A History of Federal Science Policy from the New Deal to the Present

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Chapter 1

Foreword[1]

In various conversations I have had since returning to the academic world from my time in Washington, I have been asked a number of questions about how the U.S. government handles matters of science and technology: Why isn't there a more rational approach to setting research budgets? Why don't federal agencies work more closely together? Do the president and members of Congress understand how important science and technology are to the nation? Does the president listen to his science advisor? Should the U.S. establish a cabinet-level Department of Science and Technology? One could summarize these and many other such questions with one: Why doesn't the U.S. have a science policy? But that begs another question: would anyone pay attention to it if we did? The first question does have an answer, at least a historical one, which William Blanpied discusses in detail in this excellent book. The second question is a matter of opinion; and each of us—as readers of this detailed recounting of the experiences of science advisors to presidents over the last six decades or so—may form our own view.

The objective of this book is to trace the evolution of efforts to formulate and implement a coherent national science policy in the United States from the pre-WW-II years of the Roosevelt administration through the first months of the Obama administration and to describe how science advisors to presidents have coped in the absence of a national policy. The author also provides some earlier historical background and makes some observations on the Obama Administration's handling of science policy so far. Some U.S. presidents, most recently Presidents G.H.W. Bush and Clinton, have issued policy papers describing their administrations' strategies and objectives in science and technology. President Obama has issued his "Innovation Policy," which has science and technology at its foundation. But unless such policy statements are agreed to by Congress and written into federal law, they do not have the standing of a national science policy. Other nations have adopted science policies and reviewed and modified them from time to time to meet changing circumstances. The failure of the U.S. to do so reflects, to some extent, our nation's unique form of representational democracy and various public attitudes and political factors that influence policy-making in this country. The author tells the American science-policy story in this larger context and provides examples of debates in U.S. history between those who believe that the expert opinions of scientists, especially social scientists, should be given special weight in policy debates and those who feel that the American people know best.

There are a number of tensions in play that make it difficult to set science policy on many levels. One such tension is between what the legendary science policy scholar, Harvey Brooks, called "policy for science," viz., federal budgets, regulations affecting research, and other federal policies that directly affect research activity; and "science for policy," viz., the larger realm of public policy—e.g., in health, natural security, energy, environment, the economy, etc., where science and technology play an important role. Of course there is considerable overlap between these two categorizations; in part, it is ambiguities in the overlap that complicate policy-making. Tension arises when researchers in a particular field argue for increased research funding at the same time they are advocating a particular set of policies that involve factors other than

[1] This content is available online at <http://cnx.org/content/m34652/1.1/>.

science, e.g., a reduction in carbon emissions, or where the available scientific information is sparse, e.g., the regulation of nanomaterials in the environment. Even in the first category, "policy for science," there are tensions in funding priorities between different fields; between large centers, institutes and experimental facilities vs. individual investigators and small groups; between fundamental research and "directed" research, where progress toward specific objectives is measured; between peer review and Congressional "pork barrel" projects; between unfettered investigation and constrained research, e.g., embryonic stem cell research; and many others. To be sure, some of these tensions could be lessened and, perhaps, removed by having an overarching U.S. national science policy. At the same time, their existence can help explain why the nation has, so far, been unable to establish such a policy.

The lack of any well-defined strategic vision and long-range plan for the nation's science and technology efforts is the context in which science advisors to presidents, and members of presidents' advisory committees (e.g., PCAST and its predecessors) have had to operate. Of course, during WW II, federal R&D funding did have a single focus, to invent the tools—radar, proximity fuse, analogue computers, nuclear weapons technology—that were needed to fight the war; and most of the nation's scientists and engineers were united in that cause and engaged in the war effort. And in the early years of the cold war, especially following the launch of Sputnik by the U.S.S.R. in 1957, the single focus of the nation was national security—preventing Soviet aggression while avoiding all-out nuclear war, and winning the space race as well as developing advanced missiles and satellites. During this period, often described as the "golden age" of science advice to presidents, the science advisor focused on providing advice that the president needed and knew that he needed. The Apollo program symbolized the nation's commitment to science, engineering and technology. Apollo energized a generation of bright young men and women to go into science, mathematics and engineering careers. Furthermore, the federal government provided funds for their education and, for those who chose research careers, generous funds for research as well.

Aside from those moments in twentieth-century American history—WW II, Sputnik, the space race and Apollo—when national security trumped other policy matters, the nation's needs and priorities have been many and varied: jobs and the economy, affordable energy, clean air and water and protection of the environment, human health, and others. Soon after the historic moon landings of 1969-72, and the completion of the Apollo program, the nation's science and technology priorities became much less focused, leaving many young scientists and engineers without jobs to meet their expectations. Careers in science and engineering no longer looked so attractive to young people.

Science has always had much to offer in meeting society's broader needs. But none have provided an "Apollo" rallying point. Perhaps the challenges of energy and related climate change and environmental impacts will emerge as such an issue sometime in the future. But it is difficult to imagine how that will come about. True, a charismatic president could excite a generation of young people; but that excitement would have to be sustained and funded. Lacking any long-term national strategy to offer guidance on what research should be supported and how science, engineering and technology should be employed for the public good, the decisions are largely left to individual departments and other federal agencies responding, as best they can, to priorities of different presidents (and their political appointees) and to political pressures from many sides. Indeed, since the agencies that deal with science and technology are scattered among several appropriations subcommittees of the House and Senate, with no appropriate coordination mechanism—at least with regard to science—in place in either body, it is difficult to see how an overarching national science policy would be implemented.

For these reasons, the author points out that for most of the history of scientists advising presidents, the advisors have had to split their time between advising the president and attempting to coordinate the activities of various agencies to support the president's agenda and priorities. And, to have any influence at all, each science advisor has had to earn the confidence of the president and the trust of the political advisors closest to the president. Any hint that a science advisor had an agenda (increasing funding for academic research, for example) that differed from that of the president seriously undermined his ability to do the job. There have been times when a science advisor was frozen out of budget matters or national security matters either because other senior advisors did not trust him or because they simply didn't want his involvement. The president does not have time to sort out personal disagreements between senior staff;

so if a science advisor wasn't able to establish a good working relationship with the chief of staff and other aides, he quickly found himself out of the loop on important policy matters.

The author's detailed recounting of the experiences of science advisors since Vannevar Bush shows that the effectiveness of a particular advisor often depended on events beyond that advisor's control: public opposition by some members of the President's scientific advisory committee to such policies as the Supersonic Transport (SST); public (including vocal scientists') unhappiness over the Vietnam war; distractions such as the "oil crises" of 1973 (Yom Kippur War) and 1979 (Iranian Revolution); poor economic conditions; the science communities' rejection of President Reagan's "Star Wars" program, to name a few. The political advisors who were close to the president in many administrations tend to hold the view that even though the science advisor was not a "representative" of the science community, he should have been able to influence scientists to accept the president's priorities. It seems that when the science community is at odds with the president, the science advisor's job becomes more difficult. To put it in simplest terms, the president's science advisor can be most effective by: a) getting to the president with advice he needs, even if he doesn't know he needs it; and b) staying out of trouble. It's the latter that has often made life hard for science advisors through the years.

The author does not pretend to offer a blueprint for a U.S. national science policy or even advocate that the U.S. have one, leaving those judgments to the reader. His goal is to help the reader understand why the U.S. has no such policy, in spite of efforts at various times to establish one, and describe how U.S. science and technology and presidents' science advisors have fared in the absence of a comprehensive science policy. That said, by giving the reader a rich history and informed analytical perspective on American science policy, the author provides plenty of options from which one might construct a comprehensive science policy, should there ever be the political will to do so.

This well researched and clearly written book will be a very important resource for anyone interested in U.S. science policy. William Blanpied, a physicist, has devoted most of his career to public service, both inside the federal government (National Science Foundation) and through various non-government appointments. He is internationally recognized for his expertise in science policy, particularly in an international context. It was my pleasure to work with Dr. Blanpied during the time I was Director of the NSF. His book is suitable as a textbook for a course in science policy as well as a reference work for everyone else. And, while the focus of the book is *science* policy, it offers lessons for all those interested in how policy is set at the federal level.

Neal Lane
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Chapter 2

Preface[1]

This book traces the fitful course of federal attempts to define, formulate, and implement national science policy from the pre-war years of the Roosevelt administration through the early months of the Obama administration. It speculates only in the most general terms about what might constitute a consistent national science policy—one that would apply science and technology more effectively to a wide range of agreed-upon national objectives and provide adequate financial and human resources to the effort.

Arguably, part of the fitfulness is attributable to conflicts between the government's executive and legislative branches. Inconstancy also stems from disagreements between the scientific community and the government. It is also worth noting that there is no monolithic scientific community (or, better, science and engineering community) in the United States. Rather, there are multiple communities, over a wide spectrum of disciplines, which have disagreed among themselves about science policy. However, these communities—particularly their academic components—have been virtually unanimous in insisting that government should provide them with generous financial support for their research and educational activities, and that such support is in the national interest. But executive and legislative branches alike have sometimes regarded such arguments as special pleading by just another special interest group.

Since the late 1970s, American industry's spending for research and development has exceeded federal spending, although the bulk of those expenditures are for applied research and development. Government is still the primary funder of basic research, which is largely conducted in academia. Yet American companies still have a significant stake in an effective government science policy. Since the 1980s, industry has depended on universities to provide discoveries that industry can commercialize. Industry fortunes also depend on federal regulation and the maintenance of good relations with foreign governments.

Views on what a national science policy should be have emerged from three differing perspectives:

1. Beginning in the second term of the Roosevelt administration, social scientists within the administration argued that scientific resources could be an effective tool for governance.
2. In the immediate aftermath of World War II, the scientific elite argued that a consistent national science policy was needed for scientific results to advance the public good. As a necessary corollary, a national science policy for the public good required that scientific research receive generous federal financial support.
3. Scientists who had occupied key positions in the World War II Office of Research and Development emphasized the need for a national science policy that would preserve strong links between civilian science and the military services.

The ongoing effort to build a consistent national science policy has been marked by the insistence that special access to the highest policy levels of the federal government, including the president, is essential. Such access was in place during World War II, when Vannevar Bush served as *de facto* science advisor to President Roosevelt. It flourished during the short period between the shock of Sputnik in 1957 and the assassination

[1] This content is available online at <http://cnx.org/content/m34576/1.1/>.

of President John F. Kennedy in 1963. By 1968, the effectiveness of the presidential science advisory system was noticeably fraying, and it collapsed completely when President Richard Nixon ended it in January 1973.

