largely supported the views of accountability and autonomy inherent in the compact between government and science.

Third, the assumption that there was no need to develop specific institutional mechanisms to translate the results of the basic research conducted in universities into social benefits. Rather, government accepted the three-century old presumption that a "magic hand" would ensure that the translation would occur in the best interests of the public, and that any well-meaning attempts to intrude upon the autonomy of science to facilitate that translation would be counter-productive.

Fourth, the expectation that it would remain possible to make a clean separation between long-term, non-mission oriented basic research conducted in universities, and other mission-oriented research and development activities (related to national defense, atomic energy, health, and agriculture, for example) supported by, or engaged in directly by, the federal government; that basic research support would remain a microscopic part of the federal budget; and that those engaged in the conduct of basic research could remain aloof from questions of social responsibility and essentially isolated from interest group politics.

Corollary to the third and fourth of these expectations was the implicit assumption that there was no need to negotiate a comprehensive or complex set of policies to link the country's basic research efforts either with a variety of goal-oriented research and development activities, or with more broadly conceived social and economic goals. Rather, the only requirement was for a minimum set of essentially non-interventionist policy guidelines that would assure that autonomy for science within an accountability framework acceptable to the Bureau of the Budget. The
National Institutes of Health (NIH) and NSF institutionalized this presumption in the form of peer review. The mission-oriented agencies behaved similarly, often supporting "science-driven" research while trusting it would somehow help them meet their specific, non-scientific goals.18

Development of a comprehensive policy framework would have been difficult in the late 1940s. It would have implied a need for long-range planning of the nation's basic research effort to try to meet national goals. It would have entailed explicit recognition of the conflicting societal agendas held by different groups of American citizens -- conflicts that existed even within subsets of particular groups -- and among scientists themselves. It would have conflicted with American antipathies to centralized or governmental social planning and challenged the deeply rooted aversion of U.S. scientists to the idea that scientific activity, particularly basic research activity, can be planned in the aggregate. For planning smacks of centralization, the denial of free choice by individual scientists, and the attenuation of the ability of a scientist to followup unanticipated breakthroughs that may occur in the course of research.

The erosion of this quiet compact over the past thirty-five years has led in turn to renewed debate over issues of autonomy and accountability, as well as to suggestions that the minimalist policy framework of the late 1940s may be incommensurate both with the augmented scale of science today and the heightened public perception of the significance of science to all aspects of life.

Any expectation that science and government could negotiate as roughly equal partners began to erode within a year of the creation of the National Science Foundation, and at the initiative of science rather than
government. In a February 15, 1951 memorandum to F.J. Lawton, Director of the Bureau of the Budget, William T. Golden (a special consultant to the White House) described the Board as the principal advisor to the president and Congress on the uses and directions of basic research in pursuit of long-term national objectives. He also envisioned a planning and coordinating function for the National Science Foundation. Lawton passed the memorandum on without comment to Harvard President James B. Conant, Chairman of the National Science Board. However, the Board and Foundation rejected the invitation of the Bureau to play such a limited but still important planning and coordinating role. Indeed, they rejected the position of the Bureau that the Act of Congress that created the Foundation gave it the responsibility to play that role. This continued rebuff was due in large measure to the conviction that the Foundation would not be allowed to fulfill its central mission to support basic research and graduate education, unless it remained insulated from political controversy and from political negotiations within the federal government.

In itself, this was a political decision. In retrospect, its wisdom is problematical. It may well be true that the novel idea that government should provide direct support for basic research in universities for no immediate end save the advancement of knowledge could only have taken root if the search for knowledge remained aloof not only from political negotiations within government, but also from natural or potential allies both within and outside of government. Nevertheless, by declining to play even the limited policy-advisory role envisioned both by the Congress and the Bureau of the Budget, the National Science Board abdicated a good deal of the political authority it might have had to negotiate with more powerful actors in government—including the Bureau of the Budget and the
mission agencies—on behalf of the basic research communities it claimed to represent. Scientific interests have never been clearly identified or articulated. Science continues to play a subsidiary role to government and, save for relatively brief periods of "crisis" such as followed the launching of Sputnik by the Soviet Union in 1957, it is not the formidable negotiator it was in the aftermath of World War II.