Although a presidential advisory system was given statutory authority in 1976 with passage of the National Science and Technology Policy, Organization and Priorities Act, whose passage was encouraged by then-President Gerald Ford, its effectiveness and influence have varied according to the interests of successive presidents and their advisors. A broad spectrum of bewildering new problems that were virtually nonexistent or minimally important during the heyday of the first presidential science advisory system under Presidents Eisenhower and Kennedy limited the effectiveness of the revised system even during the science-friendly first Bush administration. These included, for example, environmental and energy issues, the effectiveness of the nation's health care system, the inadequacy of pre-college education, and the effective use of science as a tool for international diplomacy.

It is worth noting that all but four presidential science advisors have been physicists. Of the four exceptions, three came out of academia, and only one out of industry. Arguably, the insistence of an influential group of physical scientists that a strong presidential science advisory system should be the *sine qua non* of a consistent and effective national science policy may have hindered formulation and implementation of such a policy. The size and diversity of the federal science and technology system renders comprehensive knowledge of its many facets virtually impossible, and without such knowledge central coordination is problematic at best. Cabinet departments and independent agencies have often pursued their own effective science policies, with at least the tacit support of the White House and some monitoring by the Office of Management and Budget and the Office of Science and Technology Policy. But by the 1990s, science-related issues had become too diverse for central coordination at the presidential level. At best, the president's science advisor can hope that policies pursued by the separate federal science-related organizations are consistent with the president's priorities.

The presidential science advisory system reached its nadir during the George W. Bush administration. A potential reversal of that decline began with the election of Barack Obama, who nominated several well-regarded scientists, including one Nobel Prize recipient, to administration posts in November 2008 and during the first months of his administration. His February 2009 economic stimulus package also included generous support for several federal scientific agencies. Whether the presidential science advisory system will thrive during and after the Obama administration remains in doubt, however, since scientific issues generally are not accorded a high priority by the public.

Many friends and colleagues have contributed to the preparation of this book. Gerald Holton, as well as the late William Carey and William Golden, all encouraged my interest in science policy and its history. I am also grateful to Richard Atkinson for encouraging me to undertake this project in the first place. Darleen Fisher and Jennifer Bond gently (and often not so gently) nudged me to carry on when I became discouraged.

George Schillinger gave me a much needed and possibly decisive nudge when he reviewed three early draft chapters and insisted that I proceed.

David Beckler, Rita Colwell, John Gibbons, Neal Lane, Irving Lerch, Norman Neureiter, Rod Nichols, Tom Ratchford, and Al Teich provided useful reviews on earlier versions of the book's chapters.

Portions of Chapters 2 and 5 were adapted for an article published in the first annual volume of the *Journal of the Society for the History of the Federal Government,* edited by Benjamin Guterman, who made useful suggestions which have been incorporated into these chapters. Lee Ann Potter, then-president of that society, also encouraged me to pursue my research and writing on this topic.

Edward David, Susie Bachtel, and Fred Beuttler have been kind enough to supply many of the photographs appearing in the book, as have the digital archivists at the American Institute of Physics, the American Association for the Advancement of Science, the Council on Competitiveness, the National Academy of Sciences, the Historian's Office of the US House of Representatives, and the Franklin D. Roosevelt and Harry S. Truman Presidential Libraries.

It has been a particular pleasure to collaborate on several projects with Tom Ratchford, a colleague for more than thirty years. In particular, we coauthored an article on science policy in the United States that was published in the 2005 UNESCO World Science Outlook, and a follow-up article published in 2010.

And finally, any errors, distortions, misrepresentations and the like should be attributed to me, rather

than to any of the many individuals who have helped and supported me in this endeavor.

William A. Blanpied

December 2009

Chapter 3

Introduction[1]

3.1 Roots of a Concept

The government has gone through decades of ad hoc situations, arrangements regarding science and technology which have not been based on any firm policy but have responded merely to the current crisis. The results have been a marked inconsistency in utility and effect. In some cases things have worked well; at other times they have worked poorly.

—Legislative History of the OSTP Act of 1976[2]

The objective of this book is to examine the history not so much of science policy itself but rather of various concepts of what science policy is or ought to be, and the ways in which those concepts have been implemented.

During the two years immediately prior to the entry of the United States into World War II, President Franklin D. Roosevelt took two relatively low-key actions that were destined to have significant impact on the relationship between science and government in the United States. On September 9, 1939, he issued an Executive Order establishing the Executive Office of the President (EoP), following the recommendation of the President's Committee on Administrative Management, chaired by Louis Brownlow; and on June 15, 1940—five days after the fall of France—he accepted the proposal of Vannevar Bush, President of the Carnegie Institution of Washington and Chairman of the National Advisory Committee for Aeronautics (NACA), to establish a National Research Defense Council (NRDC) that would aid national defense by placing relevant non-governmental science sectors at the disposal of the government. In 1941, the NRDC joined the Medical Research Council as a component of the emergency Office of Scientific Research and Development (OSRD), whose director—Bush—reported directly to the president. This set a significant precedent for the special treatment of science by government.

The five or six years immediately following World War II are frequently cited as the period in which serious considerations of U.S. science policy were initiated. Between 1945 and 1951, more science- and technology-related federal agencies and advisory bodies were established than in any comparable period before or since. These included the 1946 establishment of the Office of Naval Research (ONR) and the Atomic Energy Commission (AEC), the Council of Economic Advisers (CEA), the National Science Foundation (NSF), and the Scientific Advisory Committee to the Office of Defense Mobilization (SAC/ODM), which was elevated to the President's Science Advisory Committee (PSAC) in 1957. The National Institutes of Health (NIH) also grew during these years from a relatively minor agency to the nation's principal support of biomedical research.

Debates about the charters of these agencies thrust large numbers of working scientists into overt political roles for the first time in American history.

[1] This content is available online at <http://cnx.org/content/m34577/1.2/>.

[2] *Legislative History of the National Science and Technology Policy, Organization, and Priorities Act of May 11, 1976 (Public Law 94-282)* which, among other things, established the Office of Science and Technology Policy within the Executive Office of the President.

While this was by far the largest and most coordinated federal effort to formulate science policy, it was not the first. Benjamin Franklin, James Madison, and others at the Constitutional Convention of 1787 proposed granting the new federal government authority over the conduct and support of science (the proposal failed, largely because it was seen as taking too much power away from the states). The Civil War years saw an expanded federal reach into science aided by the absence of opponents, who were sitting in the Confederate capital in Richmond. The 1862 Morrill Act established a system of land grant colleges and the 1863 chartering of the National Academy of Sciences (NAS) created a science advisor to the federal government. Another 1863 act led directly to the 1889 establishment of the Department of Agriculture (USDA). In 1884, Congress tasked the Allison Commission with determining whether there should be a federal Department of Science. With the onset of World War I, the federal government created the National Research Council in 1916.

But the Franklin Roosevelt administration the first to try its hand at long-range science-policy planning. Roosevelt's New Deal introduced two novel ideas regarding federal authority over science: it asserted the right and responsibility of the federal government to become directly involved with issues previously considered off limits; and it advanced the then-novel idea that new programs and budget initiatives should include long-range plans.

Figure 3.1: Franklin Roosevelt, ca. 1937. Courtesy of the Franklin D. Roosevelt Presidential Library.

Those two decisions had a substantial influence on the subsequent state of science policy in the United

States.

Both decisions, made in response to perceived crises, addressed the desire of Roosevelt and his senior policy advisors to have the federal bureaucracy adapt itself to an era of rapidly changing technological capabilities, and both asserted the need for federal access to institutions' scientific knowledge.

The ideas underlying these two decisions reflected different perspectives on how government ought to accommodate to technological changes, and on the scientific or expert knowledge required to address them.

Each decision also was made in response to a different crisis. The Brownlow report was requested by a president concerned with government's response to social and economic issues underlined by the Great Depression, and derived from the premise that the federal government had to engage in rational planning in order to fulfill its constitutional responsibilities. To that end, government should make full use of the knowledge and management insights derived from the social sciences. One member of the three-man Brownlow committee, Charles E. Merriam, Professor of Political Science at the University of Chicago, was a member of the Science Committee of the National Resources Committee, the latter chaired by Secretary of the Interior Harold Ickes, and was instrumental in the development of the 1938 report, *Research: A National Resource*, which in some respects qualifies as the first significant blueprint for a coherent U.S. national science policy, particularly its first volume, *Relation of the Federal Government to Research*.

The Vannevar Bush proposal was submitted to a president convinced that the United States was likely to get involved in the war in Europe. It derived from the premise that successful prosecution of that war would require the government to draw on the nation's non-governmental scientific institutions. Bush proposed linking those institutions to government through a coordinating committee of scientists directly responsible to the president.

Both reports qualify as strategies for using scientific knowledge to address critical national problems. The Brownlow report sought to improve linkages with social and economic policy-making and with their practitioners in academia. The Bush proposal focused on the natural sciences and engineering disciplines, particularly those relevant to national defense.

During the Kennedy administration, the noted scholar Harvey Brooks, a member of the President's Science Advisory Committee, considered the pros and cons of creating a cabinet-level Department of Science. Brooks introduced the idea of a duality: policy-for-science and science-for-policy. The former incorporates policies related to the financial support of science and the development of human resources for science and technology. The latter has to do with the uses of science and technology to advance policy goals of a presidential administration.

Since the 1960s, virtually every presidential administration and a large majority of members of Congress on both sides of the aisle have been in favor of federal support for university research, although there are inevitable disagreements about funding levels and distributions among science and engineering fields. They have also been in accord with a set of principles underlying policy-for-science: e.g., the autonomy of the non-government science communities in selecting and pursuing research projects, basing financial support upon scientific merit rather than any political considerations such as regional distribution of support, and the importance of peer review.

In contrast with the general agreement in the United States not only with the principles underlying policy-for-science as well as the issues it encompasses, there continue to be serious disagreements about science-for-policy. Upon reflection, the reasons are almost self-evident. Priority issues that science can and should address change with time. For example, when the first presidential advisory system was created in 1957 by President Dwight D. Eisenhower, it was concerned from the outset primarily with defense- and space-related issues. In contrast, the priorities of the Obama administration include the environment, alternative energy sources, and health. Likewise, priorities for policy issues depend on the party controlling the White House and, to some extent, the Congress. For example, the second Bush administration ignored and for much of its eight years virtually ridiculed mounting evidence for global climate change. In contrast, the Obama administration has assigned a high priority to the effective use of science to reduce the greenhouse emissions responsible for global climate change.

Interestingly, it is often the Congress rather than the Executive Branch which has been more consistently interested in a centralized science policy. The single instance of the enunciation of a coherent, unitary science policy was enactment of the Science and Technology Policy, Organization, and Priorities Act of 1976 (PL 94-282), which, among other things, created the Office of Science and Technology policy (OSTP) and mandated a President's Council on Science and Technology (PCST) to revive the presidential science advisory system abolished in January 1973 by President Richard Nixon. However, with the exception of Ford, successive presidential administrations declined to implement what the Congress regarded as significant aspects of PL 94-282, and in some cases exhibited ill-concealed hostility towards many of its provisions.