The expectation that the legitimate stakeholders in negotiations about the public support of science would not change appreciably has also been eroded both by the expansion and consequent fragmentation of the scientific community and by the closely related heightening in the perception of the social relevance of science—in both a positive and negative sense. As early as 1946, there had been warnings that the interested stakeholders could not realistically be defined as a small group of leaders in the basic research communities and their supporters in industry and the executive and legislative branches of government. Debate over civilian vs. military control of atomic energy, and the almost concurrent debate over the Kilgore vs. the Magnuson versions of the National Science Foundation, should have suggested that stakeholders in the larger society who took a different view of the science-government relationship might one day reassert their right to a voice in the negotiations. Scientists involved in those debates took differing positions on political issues related both to the long-term health of science and the relations between science and society, suggesting that the "scientific community," if indeed it existed at all, did not always speak with one voice. Indeed the questions, Who speaks for science? And, for whom does science speak? which were scarcely articulated 40 years ago, have now become central to the problems of science, technology and their governance.
Certainly today the "metastasis" of science, in William D. Carey's words, "into all of our institutions, choices and dilemmas"\textsuperscript{21} has made it clear that the range of stakeholders extends well beyond those defined by the Bush-Magnuson version of the National Science Foundation. It has also made less tenable the myth that there is a single, monolithic scientific community led by a small handful of respected elders who are empowered to negotiate on its behalf. As in the prototypical case of the atomic scientists in the immediate aftermath of World War II, scientists during the past two decades have been involved on both sides of numerous public controversies concerning the applications of research results and even the directions of basic research itself, and have allied themselves with various other groups to press their case. And this, too, has eroded the myth that those directions or applications are, or can remain, insulated from politics in the broadest sense of the term.

Who, then, speaks for science? The National Academy of Sciences? Senior faculty in a handful of prestigious research universities? Employees of high technology industries who are constantly exhorted to greater efforts to meet the competitive threat of Japan? Scientists in Defense Department laboratories who have committed their talents to the maintenance of the security of the United States? Scientists working in less developed countries under AID auspices to discover the means for alleviating parasitic diseases?

And for whom does science speak? For U.S. universities? U.S. industry? The U.S. defense establishment? Broader segments of the U.S. population? The international scientific community? Clearly these questions cannot be answered by singling out any one of these groups.
Similarly, the third expectation—that reliance on a "magic hand" would remain the best policy to assure the translation of basic research results into social benefits—has also eroded. Ironically, the scientific communities may have been too successful in convincing the U.S. public that technology is centrally important to the resolution of significant national problems, such as maintaining national security, improving economic competitiveness, and protecting the environment; and that public support for basic research underlies essential technologies. Dollars allocated to one basic research area in preference to another are increasingly seen to influence whether and how these problems will be solved. Thus, the final expectation—that basic research would remain relatively cheap and cleanly separable from mission-oriented research and development—has also proved illusory. It is not surprising, then, that the public—and its representatives in Congress—have become increasingly skeptical about the proposition that no better policy can be found than reliance on a "magic hand" to insure rapid, optimum returns on public investments in basic research.

Since the late 1940s, there has been an immense scale-up of government supported research and development (R&D). This item now approximates 25 percent of the controllable federal budget, inviting close scrutiny from the Office of Management and Budget\(^{22}\) (OMB) and Congress. High costs and a need for coordination are strong arguments for long-range planning (and for a policy framework to define such planning) to make the most effective use of limited resources. Furthermore, the types and sites of the activities supported by the overwhelming bulk of the federal R&D budget are very different from the types of activities that lay at the center of the post-World War II debate between science and government. Yet the present
institutional structure for the support and conduct of science is such that those activities intrude heavily upon the conduct of basic research in universities.23