The committee structure of the U.S. Congress itself militates against attempts to define and implement coherent science policies. If a president were to formulate a coherent science policy, then submit it to the Congress for the requisite budget authority, it would receive no coherent consideration. Rather, thirteen different appropriations committees in the House of Representatives and an equal number in the Senate consider budget requests for the principal agencies concerned with research and development (R&D), including the Departments of Defense (DoD), Energy (DoE), Agriculture (USDA), and Homeland Security (DHS), and NIH, NASA, and NSF. Moreover, within each committee, these R&D organizations must compete for funds with agencies that do not provide appreciable support for R&D. For example, the budget requests of NSF and the Department of Veterans Affairs are considered by the same appropriations committees. A few science advisors, including Bromley, have been able and willing to communicate with key congressional committees and attain some semblance of the president's budget requests for high priority science-for-policy items. More often, the budgets approved by the appropriations committees and then the full House and Senate have little science policy coherence.

Because of the difficulties inherent in defining a coherent national science policy, a more important issue than whether such a policy *can* be defined might be whether and how well (particularly in view of congressional fragmentation) the elements of a science-for-policy in a given period of time—for convenience, a presidential administration—can be implemented. That is, how strong and effective is the institutional basis of the U.S. science and technology system?

Since November 1957, with a lapse between January 1973 and May 1976, a presidential science advisory system centered on a presidential science advisor has been largely responsible for overseeing and to some extent coordinating the federal science and technology system, as well as implementing those elements of science-for-policy that have been assigned a high priority by the incumbent president. The presidential science advisory system has also been responsible for trying to assure that an adequate policy-for-science is implemented. Finally, the advisory system, and particularly the president's science advisor, has in the best of times sought to maintain cordial relations with Congress, the scientific community, and the broader informed public.

Since World War II, public consciousness of the importance of science in public affairs has moved increasingly from the periphery to a position much nearer the center of political thinking and action. Yet diverging perspectives, and often major disputes, about the scope of science policy continue to frustrate most attempts to define, let alone formulate, anything resembling a comprehensive national science policy. Arguably, those divergences and disputes have also diluted the effectiveness of science in public affairs.

Occasionally, concepts of what a science policy ought to be emerged from a coherent theoretical concept, such as the efficacy of national planning based on objective data and analysis of constitutional limits on the use of expert knowledge in governance. Sometimes they have been the result of assessments based on historical insight, such as the experiences of war projected into a peacetime era. Sometimes, too, they have been little more than *post-hoc* justifications for a political *fait accompli*, such as the insulation of defense-oriented policies from the political debates that shaped science policy more broadly. But in all cases, those concepts have been shaped by—and given shape to—relationships among the institutions that comprise what can be loosely referred to as the U.S. science and technology (sometimes science and engineering) system.

Those institutions include, first and foremost, the components of the presidential science advisory system, including the Office of Science and Technology Policy (OSTP) and the President's Council of Advisors on Science and Technology (PCAST). They also include the principal U.S. government agencies that conduct research in their own laboratories and/or support extramural research and development; corresponding congressional oversight committees and the congressional research arms, particularly the Congressional Research Service (CRS); as well as the Office of Management and Budget (OMB), which succeeded the Bureau of the

Budget in 1974, the Federal Coordinating Committee for Science, Engineering and Technology (FCCSET—after 1993, the National Science and Technology Council—NSTC) that are ostensibly responsible for coordination of the federal research and development effort. They include the university and industrial research and development establishments. Importantly, they also include the complex array of official advisory committees to the principal science-related government agencies, as well as a number of science-related public interest organizations with access to those agencies.

Vannevar Bush's confident assertion in his seminal July 1945 report that if the federal government adopted his key recommendation, it should support research in universities and adopt a hands-off policy towards research in industry, it would thereby provide an essential basis for continued health, prosperity, and security. That recommendation, which was considered radical at the time, became the cornerstone of U.S. science policy.

During the approximately two decades following the end of World War II, when the United States was the most powerful and influential nation on earth, its military and industrial capabilities unsurpassed, Bush's industrial policy made sense. However, during the 1970s, the international competitiveness of U.S. industry was weakened by the reemergence of Western Europe and Japan, both of which had been devastated during World War II. As a consequence, the Bush report's assertion that the federal government should play no role whatsoever in industrial research and development came under reexamination. Did the United States require a broader science policy than Bush had advocated? In particular, could it define and implement elements of a technology policy linked with its science policy? This issue was debated by several key organizations, including the National Academies of Science and Engineering, and was addressed seriously during the first Bush administration.

During the 1980s, a select group of economists began to examine the question of whether Bush's assertion that science and technology in and of themselves could provide the basis for US prosperity and competitiveness was sufficient. Several scholars advanced the concept of a national innovation system, including not only science and technology but also economic factors such as legal and regulatory regimes, and venture capital firms. Since the early 1990s, then, the question of whether the United States can formulate and implement a coherent national science policy has been expanded to include the question of whether the nation can formulate and implement a national innovation policy.

Despite the absence of a coherent national science (or innovation) policy during this first decade of the twenty-first century, the U.S. science and technology systems continue to outpace those of other nations. Largely as a result of legislation enacted in the immediate aftermath of World War II, the U.S. research university system is universally acknowledged as the best in the world.[3] The United States remains the world's leader in industries such as information and communications technologies, biotechnology and nanotechnology, which are often cited as examples of industries based on the university-based knowledge economy, although other nations—particularly China and to a lesser extent India—are bidding to close the gap.

There are, of course, many significant technology-related problems that the U.S. government is only now beginning to address, including environmental problems, with an emphasis on global climate change, overreliance on petroleum, the development of alternative, sustainable energy sources, significantly rising costs of adequate health care, and woefully inadequate K-12 education. Perhaps some of these problems could be more adequately addressed if the United States had a coherent science policy.

The conviction that scientific knowledge and process are both important for governance predates World War II by at least 150 years. It is evident in the debates in the Constitutional Convention of 1787 and in the careers of Benjamin Franklin and Thomas Jefferson, for example. But something more than private conviction was required before the concept of a feasible national science policy could begin to take shape. What was required was the idea that the federal government has legitimate responsibilities for the national scientific enterprise extending beyond its own internal agencies and bureaus, and that discharging those responsibilities would be essential to its own capacity to govern and promote the national welfare. Those related concepts, which began to emerge during World War I and became pronounced during the early years of the New Deal, were articulated—if hesitantly—by both the Brownlow and Bush proposals.

[3] See, e.g., Richard C. Atkinson and William A. Blanpied, "Research Universities: Core of the US Science and Technology System," *Technology-in-Society* 30 (2008), 30-48.

Science has increased enormously in its capabilities and institutional complexities during the three-quarters of a century since those proposals were developed, even as the issues it has been called upon to address have proliferated—and its limitations in addressing them have become more clearly understood. The complexity of the external environment for U.S. science has likewise increased concurrently with the expansion of government, its responsibilities, and recognition of its limitations. As a result of these and other factors, the scope of what a coherent national science policy ought to entail has broadened and become significantly more complex.

Yet to a remarkable extent, the precedents that shaped the Bush and Brownlow perspectives persist in discussions and debates about the appropriate nature and scope of science—and innovation—policy today. One likely reason is that they reflect persistent themes in American intellectual history. How—or whether—those distinct sets of themes might have converged to yield a different kind of science policy in the absence of the overriding obsession with national defense that has been the dominant theme in postwar policy-making remains a fascinating question.

However, it is consistent with the implied assertion of *Science—the Endless Frontier* that science depends on its prosperity and its ability to serve the national interest in large measure with the changing political environment and, therefore, the broader policies of the federal government. Despite what many scientists would prefer to ignore, the advancement of science is dependent on politics. Examples abound since the establishment of the republic: the failure of Franklin and his colleagues to provide the federal government with broad authority for science in 1787; the establishment of the Land Grant Colleges and creation of the National Academy of Sciences during the Civil War when advocates of states' rights were sitting in the Confederate Capital at Richmond; the creation of the National Research Council during World War I; and the response of the Roosevelt administration to the successive crises of the Great Depression and World War II. This book highlights the increasing dependence of science on its relations with government—and vice-versa—starting with the responses of both science and government to the politics underlying those latter two crises.

Chapter 4

Knowledge for Governance: Social Science Perspectives on Science Policy through 1940[1]

Research is one of the Nation's very greatest resources and the role of the Federal Government in supporting and stimulating it needs to be reexamined.

—Franklin D. Roosevelt to Frederic A. Delano, July 19, 1937

The history of science as a facet of federal policy effectively begins with the Franklin D. Roosevelt administration. Before then, science in government fell haphazardly under the purviews of various government agencies and the military, with no central coordination by the president's office.

In November 1938, Roosevelt's Science Committee—part of the National Resources Committee—issued a report entitled *Relation of the Federal Government to Research*, the first in the three-volume *Research: A National Resource*. (*Industrial Research* and *Business Research*, the second and third volumes in the series, were issued in December 1940 and June 1941, respectively.) Because it made a strong, sweeping case for the federal government's interest in (and, to some extent, responsibility for) scientific research outside of its own bureaus, *Research: a National Resource*—and particularly *Relation of the Federal Government to Research*—is the first comprehensive federal government attempt to articulate a national science policy.[2]

Chaired by Secretary of the Interior Harold Ickes, the National Resources Committee's membership included the Secretaries of Agriculture, Commerce, Labor and War, and Works Project Administrator Harry Hopkins. Frederic A. Delano, President Roosevelt's maternal uncle, served as vice chairman of the full committee as well as chairman of its five-member, non-governmental working group. Prominent among the latter was Charles E. Merriam, chairman of the University of Chicago's innovative political science department, founder (in 1923) of the Social Science Research Council, and (in 1936-37) a member of Louis Brownlow's three-person Committee on Administrative Management. That committee's 1937 report would lead to creation of the Executive Office of the President.

In post-World-War-I America, there were three distinct sectors for scientific research: the government, academic, and industrial. Each had been established and developed during different periods. From the Washington presidency (1789-1797) until the Civil War (1861-65), government bureaus, including military departments, were virtually the sole institutions conducting professional scientific work.

After the Civil War, several old-line colleges transformed themselves into research universities based on a model that had emerged in Germany around 1820, and a number of new research universities were founded.[3]

[1] This content is available online at <http://cnx.org/content/m34578/1.2/>.

[2] National Resources Committee, "Relation of the Federal Government to Research," in *Research: a National Resource* (Washington, DC: US General Printing Office, 1938).

[3] See, e.g., Richard C. Atkinson and William A. Blanpied, "Research Universities: Core of the US Science and Technology System," *Technology in Society* 30 (2008), 30-48

The early twentieth century saw establishment of the nation's first industrial research laboratories. Their number and significance increased substantially as a result of World War I; by 1930, industry was the primary funder and conductor of scientific research.[4]

All three sectors suffered considerable setbacks as a result of the Great Depression, but all were recovering by the end of the 1930s.