The Department of Defense (DoD) dominates the total federal research and development (R&D) budget, but is a relatively minor recipient of funds for the support of basic research in universities. In fiscal year 1984 (which began on October 1, 1983), the total amount appropriated for R&D by Congress was $43.2 billion, of which $26.4 billion, or 61.1 percent, was earmarked for defense and military purposes.24 Basic research funds appropriated for DoD during fiscal year 1984 were, however, only $847 million, or 3.2 percent of all defense-related R&D.25 In his fiscal year 1986 budget (effective beginning October 1, 1985), President Reagan proposed obligations of $39.4 billion for defense and military related R&D, or 68.4 percent of the total proposed R&D budget of $57.6 billion. Of this total, $934 million or 2.4 percent of defense R&D was earmarked for basic research.

By way of comparison, a total of $10.7 billion, or 24.7 percent of the total federal R&D budget, was appropriated for basic research (both civilian and military) in fiscal year 1984. Proposed obligations in the president's fiscal year 1986 budget were $12.0 billion, or 21.0 percent of the total requested for R&D. In fiscal year 1984, $3.9 billion was appropriated for the two federal agencies that support most civilian basic research--the Department of Health and Human Services (HHS) and the National Science Foundation (NSF). For fiscal year 1986, the president proposed obligations of $4.4 billion for basic research in HHS and NSF. Research grants awarded to independent investigators and institutions by these agencies are dispersed according to procedures very much in accord
with the post World War II compact that assigns decisions about detailed research priorities to the scientific communities. The goal of such research--publication in the open scientific literature--is generally viewed as unproblematical.

Even though money available from the Department of Defense for basic research in universities is relatively modest compared with funds available from the civilian agencies and has remained substantially constant, universities have increased their competition for it. Accountability requirements can be more onerous in defense-related research; and questions arise concerning publication in the open literature and communication with scientists and engineers in foreign countries. 26

Further strains in the science-government relationship originate from the growing capital requirements in different fields of basic research. Decentralized and uncoordinated research has become economically unfeasible in many cases. Recognizing that slices of the pie, while bigger, may be fewer, individual institutions compete more and more intensely for their share. 27 The high cost and consequent need to centralize large-scale facilities for basic research, such as particle accelerators and radio telescopes, has made possession of such facilities an economic plum, subject to competition in the political arena beyond the control of the scientific communities. Scientists and engineers themselves have institutional loyalties and are not above lobbying against one another when representing those institutional interests.

All these arrangements blur further the lines between basic research and other types of R&D activities, justifying further public skepticism of scientific claims to value neutrality. Once again we face the question, Who speaks for science?
Facing Up to Political Choices

In summary, strains in the post World War II system of government support for science have arisen largely because of the decreasing viability of the centuries-old assumption that scientific autonomy would in itself suffice to bring social benefits to king and pauper alike. But paradoxical as this assumption appears, there is ample anecdotal evidence that the results of undirected basic research conducted by relatively autonomous scientific communities have yielded a long stream of such benefits. A central problem, then, is how to modify the post World War II compact between science and government to take account of the present realities of the increased scale and augmented social relevance of science, while preserving sufficient autonomy for truly creative scientific work--creative work that will very likely to continue to underlie a great deal of social progress.

We would begin by recognizing that science, as an important social activity conducted in large measure with public resources, is necessarily conducted in the political arena. We would recognize that the myth that any part of scientific activity can be insulated from political processes is just that--a myth. Basic research has remained relatively insulated from interest group politics not because the apolitical nature of that small but centrally significant component of scientific activity was universally conceded in advance. Rather, its insulation was negotiated between scientific and other interest groups as part of the political compact of the late 1940s, and thus became a cornerstone of U.S. science policy.
In recent years, even that presumably insulated component of science has been subject to increasingly political definition, as contending groups have begun to recognize the significance of science to their short-term interests. So science itself has become politicized. But the myth of insulation has prevented science from developing a strong, overt negotiating stance as it did in the late 1940s, and the terms of its politicization are not necessarily those that are in the best interests of science or society. The myth may still be useful, but to whom?