Prior to World War II, these three sectors operated independently. Federal government bureaus would frequently contract with industrial laboratories for specific purposes, and industry provided some funding for university research. However, the federal government provided no financial support for research or instruction in universities. So the recommendation in *Relation of the Federal Government to Research* that the federal government provide limited funds for university research through a contract mechanism was considered radical by a handful of leading scientists, including the president of the National Academy of Sciences.

In 1940, the last full year before American entry into World War II, total U.S. expenditures for research and development were approximately $345 million, or $3.75 billion in constant, inflation-adjusted 2000 dollars.[5] Private industry accounted for 67.8 percent of these expenditures. The federal government was a distant second, at 19.4 percent, and universities and colleges accounted for 9 percent, with the remainder coming from other sources, including state governments and nonprofit institutions.

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[4] A. Hunter Dupree, *Science in the Federal Government: a History of Policies and Activities to 1940* (Cambridge, Mass.: The Belknap Press of Harvard University, 1957), 326-68.

[5] National Science Board, *Science and Engineering Indicators—2000*, vol. 1 (Arlington, VA: National Science Foundation, 2000), 1-9, Table 1-3.

expenditures were relatively modest, never amounting to more than one-half of 1 per cent.

TABLE I.—*Comparison of national research and development expenditures, 1930–1945* (excluding atomic energy)*

Year	Millions of dollars expended					Percentage of total expenditures			
	Total	Federal Government	Industry	Universities	Other [1]	Federal Government	Industry	Universities	Other
1930	166	23	116	20	7	14	70	12	4
1932	191	39	120	25	7	20	63	13	4
1934	172	21	124	19	8	12	73	11	4
1936	218	33	152	25	8	15	70	11	4
1938	264	48	177	28	11	18	67	11	4
1940	345	67	234	31	13	19	68	9	4
1941–45 average	600	500	80	10	10	83	13	2	2

[1] State Governments, private foundations and research institutes, including nonprofit industrial institutes.
*See appendix II for sources of estimates.

Government's Share

The Federal Government's share of the national research and development budget during this period ranged between 10 and 20 percent. Federal expenditures increased more rapidly than those of the other groups, rising from an annual rate of $23 million in 1930 to $39 million in 1932, $48 million in 1938, and $67 million in 1940. They were thus nearly tripled in the decade.

Industry

Research and development expenditures by industry about doubled in the same period, increasing from $116 million in 1930 to $234 million in 1940. It is significant that industrial expenditures in these fields continued to expand, despite the seriousness of the economic depression. This was true throughout the whole period, except for the years 1931–1933.

The number of industrial laboratories also sharply increased, continuing the rise which began shortly after the first World War. By 1940, there were approximately 2200 of these institutions, constituting a very significant sector of our total facilities.

Universities

Research expenditures of the universities and the non-profit research institutes also expanded during the 'Thirties, but at a much slower rate than those of the Government or of industrial laboratories. This fact is of significance because the larger share of such expenditures is for basic research, rather than for development. The amounts involved were relatively small—some $26 million in 1930 increasing to $42 million in 1940. The tendency for developmental and applied research to outrun basic research, greatly accelerated during the period of defense and war mobilization, was evident even in the 'Thirties.

Figure 4.1

From 1940 through 1945, government expenditures increased by a factor of almost five, due to military outlays during World War II, outstripping all other sources (Figure 1). Government R&D continued to dominate total national expenditures into the mid-1980s, when industrial expenditures began to take the lead and the divergence between government and industrial R&D continued to widen.

Total U.S. national expenditures for R&D in 2007 were $340.4 billion, or $307.6 billion measured in constant, inflation-adjusted 2000 dollars, with industry accounting for approximately 72 percent, the federal government for 25 percent, and the balance from universities and colleges and other non-profit institutions.[6] That is, the percentage of R&D investments by industry in 2007 was somewhat greater than in 1940, while the percentage of the federal government's investments was approximately 46 percent greater. However, total national R&D expenditures, measured in constant dollars, were a factor of over eighty times greater in 2007 than in 1940. This sharp increase brought radical changes in the status of American science and technology enterprises after World War II.

4.1 Social Science and Government

Although the social sciences were relative newcomers both as scientific disciplines and as members of and/or advisors to government, by 1937 their methodologies and insights had already made considerable inroads. *Relation of the Federal Government to Research* pointed to several earlier commissions created by Congress that had made effective use of the social sciences. These included the Industrial Commission (June 1898), the Immigration Commission (February 1907), the National Monetary Commission (May 1908), the Industrial Relations Commission (August 1912), and the Joint Commission on Agricultural Inquiry (June 1921). One result of the work of the last commission was the 1922 establishment of the government's second major permanent social science bureau: the Bureau of Agricultural Economics in the Department of Agriculture, which at that time oversaw the federal government's most extensive scientific research system. The first such bureau—the Bureau of Census in the Department of the Interior—had been established in 1902.

Had *Relation of the Federal Government to Research* not been overly concerned with political sensitivities, it might also have noted that the Hoover administration had also recognized the worth of the social sciences to government. *Report of the President's Research Committee on Social Trends*, published during the waning months of the Hoover administration (1929-33), compiled and analyzed indicators on a wide variety of societal matters that had been affected by World War I and the Great Depression.[7] Charles Merriam, vice-chairman of that committee, was instrumental in convincing Hoover to appoint the committee and to have it organized through his Social Science Research Council. A decade earlier, the non-governmental Institute for Government Research (later called the Brookings Institution) had issued an extensive series of *Service Monographs* that provided a bureau-by-bureau analysis of scientific activities in the executive branch.

While Hoover was interested in planning as a means for creating programs, Roosevelt saw it as a guide for action. Very early in the New Deal, Merriam came to Washington in an advisory capacity. He was the most prominent American social scientist to serve the Roosevelt administration while not actually accepting a position in it, although he finally did do so at the end of the 1930s. While Merriam rarely if ever is regarded as a founding father of science policy (and probably never would have thought of himself as such), he had significant direct and indirect influence on the formulation of such a policy.

4.1.1 Louis Brownlow

Although not an academic social scientist,[8] Louis Brownlow was responsible for bringing the insights of applied social sciences to bear on governance.[9] He was among those who convinced Secretary Ickes to bring Merriam to Washington early in the New Deal. A reporter in his younger days, Brownlow had devoted

[6] National Science Foundation, *National Patterns of Research and Development 2007* (Washington, DC: National Science Foundation, 2007), Table 1.

[7] Barry. D. Karl, *Charles E. Merriam and the Study of Politics* (Chicago: University of Chicago Press, 1974), 196-98.

[8] Brownlow occasionally joked that the last examination he ever took was to obtain his driver's license.

[9] Barry D. Karl, *Executive Reorganization and Reform in the New Deal: the Genesis of Administrative Management, 1900-1939* (Chicago: University of Chicago Press, 1979).

the bulk of his career to the professionalization of public administration. He had been a Commissioner of the District of Columbia for five years during the Woodrow Wilson administration and had later served as city manager of Petersburg, Virginia, and Knoxville, Kentucky. His Chicago-based Public Administration Clearing House—created with the encouragement of Merriam—was conceived as an umbrella organization for maintaining communication and information exchange among separate professional organizations of public administrators and for encouraging broader development of the public administration field. While in Chicago, Brownlow not only grew personally and professionally close to Merriam, but also became a political ally of Ickes. During the early weeks of the New Deal, Brownlow suggested to Ickes that a national planning board be appointed to advise him on oversight of public works. He also recommended that its three members be Frederic Delano, Charles Merriam, and Wesley Mitchell, the latter two having served as the vice-chair and chair, respectively, of the Hoover administration's Research Committee on Social Trends.

Brownlow's experience as a city manager formed his vision of professional public administration at the federal level. The city manager concept as it developed during the early years of the twentieth century held that the often competing demands for accountability to an electorate and efficient management could be reconciled through the appointment of a specialist (often an engineer) who would oversee management of municipal departments while answering to elected officials rather than an electorate.[10] Brownlow established his Public Administration Clearing House as a means for communication and information exchange among public administrators about their experiences, both positive and negative, with the expressed objective of professionalizing public administration at all levels of government. During the late 1920s and particularly following the onset of the Great Depression in 1929, the efforts of Brownlow and others to professionalize urban public administration came to the attention of several state governors, including Roosevelt in New York. In March 1936, Brownlow was named chairman of the President's Committee on Administrative Management, and was in a position to try to implement his ideas at the federal level. The committee's report was transmitted to President Roosevelt early in 1937, well before the November 1938 transmission of *Relation of the Federal Government to Research*.

4.1.2 Charles E. Merriam

Barry D. Karl, Charles Merriam's biographer, has characterized him as "an academic entrepreneur whose extraordinary sensitivities to the ideas of his times were combined with a willingness to govern the resources available for the development of those ideas to produce a phenomenon rare even in its day: a genuine school of thought." [11]

Merriam's principal methodological innovation as the first member (in 1903) of the University of Chicago's political science department and eventual full professor and chair of that department was to give political science less theoretical and more empirical grounding. In particular, he made use of Chicago itself as a laboratory for field research, following the example set earlier by academic sociologists. His *Non-Voting: Causes and Methods of Control*, co-authored with his colleague H.F. Gosnell and published in 1924, marked "the public debut of what came to be known as the Chicago School."[12] This study, "utilizing a research staff of undergraduate as well as graduate students, studied the Chicago mayoralty campaign of 1923." It was "the first major study in political science to use both random sampling and the statistics of attributes."

Non-Voting and its underlying methodology drew largely favorable reactions from academic social scientists, and Chicago business and political leaders were impressed with the potential of such studies to serve as tools for urban planning. Merriam and his colleagues saw no conflict of interest in involving academic social scientists in business and government. After all, the European founders of the social sciences regarded them as a basis for social engineering that could result in rational policy developments. Part of a wave of politically engaged pre-World-War-II American social scientists, Merriam was active in Chicago politics. He was elected as an alderman, and in 1911 waged an unsuccessful campaign for mayor.

[10]Harold A. Stone, Don K. Price, and Kathryn H. Stone, *City Manager Government in the United States: A Review After Twenty-five Years* (Chicago: Public Administration Service, 1940).

[11]Ibid., viii.

[12]Ibid., 148.

In 1923, Merriam took the lead in establishing the Social Science Research Council (SSRC), modeling it explicitly on the National Research Council (NRC). The NRC, based on the National Academy of Sciences (NAS), was created in 1916 as a means for applying the expertise of the nation's natural scientists to problems that would be encountered in World War I. Following the war, the NRC became involved across the spectrum of the sciences, raising funds for research and for fellowships. In cooperation with its parent NAS, the NRC also undertook specific studies at the request of federal bureaus and the U.S. Congress. Merriam had similar ambitions for the nascent SSRC.

Consistent with his conviction that academic social science should be closely linked with governance, Merriam engaged throughout the 1920s in building associations of local government officials. "The purpose of such an organization was to be the same as that for social science: exchanges of information, the creation of machinery for research, interchange and identification of personnel."[13] In 1930, Merriam was also instrumental in establishing Louis Brownlow's Public Administration Clearing House, conceived as an umbrella organization for maintaining communication among professional organizations of public administrators, and for encouraging the broader development of the public administration field. Although Merriam and Brownlow first met in 1931 when Brownlow came to Chicago to set up his Public Administration Clearing House, the two men had known of each other's work for several years, and were to become close colleagues and friends.

4.2 The National Planning Board

During the 1920s and early 1930s, Roosevelt was one of several governors who appreciated Merriam's and Brownlow's efforts to professionalize public administration. During his 1932 campaign for the presidency and his first weeks in office, Roosevelt sought the advice of a number of academic social scientists. Known as his "brain trust," the group included Rexford Tugwell, Raymond Moley, and Adolph Berle. "Roosevelt," as Merriam's biographer notes, "could scarcely have avoided turning up Merriam."[14] From the earliest days of the New Deal, Merriam had reasonable inside knowledge of the trends in the young administration through his Chicago friend and political ally, Harold Ickes, an old line Progressive who had managed Merriam's unsuccessful mayoral campaign.

The New Deal's early years were memorable for the large number of new federal bureaus created to deal with the multiple crises of the Great Depression and to establish mechanisms to mitigate future crises. The federal government assumed unprecedented responsibility for dealing with a far greater range of social and economic matters than anyone—even Roosevelt himself during the 1932 campaign—had envisioned.

A second, less widely appreciated Roosevelt innovation was his development of planning as a tool for governance. It was a revolutionary idea; his predecessor, Hoover, was convinced that elevating government planning to the level of the presidency would cause too much centralization, leading to quasi-socialism or quasi-fascism.[15]

During his first months in office, Roosevelt tried without success to persuade Merriam to join his administration. Taking the first step in elevating Merriam's concept of scientific (i.e., *social* scientific) planning to the federal level, Roosevelt did convince Merriam to become one of three members of a new, non-governmental advisory committee: the National Planning Board.[16] The other two members were Frederic Delano and Wesley C. Mitchell, the latter a distinguished economist, research director of the National Bureau of Economic Research, and former chair of the Hoover administration's Research Committee on Social Trends (for which Merriam had been vice-chair). Among the committee's first actions was an April 1934 request that the National Academy of Sciences prepare a report on the role of science in planning.[17]

[13]Ibid., 226.
[14]Ibid.
[15]Ibid., 244.
[16]Dupree, *op.cit.*, 354.
[17]Ibid.

4.3 The Science Committee of the National Resources Committee

The next few years saw a dizzying series of committee name changes and remapping of the federal bureaucracy that added up to a steady expansion of the National Planning Board's mandate, and its movement closer to the federal center of power. In 1934, it was replaced by the National Resources Board, which in turn became the National Resources Committee in 1935. The new board was a governmental organization chaired by Ickes and including the secretaries of several cabinet departments concerned with natural resources. The former three-member non-governmental National Planning Board members now were the advisory committee to the National Resources Board/Committee, and Frederic Delano was appointed its vice-chair.

Ickes had convinced the president that national planning was urgently needed to support federal initiatives in the management of land, water, mineral, and power resources. Technical committees were appointed in each of these areas. Then the National Resources Board decided to undertake the study of human as well as natural resources. In February 1935, the board invited the National Academy of Sciences, the Social Science Research Council, and the American Council on Education each to nominate five members to an advisory Science Committee.[18]

Edwin B. Wilson, a mathematical physicist on the faculty of the Harvard School of Public Health, chaired the science committee. During 1936, the committee focused its attention on population problems and the social consequences of invention. Early in 1937, it convinced Delano to propose to the president that they study the "interrelations of government and the intellectual life of the nation, whether in research, in education, or in technology."[19] The following July, Roosevelt approved "a study of Federal Aids to Research and the place of research (including natural and social science) in the Federal Government."

[18] One of the three members designated by the National Academy of Sciences was John Merriam, a distinguished paleontologist, who was Charles Merriam's elder brother.

[19] Dupree, *op. cit.*, 359.

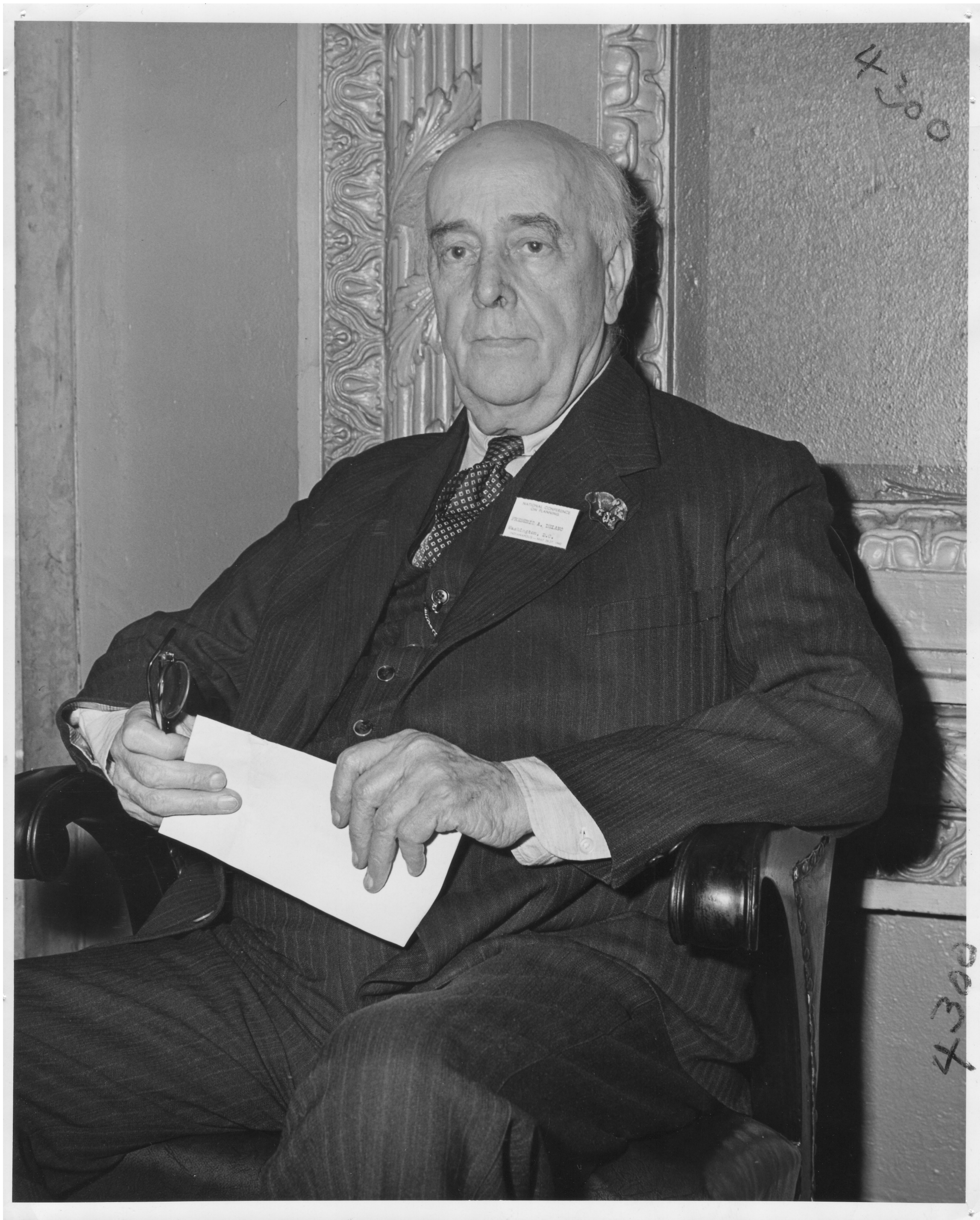

Figure 4.2: Frederic A. Delano. Courtesy of the Franklin D. Roosevelt Presidential Library.

In view of Merriam's interest in planning as a tool for governance, it was inevitable that the resulting

Relation of the Federal Government to Research should have emphasized both natural and social science. This was the first official government report to view the entire system of science as a potentially significant tool for federal governance. It was also the first to recognize the importance of establishing stronger links between the federal scientific enterprise and non-government scientific research.

The report was groundbreaking. Produced under the auspices of a committee made up largely of social scientists, it broadly defined what qualified as research. It also took historic steps toward formulating a national research policy in which the federal government would assume some measure of responsibility for research outside of government in both the natural and social sciences. Previously, the federal government (with the single exception of agricultural research in the land grant colleges created by the Morrill Act of 1862, and the National Advisory Committee for Aeronautics) had provided no financial support for research in universities.

Relation of the Federal Government to Research consists of a sixteen-page Report of the Science Committee and more than two hundred pages of "Supporting Studies,"[20] many based on written questionnaires and interviews with over fifty federal bureaus involved in natural and social science research. These studies include over fifty pages on "The Legislative Branch and Research," and thirty pages on "Research in American Universities and Colleges." In particular, the report recognized the vital importance of statistical data collected by various federal bureaus to social science research in academia. This emphasis implicitly recognized the pivotal importance to academic social science of the innovative work of Merriam and his colleagues in Chicago during the 1920s.

From the perspective of the twenty-first century, some of the more pertinent findings are these:

- Competition for research workers and the demand for large funds to support research have created a situation which calls for better coordination of the research facilities of the Nation than now exists.
- The recruiting, placement, and in-service training of research workers in the Government are, under present conditions, less satisfactory than they might be.
- The solution of the problems of the utilization of the research facilities of the country as aids to research in the Government is rendered readily possible by the existence of a number of national councils made up of the scientific specialists in the major lines of research.
- It seems feasible to make more extended use than at present of the plan of entering into contracts with national research organizations to take charge or research projects.
- International cooperation in scientific research now exists on a large scale. It could be encouraged to the great advantage of the Nation if the Federal Government would adopt the practice which is common among the Governments of other nations of according official recognition and, wherever necessary, financial support to international gatherings of scientists.

On the basis of these and other findings, the report made several recommendations, including:

- That steps be taken to improve the methods of recruiting research workers for governmental service and to provide more effective in-service training for Civil Service employees of the Government.
- That research agencies of the Government be authorized and encouraged to enter into contracts for the prosecution of research projects with the National Academy of Sciences, the National Research Council, the Social Science Research Council, the American Council on Education, the American Council of Learned Societies, and other recognized research agencies.
- That research agencies of the Government extend the practice of encouraging decentralized research in institutions not directly related to the Government and by individuals not in its employ.
- That the interrelations of governmental research agencies be furthered by the organization of central councils along the lines followed by the existing national councils of research specialists. These interagency councils would serve to systemize the efforts which are now made by various interbureau committees to coordinate the research activities within the Government.