How, then, can science participate as a strong actor in the political process, while maintaining or even improving its internal governance structure and autonomy? First, science will probably have to abandon the myth that it is—and must remain—totally insulated from political influences. Scientists and engineers and their organizations surely recognize that they can and do play important roles in negotiating directions and priorities for research. They realize that their interests may conflict even with one another and even within a discipline. Even though it is no longer possible to identify a small handful of elders who can speak for science, most scientists recognize and can agree about the essential linkages between science and various other aspects of national life. Most also agree about the need for science to maintain a reasonable degree of autonomy if it is to maintain a viable relationship with other social sectors, although they often disagree about what the nature of such relationships can or should be.

General directions and priorities for dollars for research are clearly politically negotiated, and scientists, engineers, and their organizations can and should play important roles in those negotiations. Judgments about the scientific value of particular research efforts should continue to be
vested in scientific peers, although it is sometimes difficult to identify those peers or the best mechanisms through which to engage their services. In addition, it is sometimes difficult to determine the nature and limits of scientific value. Nor is it clear how choices between widely different research areas should be made. Nonetheless, accountability legitimately demands intelligent and intelligible explanations. At times, accountability will raise important issues, overlooked by a narrowly defined group of scientific peers, that should be considered before final judgments are made.

Science will also have to consider the necessity for aggregated long-range planning, since the cost of research, even in many basic research disciplines, requires planning to make the most effective use of limited financial resources. Indeed, despite the persistence of the autonomous governance model and the corollary distaste for planning, U.S. scientific communities do engage in considerable planning, and do so increasingly as the cost and scale of basic research escalates. For example, basic research activity in several disciplines requires extensive capital investments in costly, centralized facilities, such as optical and radio telescopes, particle accelerators, or oceanographic vessels. A decade or more may be required to design, construct, and test such facilities, dictating the need for long-range planning and long-range decisions about the allocation of financial and human resources. Once constructed, such unique, centralized facilities are expensive to operate. Moreover, they rarely have the capacity to satisfy requests for their use by qualified scientists from all over the country—and from many foreign countries. Therefore planning for the optimum, equitable use of research facilities is necessary, as is delegation of a large measure of authority to those who manage the facilities.
Long-range planning is not limited to the construction and operation of facilities in the "big-science" disciplines such as astronomy, particle physics, or oceanography. It must also take usage into account. For the resources allocated by the president's annual budget to the federal agencies that support basic research in universities--principally the Departments of Defense and Energy, the National Aeronautics and Space Administration, the National Institutes of Health (within the Department of Health and Human Services), and the National Science Foundation--are insufficient to satisfy the claims of all qualified scientists. Therefore, these agencies--working in concert with their scientific constituents--must necessarily plan on how to make the best use of those limited resources. And that planning process must inevitably address the questions, Who speaks for science? and For whom does science speak?

Current planning is, in most instances, carried out in an ad hoc, piecemeal fashion. There is little coordination among agencies except for that which the Office of Management and Budget imposes in preparation for the president's annual budget. Planning remains piecemeal in part because of an aversion to centralization. More important, it remains piecemeal because the United States--unlike other industrialized countries--still lacks an explicit, comprehensive national science policy that would provide an agreed upon framework for such planning. That is, the United States has never attempted to develop a coherent statement of goals for science and engineering.

However, in one sense this chapter has described current U.S. science policy--a policy based on a tradition of American faith in scientific progress. Tracing back to the post-World War II compact, that faith requires that public funds be expended to support the basic research that
scientists themselves decide is important, and that the university-based scientific community enjoy the greatest possible measure of autonomy in the conduct of that research. It assumes that science policy should consist of little more than a reasonable assurance that funds appropriated for the conduct of basic research be more or less adequate, and a set of guidelines for targeting resources to meet explicit and usually short-term science-and technology-related objectives of the federal government.

Such a policy and the faith that underlies it carry the corollary assumption that science best serves broad social purposes when it speaks primarily for itself. Finally, they require the subsidiary notion that scientific research—particularly basic research—can be insulated from politics and that a magic hand can be relied upon to facilitate the transfer of research results into tangible benefits for each and every one of us—as we have already noted. The compact can also accommodate other subsidiary objectives: for example, directing ample scientific resources to meet defense requirements; or supporting science education largely as a spin-off of basic research support in universities. It has the advantage of appearing to take the politics out of science, and it satisfies powerful political forces both inside and outside of science.

This view is perhaps most appropriate, pragmatically speaking, when federal budgets for the civilian science agencies are expanding. In such times, even those agencies with strong mission orientation can afford to support "science-driven" science that is only peripherally related to their specific objectives. They can afford to accommodate, quietly, the goals of groups that do not dominate in the process. In lean years, however, federal agencies—particularly the mission agencies—are forced to retrench and focus more narrowly on their objectives. This process may be
labelled apolitical because for the most part it occurs administratively and does not involve specific discussions in the political estate. Nevertheless, such refocusing constitutes defacto policy making.

A broader view than what we have grown accustomed to during the past 40 years would envision national science policy as including, in addition to most of the pieces that comprise this existing minimalist policy, explicit provisions and strategies for incorporating scientific information and insights into decision making on a wide range of national issues that may not relate directly to the conduct of research: for example, the assessment and management of the hazards of toxic chemicals in the environment, or the problem of making effective use of science and technology as adjuncts to U.S. foreign policy.

Implementing a broad policy of this sort would require political negotiations of the kind that may have begun with an extensive series of special hearings scheduled during 1985 and 1986 by a House of Representatives task force under the chairmanship of Representative Don Fuqua of Florida. Certainly the formulation and implementation of a broader science policy would require scientists and engineers to develop clearer ideas of the appropriate roles for their expertise in democratic decision making. It would also require the development of initiatives well beyond those appropriate to the federal government. Such a policy—or set of policies—would have to include, at a minimum, strategies to stimulate and focus research and development activities elsewhere than in the federal government and in the institutions that rely heavily upon federal support. Such policies would have to articulate, explicitly, distinctions between the roles of the federal government, universities, private industry, and state governments, for example, in realizing national science- and
technology-related objectives. They would also have to specify areas in which the federal government would depend primarily upon universities and industry to attain national objectives, and areas in which it would not intervene in university and industry activities.

But of course no new science policy could be implemented prior to its formulation. And formulation of a comprehensive science policy—or, alternatively, forging a new, more comprehensive compact between government and science—would require undertaking a wide ranging political discussion and achieving a broad political consensus on a number of difficult issues, many of them only peripherally related to the conduct of research and many involving constituencies that are not presently regarded as natural allies of university-based scientific research communities. A more comprehensive policy need not imply more centralized control. On the contrary, negotiations leading to a more comprehensive compact between government and science would have to involve interests presently without a substantial voice in establishing priorities for federal support of scientific research. These interests would include, but would not be limited to, those which the Kilgore version of a National Science Foundation might have given a voice in the late 1940s. In other words, reopening serious negotiations would require facing the question, For whom does science speak?

Since a comprehensive national science policy would subject the basic research component of the annual federal R&D budget to considerably more political negotiation than at present, it can and has been argued that support for scientific research in universities might be subject to changing political fashions. However, despite this very real risk, there is by now a long-standing consensus about the desirability of stable basic
research support at reasonable levels. That consensus is likely to persist, despite negotiations about other, closely related components of the federal R&D budget.

A converse argument can also be made. Namely, that the process of negotiating a more comprehensive science policy could actually foster the autonomy of science within universities and even increase the resources devoted to scientific activities in those settings. For at present, science negotiates with government for resources and preservation of autonomy from a relatively weak position. However, if science were to seek and forge alliances with other groups with a strong interest if a less direct stake in the outcome of scientific activity, then it might be able to convince those groups about the long-range value of its vision of human knowledge and the essential character of its governance mechanisms, such as the peer review process.* It might then come to enjoy a much stronger negotiating position with respect to its core values, even though it might have to accept more realistic limits on the political uses of scientific knowledge. Science cannot and does not solve political problems, although it can help define, illuminate, and even partially resolve such problems within a well defined political structure and set of political procedures.