[20] National Resources Committee, *op. cit.*

4.4 Knowledge for Governance

The three-volume *Research: A National Resource* made a strong case for a national policy linking scientific knowledge to the problems of governance. It argued that research should be regarded as a national resource at least on a par with physical resources. It recognized that the U.S. government's natural sciences *and* social sciences bureaus existed in the context of a national research system that depended on the federal system, and that the federal system in turn depended on a vigorous external system. This amounted to an argument that the United States needed a comprehensive policy for linking science with the nation's social and economic objectives—what Harvey Brooks would later call science-for-policy. The report went on to recommend several steps to achieve that end, including expansion and modification of the federal contracting system to facilitate the support of university research in areas of clear national benefit.

Academic social scientists who joined the Roosevelt administration saw no conflict between academic research and government service. They believed that academic social science depended upon its relationship with government to prosper, and that government depended upon insights from the social sciences to function effectively.

The 1937 report of the President's Committee on Administrative Management marked the apex of the influence of social science in the New Deal. Roosevelt established the committee with the aim of making "a careful study of the organization of the Executive branch of Government . . . with the primary purpose of considering the problem of administrative management."[21] The ostensible reason for the study was to bring greater organizational coherence to the host of specialized agencies that proliferated during the first years of the New Deal. A second reason was Roosevelt's desire for an administrative structure "to give the President authority to carry out his responsibilities under the Constitution," or, in effect, to provide him with the tools to get his arms around his government.

The evolution of the Bureau of the Budget (BoB, which became the Office of Management and Budget, OMB, in 1974) provides an example of the increasing complexity of the federal government.[22] Prior to 1921, the president did not submit a consolidated budget to the Congress. Instead, individual cabinet departments and independent agencies submitted their own budget proposals directly to relevant congressional committees. In 1921, Congress created the Bureau of the Budget within the Treasury Department as a means of encouraging the preparation and submission of a more coordinated, consolidated budget. With the rapid expansion of federal emergency agencies during the first years of the New Deal, the organizational position of BoB within one of several cabinet departments made the federal budget process increasingly inefficient.

One of the key recommendations of the Committee on Administrative Management was that BoB should become one of three agencies within a newly created Executive Office of the President (EoP) and thus in close proximity to the president himself. As it turned out, the refashioned BoB was to become not only a presidential budget tool but also the arbiter and enforcer of presidential policies throughout his government.

Although the report had nothing to say about the role of research within the federal government and therefore cannot be regarded as a precursor of attempts to create a consistent government science policy, it helped set the stage in two ways: it recognized sound data as essential for governance; and it led to the creation of the Executive Office of the President, the organizational home of several World War II emergency agencies (including the Office of Scientific Research and Development, headed by Vannevar Bush), which eventually would house several incarnations of a presidential science advisory system.

The seeds for that study were sown in November 1933 by the three-member National Planning Board—namely, Frederic Delano, Wesley Mitchell, and Charles Merriam.[23] Each developed his own ideas about national planning, with Merriam developing a concept for a governmental and political plan, which he completed and shared with members of what then was about to become the National Resources Committee. Roosevelt then asked Merriam to prepare a memorandum on the subject, which he did in cooperation with Brownlow. The memorandum eventually led to creation of a report by the Committee on Public Administration of the Social Science Research Council (SSRC), which was transmitted to Roosevelt early

[21] Barry D. Karl, *Executive Reorganization and Reform in the New Deal: the Genesis of Administrative Management, 1900-1939*, *op. cit.*, 209.

[22] Percival Brundage, *The Bureau of the Budget* (New York: Praeger Publishers, 1970).

[23] Karl, *Executive Reorganization and Reform in the New Deal, op. cit.*, 203-04.

in 1937. It opened with an introduction by Brownlow on The Purpose of Reorganization: "There is but one purpose, namely, to make democracy work today in our National Government; that is, to make our Government an up-to-date, efficient, and effective instrument for carrying out the will of the Nation. It is for this purpose that the Government needs thoroughly modern tools of management."[24]

The report went on to recommend consolidating various existing bureaus within cabinet departments, reorganizing the federal government's fiscal and accounting system, and appointing a six-person White House staff to serve as liaison to cabinet departments.

Figure 4.3: President's Committee on Administrative Management, 1937. Left to right: Louis Brownlow, Luther Gulick, Charles Merriam. Courtesy of the Franklin D. Roosevelt Presidential Library.

The centerpiece of the report was its recommendation of a new Executive Office of the President (EoP) that would put budgeting, planning and personnel management—which committee members regarded as the essential tools of public administration—under direct control of the president. These would be administered on behalf of the president by the National Resources Planning Board; an office to supercede the quasi-independent Civil Service Commission; and the Bureau of the Budget, which had been housed in the Treasury Department since the bureau's creation in 1921.

[24]Karl, *Executive Reorganization and Reform in the New Deal, op. cit.*, 229.

4.5 Congressional Reaction

Roosevelt transmitted the report to Congress on January 12, 1937, a few days before his second inaugural. But coming hard on the heels of his controversial court-packing proposal, the bill that would have implemented the recommendations was rejected by the Senate, which regarded it as a "dictator" bill that intruded on congressional prerogatives. Despite this defeat, many of the Brownlow committee's recommendations were quietly put into effect through piecemeal actions over the next two years. The EoP was established temporarily in 1939, extended with the War Powers Act of 1941, and given permanent status with the Reorganization Act of 1945. Although Congress continued to deny Roosevelt the authority to reorganize the quasi-independent Civil Service Commission (now the Office of Personnel Management) as an executive office, it approved the plan to reorganize the National Resources Committee and elevate its status to that of the National Resources Planning Board within the Executive Office of the President; and to transfer the Bureau of the Budget to the EoP from the Treasury Department. At this point, Merriam finally assumed a position within the federal government as vice-chair of the three-member National Resources Planning Board, serving under the chairman Frederic Delano.

This was to prove a short-lived triumph. Under siege by congressional critics who still regarded central planning with suspicion, and with the president's attention absorbed by the looming war, the National Resources Planning Board was abolished in 1941, and the postwar period saw the ascendance of natural scientists. Not until the late 1960s would social sciences again be recognized as worthy of federal support.

4.6 Aftermath

Still, the idea that social-science-informed planning was essential to effective management of the executive branch survived. The executive office structure turned out to be well suited to the temporary emergency agencies created during World War II. In 1946, the EoP became home of the new Council of Economic Advisers, a body established with the expectation that sound data and expert knowledge, coupled with access to the president, would advance domestic prosperity. A year later, the National Security Council became an additional arm of the EoP with the expectation that it would serve an analogous function for the president's management of expanding international responsibilities. And the concept of rational planning based on expert knowledge as essential to the modern presidency obviously survives in the form of our presidential science advisory system, as does the EoP as its organizational home.

Acceptance by government of the proposition that expert knowledge is essential to effective governance also attracted to Washington many energetic and talented young men who had been exposed to the ideas of Merriam and Brownlow and who were convinced that government service during the New Deal provided an opportunity to make a difference. Prominent among these were Elmer Staats, who received his Ph.D. from the University of Minnesota in 1939 after a year-long fellowship at the Brookings Institute, then joined the BoB, becoming its assistant director in 1947, and going on to serve as Comptroller General from 1961 to 1988. Brownlow's protégé Don K. Price joined the BoB in 1943, audited the super-secret facility at Los Alamos, helped organize a new relationship between science and government, and later became Dean of the Littauer (now the Kennedy) School of Government at Harvard University. William D. Carey came to Washington in 1942 and served as principal federal negotiator between the Congress and the scientific community from 1946 to 1950, helping forge the bill creating the National Science Foundation.

With the refusal of the Congress to transfer the personnel management functions of the Civil Service Commission to the EoP and the demise of the National Resources Planning Board in 1941, the BoB became, by default, the primary embodiment of the idea within the federal government that knowledge and governance ought to be closely coupled. Thus the BoB became the home of energetic young men who were convinced that they could make a difference by means of careers in government. These young men, inspired by the ideas of Merriam, Brownlow, and others, were instrumental in establishing the structure of post-war science policy in the United States.

Chapter 5

Science for the Public Good: Natural Science Perspectives on Science Policy through 1940[1]

We might as well command the sun to stand still as to say that science should take a holiday.... Merely because it has served us well is no reason why we should charge science with our failure to apportion production to need and to distribute the fruits of plenty equitably.

—Henry A. Wallace, 1934

In a 1934 address entitled, "Research and Adjustment March Together," Secretary of Agriculture Henry A. Wallace took exception to the prevailing view that the New Deal should be exclusively concerned with short-term expedients aimed at the Great Depression.[2] Although he oversaw what was then the federal government's most extensive research system, Wallace's vision of science as a key to national prosperity was considerably broader. Acting largely on his advice, Roosevelt issued an executive order in July 1933, establishing a Science Advisory Board "with authority. . .to appoint committees to deal with specific problems in the various Departments and thus to carry out 'to the fullest extent' the Order of May 11, 1918, requesting the National Academy of Sciences to perpetuate the National Research Council."[3]

[1] This content is available online at <http://cnx.org/content/m34579/1.1/>.

[2] A. Hunter Dupree, *Science in the Federal Government* (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1957), 350.

[3] *Report of the Science Advisory Board: July 31, 1933 to September 1, 1934*, 11.

Figure 5.1: Henry A. Wallace and Franklin D. Roosevelt, 1940. Courtesy of the Franklin D. Roosevelt Presidential Library.

Chaired by MIT President Karl Compton and housed within the National Research Council (NRC), the Science Advisory Board consisted of nine members during its first year and was expanded to sixteen in May 1934. Among its more notable members were Simon Flexner, Director of the Rockefeller Institute for Medical Research; Frank B. Jewett, Vice-President of the American Telephone and Telegraph Company (and later President of the National Academy of Sciences); Charles Kettering, Vice-President, General Motors Research Corporation; John C. Merriam (the elder brother of Charles Merriam), President, Carnegie Institution of Washington; and Robert A. Millikan, Director, Norman Bridge Laboratory of Physics, California Institute of Technology.

The board was initially supported by a small grant from Louis Brownlow's Public Administration Clearing House, and subsequently by a more substantial grant from the Rockefeller Foundation's Social Science Division, whose research agenda owed a great deal to Charles Merriam.

The Science Advisory Board established committees to inquire into the organization, objectives, and programs of various government scientific bureaus, most often in response to direct requests from the Secretaries of Agriculture, Commerce, and Interior. In so doing, it followed the established procedures of the National Research Council in responding to requests for advice from the federal government, albeit on a considerably more extensive scale. For example, the board's first report, issued on September 1, 1934, lists summary reports of the activities of the Department of Agriculture, the Bureau of the Budget, the Department of Commerce, and the Department of the Interior, with several appendices including proposed draft legislation "to authorize appropriations to pay the annual share of the United States as an adhering member of the International Council of Scientific Unions and other associated unions."