A comprehensive, negotiated science policy, then, might help to improve the political position of university-based research communities. In addition, it could direct science and engineering activities more purposefully toward the illumination and resolution of a broader range of national problems, as perceived by a wider range of social groups, than at present. But formulation and implementation of such a policy would require that science accept Bacon's vision of science as an integral component of
the larger society and larger culture. Then a broad spectrum of stakeholders might speak for science, and the answer to the question, For whom does science speak? would be almost self-evident.

**References**


2. ibid.


4. ibid., 5

5. ibid., 12

6. "It has been basic United States policy that Government should foster the opening of new frontiers. It opened the sea to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the frontier of science remains. It is in keeping with the American tradition--one which has made the United States great--that new frontiers shall be made accessible for development by all American citizens." Ibid., 11.


9. The early development of the peer review system that was destined to become central to the internal governance of science has been highlighted by Harriet Zuckerman and Robert K. Merton, "Patterns of Evaluation in Science: Institutionalization, Structure and Functions of the Referee System.," *Minerva.* 9 (January 1971): 66-100.


16. The phrase "interest group politics" as we use it here refers to processes through which interest groups such as organized labor, business, minority groups, and educational associations, for example, negotiate within the political arena in attempting to achieve their aims. William Carey has remarked on the absence of this sort of political negotiation for science policy, noting that, "When policies for science do emerge, they are not negotiated policies. The customary bargaining, the give-and-take, and the negotiating that shape economic and fiscal policies, foreign and defense policies, or policies for energy or tariffs or trade, do not occur when policies for science are involved." William D. Carey. "Science and Public Policy," Science Technology and Human Values. 10 (Winter 1985): 12.


24. Total R&D appropriations for fiscal 1984 (in billions of dollars) for the six federal agencies accounting for over 90 percent of the R&D budget, and obligations requested for those agencies in President Reagan's fiscal year 1986 budget, were:

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY 1984</th>
<th>FY 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>$26.4</td>
<td>$39.4</td>
</tr>
<tr>
<td>Department of Health and Human Services (HHS)</td>
<td>4.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>4.6</td>
<td>4.7</td>
</tr>
<tr>
<td>National Aeronautics and Space Administration (NASA)</td>
<td>2.9</td>
<td>3.7</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Department of Agriculture</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>


25. Fiscal year 1984 appropriations for basic research (in millions of dollars) and obligations requested for basic research in the president's fiscal year 1986 budget for the six agencies whose total R&D budgets are
listed in reference 24 were:

<table>
<thead>
<tr>
<th>Agency</th>
<th>FY 1984</th>
<th>FY 1986</th>
</tr>
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<tbody>
<tr>
<td>Department of Defense</td>
<td>$847</td>
<td>$962</td>
</tr>
<tr>
<td>Department of Health and Human Services (HHS)</td>
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<td>3049</td>
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<td>Department of Energy</td>
<td>827</td>
<td>934</td>
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<tr>
<td>National Aeronautics and Space Administration (NASA)</td>
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<td>834</td>
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<tr>
<td>National Science Foundation</td>
<td>1132</td>
<td>1366</td>
</tr>
<tr>
<td>Department of Agriculture</td>
<td>393</td>
<td>418</td>
</tr>
</tbody>
</table>


27. The economic advantage in having specialized research facilities has led, since 1983, to a number of so-called "pork barrel" incidents in which universities, often with the assistance of professional lobbying firms, have taken their case for funding such facilities directly to Congressional Committees or the floor of Congress, thus circumventing—or as some would subverting—established peer review procedures for determining the need and the location of such facilities. cf. Colin Norman, "Pork Barrel Scorecard," Science, 226, (November 2, 1984): 519; Richard C. Atkinson and William A. Blanpied. "Peer Review and the Public Interest," Issues in Science and Technology, 1, #4 (Summer 1985): 101-114; Congressional Record, September