The board's second annual report was considerably more ambitious.[4] Its first section proposed "A National Program for Putting Science to Work for the National Welfare." Many scientists regarded it as a proposal "Putting Science to Work for the Welfare of Science"—the beginning of a long argument by scientists and engineers that if science is to serve the public good, the nation had to be concerned with the welfare of science itself.

Compton and his board asked the President to appropriate $5 million annually over a five-year trial period for the support of science and engineering research outside of government—primarily in universities—as a basis for public works programs and a means to provide work for unemployed scientists. The program would use existing university facilities to conduct research regarded as being consistent with national needs, thus linking science with social and economic objectives while providing financial resources for science itself.

Roosevelt turned the proposal over for evaluation by Delano, Charles Merriam, and Wesley Mitchell,

[4] *Report of the Science Advisory Board: September 1, 1934, to August 31, 1935*, 11.

all of whom regarded it as too narrowly emphasizing the natural sciences and engineering.[5] Delano wrote bluntly to Compton in December 1935, "I feel, and I think I may safely say that my colleagues feel, that we cannot undertake the program for pure and applied science without considering the merits of similar but doubtless ambitious programs of the social sciences, of economics, and of education in general."[6] Shortly thereafter, the Science Advisory Board was allowed to die a quiet death. The board's demise was partly due to the failure of Compton and his colleagues to make a convincing argument for special federal treatment of natural science and engineering, and partly due to the New Deal's priorities in 1934-35, when the focus was still on immediate relief measures. The plight of unemployed scientists did not loom large in this scheme of things.[7] Members of the Science Advisory Board also had failed to grasp the realities of the New Deal's intellectual-political environment, in which many of their academic colleagues from the social sciences exerted considerable influence.

The travails of the Compton committee had a long history. Many leading American colonists believed that science was essential to a progressive nation. In 1743, Benjamin Franklin founded the American Philosophical Society for the purpose of "promoting useful knowledge";[8] the Boston-based American Academy of Arts and Sciences was established along the same lines in 1790, with President John Adams one of the prime movers. Several participants in the 1787 Constitutional Convention, convinced that science was integral to the public good, wanted to write into the Constitution far-reaching authority for the executive branch to engage in and support scientific activities. Faced with strong opposition from delegates concerned with states' rights, they had to settle for granting authority to the executive branch to grant patents, control standards of weights and measures, and conduct a decennial federal census. Even efforts to foster science with charitable contributions met opposition: When George Washington bestowed land to the federal government for establishing a national university, his gift was turned down by Congress on the grounds that it would have bestowed control of an internal improvement on the federal government. Internal improvements were what we would now call infrastructure developments, including roads, bridges, canals, and institutions of higher education. A few years later, the same argument killed Thomas Jefferson's attempt to establish a national university.

The most ambitious pre-Civil-War attempt to institute a national science policy was spelled out in John Quincy Adams's 1826 message to Congress.[9] Adams asserted that the rapid development of the United States required some measure of federal authority over such tangible internal improvements as roads and canals, and that government had a duty towards knowledge as "among the first, if not the first, instrument for the improvement of the condition of man." He called for the establishment of a national university and a national observatory, and for voyages of discovery. His congressional allies proposed a Constitutional amendment giving Congress authority to "make surveys . . . to construct roads . . . to establish a National University . . . and to offer and distribute prizes for promoting agriculture, education, science and the liberal and useful arts."[10] But the amendment failed, as did virtually all of Adams's other proposals. Subsequently, as a member of the House of Representatives from Massachusetts, he helped shape the contours of the Smithsonian Institution.

This bequest of James Smithson to the United States to establish a scientific institution was at first opposed in Congress on the by-then-familiar internal improvements grounds. Adams, however, managed to broker an agreement that would make the Smithsonian a research facility, forswearing any ambitions to become a national university. Congress appropriated no funds, simply accepting and providing shape and substance to a private bequest, and stipulated that a political, non-scientific Board of Regents would oversee the Smithsonian's scientific work. The first secretaries of the Smithsonian (in particular the very first, Joseph Henry, who had been a distinguished professor of physics at Princeton University), drawn from outside government and not beholden to Congress for resources, enjoyed a degree of autonomy comparable to

[5]Since both Merriam and Mitchell were members of the board's Committee on the Relations between Fundamental Science and the Study of Human Problems, they very likely had some foreknowledge of its proposed program.

[6]Dupree, *op. cit.*, 356

[7]The Works Project Administration (WPA), which employed writers and actors, for example, in addition to civil engineers, architects, and trained craftsmen, was a second term New Deal initiative.

[8]http://www.amphilsoc.org (<http://www.amphilsoc.org>).

[9]Ibid., 39-43

[10]Ibid., 41-41

that of the heads of non-governmental institutions, even though they were federal employees and remained legally accountable to the president and the congress.

Prior to World War II, a strict reading of the Tenth Amendment (granting to states all authority not explicitly conferred on the federal government) held sway in congress, thus denying the federal government any authority over education at any level. One result was a resolute hands-off federal policy regarding non-governmental scientific institutions. Even after the war, when the federal government began providing research grants to university faculty, it devised a system whereby funds were provided not for universities but for specific scientific projects to be conducted by specific faculty members.

Congressional reluctance notwithstanding, the geographical expansion, industrialization, and urbanization of the United States during the nineteenth and early twentieth centuries highlighted the importance of science to the federal government in discharging its growing responsibilities and promoting the public good. There was a steady expansion of the government's scientific bureaus and capabilities, and increasing awareness that government could benefit from the growing capabilities of American science. By 1938, proponents could argue openly in *Relation of the Federal Government to Research* that the federal government should:

1. conduct scientific activities required for government to exercise its explicit, Constitutionally conferred authority and responsibility;

2. provide services, including generic information, to essential non-government sectors whose sub-units lacked the individual means to support those services by themselves; and

3. offer a locus to support and facilitate research and related activities underlying new technologies of demonstrable importance to the national welfare.

The origins of the U.S. Geological Survey (USGS) provide a good example of the first rationale. National defense was (and is) the most clear-cut area of federal responsibility requiring input from science, and a wide variety of programs initiated under the defense umbrella were later consolidated under new bureaus within non-defense departments. Foremost among these were the extensive scientific surveys of the western lands for which the Lewis and Clark expedition of 1803-05 became the gold standard.

As to the second rationale, the Department of Agriculture, whose progenitor was established in 1862, was the federal government's first and for almost a century its foremost cabinet department, existing primarily on the rationale that government has the responsibility and authority to provide expert information and services to an essential non-governmental sector.[11] In 1863, Congress (abetted by the absence during the Civil War of southern legislators) enacted two additional pieces of science-friendly legislation: the Morrill Act, deeding federal land to states on the condition that they build colleges of agriculture and mechanics; and a charter granted to the National Academy of Sciences to create a non-federal institution providing scientific assistance to the government. Finally, the 1902 establishment of the National Bureau of Standards signaled growing acceptance by Congress of the proposition that U.S. industrial needs for standardized, baseline information from government justified a broad interpretation of the constitutionally conferred federal responsibility for maintaining standards of weights and measures.[12]

The third rationale came into play near the end of nineteenth century, when Congress took its first tentative steps into the public health arena. In 1891, it moved a Marine Hospital Service medical research laboratory from Staten Island to Washington, DC, and renamed it the Hygienic Laboratory.[13] Subsequently, Congress incorporated the Marine Hospital Service into a broadened Public Health and Marine Hospital Service, which became the Public Health Service in 1912. The same Act of Congress authorized the service to "study and investigate the diseases of men and conditions influencing the spread thereof," thereby sanctioning the broad involvement of government in the field of public health research. The Hygienic Laboratory expanded slowly within the Public Health Service, and in 1930 became the National Institute of Health.

In 1915, Congress also established the National Advisory Committee for Aeronautics (NACA) with authority to "supervise and direct the problems of flight, with a view toward their practical solution, and to determine the problems which should be experimentally attacked. . . ."[14] Composed of five non-government experts and (at the insistence of Roosevelt, who was then Assistant Secretary of the Navy) seven government

[11] Ibid., 149
[12] Ibid., 281
[13] Ibid., 257-58
[14] Ibid., 291

members, the NACA provided an essential precedent for the Office of Scientific Research and Development (OSRD) during World War II, and eventually for NASA, into which it would be subsumed in 1958.

5.1 A Department of Science?

In 1863, Congress took the country's first step toward more direct federal involvement in the sciences when it chartered the National Academy of Sciences (NAS). Although established as a privately administered, honorific body akin to the scientific academies of continental Europe or the Royal Society of London, the NAS was also authorized to respond to requests by government for scientific assistance and advice. Accordingly, Congress would implement an NAS recommendation in 1879 that various federal efforts be coordinated under the new U.S. Geological Survey. And a Joint Congressional Commission, chaired by Senator W.B. Allison from 1884 through 1886, "to study the organization of the surveys of the chief countries of Europe, and to recommend methods of coordinating the scientific branches of the government,"[15] was the outcome of another NAS recommendation.

The NAS's response to the Allison Commission's request emphasized the principle of autonomy which had long been the bedrock in relations between science and government. Additionally, it sought to establish boundaries around federal involvement in research: "The government should not undertake what 'can equally well be done by the enterprise of individual investigators.' It should cooperate with universities but not compete with them, and should also confine itself 'to increase and systemization of knowledge tending to "promote the general welfare"' of the country." [16]

Accordingly, U.S. Geological Survey head John Wesley Power suggested consolidation of existing federal scientific bureaus—except for those in the military and the Department of Agriculture—into a cabinet-level Department of Science, with its secretary selected by the president in consultation with NAS. Another proposal was to combine most non-military science bureaus under the auspices of the Smithsonian Institution.

Non-government scientists were dubious. In his committee testimony, Alexander Agassiz of Harvard's Museum of Comparative Zoology sounded the oft-invoked themes of pluralism and autonomy, casting his argument in terms of what Dupree calls classical *laissez faire* political rhetoric: "Moderate centralization, allowing of great competition, is the ideal of scientific activity, and the government should limit its support of science to such work as is within neither the province nor the capacity of the individuals or of the universities, or of associations and scientific societies." [17]

In the end, no such consolidation came about, but the Allison Commission's consideration of such a proposal is worthy of note as the first attempt to establish a central institutional basis for a federal science policy.

5.2 Rise of the U.S. Academic Research Sector

Aside from the land grant colleges established as a result of the 1862 Morrill Act, the first American universities with faculty expected to engage in research as well as teaching were created after the Civil War.[18] The first colleges to become universities were those that had been established during the colonial period. Harvard, for example, created the Jefferson Physical Laboratory—the first American university facility devoted exclusively to research and teaching in a single scientific discipline—in the early 1870s. Newer universities founded after the Civil War soon took the lead. Johns Hopkins, founded in 1876, was the first American university established as a research university from the outset; during its first two decades, it produced more Ph.D. degrees than Harvard and Yale combined.[19] Johns Hopkins was followed by Clark University (1889),

[15]Ibid., 215
[16]Ibid., 216
[17]Ibid., 221
[18]Richard C . Atkinson and William A. Blanpied, "Research Universities: Core of the U.S. Science and Technology System," *Technology in Society* 30 (2008), 30-48.
[19]National Science Foundation Division of Policy Research and Analysis, *The State of Academic Science and Engineering* (Washington, DC: National Science Foundation, 1990), 33.

Stanford University (1891), and the University of Chicago (1892). By the turn of the century, several state universities had also become leading research institutions. Among them were the universities of California, Michigan, Wisconsin, Minnesota, and Illinois.[20]

By the turn of the century, distinctions were also being drawn between basic (or fundamental) research and applied research, with most arguing that direct government involvement should be goal-directed, and therefore limited to applied research, with universities being the appropriate sites for basic research.

Until immediately after World War II, the consensus held that the federal government had no constitutional authority for education, particularly in privately endowed universities where a good deal of the best research was being conducted. For their part, research universities, their endowments often supplemented with funds for special projects from private foundations, had no need for government support.

5.3 World War I and the 1920s

In 1916, Woodrow Wilson issued an executive order establishing the National Research Council and directing it to explore ways to mobilize the nation's scientific resources in the event that it was drawn into the European war. The NRC was conceived as an organization that could call on a broader range of American scientists than was represented by the National Academy of Sciences' strictly honorific membership. During World War I, it recruited qualified scientists for military research, with the recruits given service commissions and sent to work in military research facilities. In May 1918, near the war's end, Wilson issued a second executive order permanently establishing the NRC.

World War I increased the number and prominence of industrial research laboratories in the United States. From a pre-war handful, their number grew rapidly during the war itself and the subsequent decade of prosperity. As Secretary of Commerce during the Harding and Coolidge administrations, Herbert Hoover, himself an engineer, recognized the contributions that government, university, and industrial science individually and collectively could make to national prosperity. He took steps to improve the Commerce Department's scientific bureaus, particularly the National Bureau of Standards, urging them to make greater use of federal contracting authority to obtain assistance from companies and universities. Hoover also exhorted business to invest more in its research laboratories and provide assistance to university research, proposing that industry establish a $2 million National Research Fund to endow projects in universities.[21] Announced with great fanfare in 1926, initial enthusiasm for the fund waned after Hoover became president in 1929, and the fund itself expired quietly during the first years of the Great Depression.

5.4 The Great Depression and the Early New Deal

During the Great Depression, budgets and personnel in government research bureaus and industrial research laboratories were reduced substantially. Private universities, with their endowment incomes shrinking, also reduced support for basic research. A strong current of public opinion held the business-oriented scientific establishment responsible for many depression-era dislocations. Secretary of Agriculture Wallace addressed the situation during the first months of the New Deal by advising Roosevelt to issue his July 1933 executive order establishing the Science Advisory Board.

The failure (or disinterest) of government to turn more frequently to the NAS for strictly scientific (as opposed to policy) assistance was a perennial complaint among its more ambitious members. Thus creation of the NRC was primarily an attempt to revitalize the NAS system, with establishment of Karl Compton's 1933-35 Science Advisory Board within the NRC a further attempt. Indeed, the first report of the Compton board suggested, "Arguments can be presented for the value of such a Board to implement and increase the effectiveness of the National Academy of Sciences and the National Research Council. For example, there

[20] In 1906, James Cattell counted the top one thousand scientists in the nation. Based on the number of scientists in this group, the fifteen leading American research universities were (in descending order): Harvard, Columbia, Chicago, Cornell, Johns Hopkins, California, Yale, Michigan, MIT, Wisconsin, Pennsylvania, Stanford, Princeton, Minnesota, and Illinois. James McKeen Cattell, "A Statistical Study of Men of Science," *Science* 24 (1906).

[21] Dupree, *op. cit.*, 340-43.

is undoubted aid in the prestige and authority of appointment by the President of the United States in dealing with the new officers of any Administration."[22] In other words, the Compton board saw a special relationship between science and the president as being in the public interest.

When the Compton board was established, it seemed reasonable that university research could substantially aid the New Deal's recovery plan and that modification of the NRC system would be a reasonable way for government to assist in the recovery of the university research system itself.

To the extent that the Compton board's rejected proposals qualified as a blueprint for a national science policy, they differed in several respects from those that were proposed four years later by the National Resources Committee. First, of course, they restricted their definition of "science" to the natural sciences and engineering. Second, they assigned a high priority to the health of science itself as well as ways science could aid the Roosevelt administration's recovery efforts. Third, its proposals for government support to universities were seen as a pragmatic, short-term experiment rather than a fundamental change in the relationship between science and government. Finally, that support was to be filtered and monitored by the non-governmental NRC.

By the 1930s, the natural sciences had had almost a century and a half of experience in dealing with government. During that time, science outside of government had grown accustomed to being government's equal partner, particularly since most often it was government that required assistance from science, and not vice-versa. By World War I, American science had established a substantial internal governance system based on traditions extending back to the founding of the Royal Society of London in 1660 and buttressed by adaptation of the German research university model during the late nineteenth century. A central tenet of that system was that intrinsic scientific merit, as judged by scientific peers, was the basis for an individual's standing. Autonomy, or the guarantee of non-interference from the non-scientific world, was regarded as a necessary precondition for optimizing the pursuit of scientific merit.

5.5 Changing White House Priorities

As the second and third volumes of *Research: A National Resource* neared completion, the White House became preoccupied with the war in Europe. In June 1940, five days after the fall of France, President Roosevelt accepted Vannevar Bush's proposal for a special relationship between government and those scientific disciplines that could help with the rapid advancement and deployment of new military technologies.

[22] *Report of the Science Advisory Board: July 31, 1933 to September 1, 1934*, *op. cit.*, 13.

Figure 5.2: Karl Compton (right) and Vannevar Bush. Courtesy of MIT Historical Collection.

In May 1940, Bush had presented a memorandum outlining his thoughts about the organization of science for war through a National Defense Research Committee (NDRC). Bush's memorandum argued, "There appears to be a distinct need for a body to correlate governmental and civil fundamental research in fields of military importance outside of aeronautics. . . It should supplement, and not replace, activities of the military services themselves, and it should exist primarily to aid these services and hence aid in national defense. In its organization it should closely parallel the form which has been successfully employed in the National Advisory Committee for Aeronautics."[23]

The memo's reference to NACA provides an essential clue to Bush's thinking. That body was an advisory committee, comprised of both non-government and government specialists and largely independent of cabinet-level bureaus, that operated its own facilities and could enter into research contracts with private institutions.

On June 27, the president, by means of an executive order, created the NDRC, naming Bush as its chairman. It consisted of four non-government members (Bush; James B. Conant, President of Harvard; Karl Compton; and Frank Jewett, President of the National Academy of Sciences) and four statutory government members. A year later, on June 28, the president issued a second executive order expanding Bush's authority by naming him chairman of a newly created Office of Scientific Research and Development (OSRD). The OSRD was comprised of the NDRC (with Conant as its chairman) and a Medical Research Council, with the scope of the OSRD expanded to encompass engineering development as well as scientific research,[24] and its chairman given direct access to the president. Roosevelt's executive order establishing the new office stated that it "serve as a center for mobilization of the scientific personnel and resources of the Nation in order to assure maximum utilization of such personnel and resources in developing and applying the results of scientific research to defense purposes . . . [and] to coordinate, aid, where desirable, supplement the experimental and other scientific and medical research activities relating to national defense carried on by the Departments of War and Navy and other departments and agencies of the Federal Government."[25]

The creation of OSRD shifted the focus of federal science policy away from the social scientists' emphasis on science for governance and that of the natural scientists on science for the public good to a third rationale for science policy: science for national defense.

Because of the government's obvious need for substantial scientific assistance for World War II, Bush was able to insist that science should be mobilized around existing institutions that would preserve a large measure of their autonomy. Rather than electing to become a scientific czar who would centralize and control all aspects of the wartime research effort, he assumed the roles of buffer and arbiter between science and the technical bureaus of government, particularly within the military. Because of his special relationship with Roosevelt, Bush was able to beat back attempts by Secretary of Agriculture Henry Wallace and Secretary of the Interior Harold Ickes to put the science effort in their departments.

Bush and his colleagues also convinced the president (if not all the old-line scientific bureaus) that science could best serve wartime emergency needs if scientists remained civilians and worked in their own university and industrial laboratories except in special cases, such as the Manhattan Project. Perhaps the best example was the Radiation Laboratory (or Rad Lab) at MIT, a classified facility where scientists throughout the country were recruited to conduct research and engineering development on radar systems.

Bush insisted on focusing attention on a relatively narrow range of problems where scientific research could make an appreciable impact during the limited duration of the war. He also insisted that he report directly to the president, thus insulating his system from the federal bureaucracy.

The pre-war institutional relations between the federal government and non-governmental scientific institutions were left intact by the way in which science was mobilized during World War II, and the experiences of the scientists and engineers involved in Bush's wartime system provided the basis for their perspectives on what science policy should be in the aftermath of that conflict. Guided in part by Bush himself, the U.S. scientific community put forth, and managed to have the president and the Congress accept, proposals that were far stronger than those of the ill-fated Compton Board. Ever since, the notion that science deserves

[23]A. Hunter Dupree, in Gerald Holton (ed.), *The Great Insturation of 1940: The Organization of Scientific Research for War* (New York: Norton), 450

[24]The first prominent coupling of research with development (R&D), which by now has become commonplace, seems to have been made at the time the OSRD was created.

[25]Dupree, *Science in the Federal Government, op. cit.*, 371.

direct access to the president, largely bypassing the federal bureaucracy, has remained central to the vision of science for the public good.

Chapter 6

Science and Security: National Defense Perspectives through 1950[1]

The military ask for the impossible, but they can pay for it. It's a rather odd way of getting scientific and technological advance, but this has been the situation ever since the end of World War II.
—I.I. Rabi, 1980

6.1 Accomplishments and Ambitions of Vannevar Bush

Vannevar Bush's contributions in organizing science through the World War II OSRD and legitimizing government's direct support of non-government science have largely overshadowed his concern with preserving close working relations in peacetime between OSRD and the military. He was directly involved in that effort into the early years of the Eisenhower administration (1953-1961), a decade after he had stepped back from active involvement in the broader debate about post-war science policy. One of Bush's biographers has made a sound case that he aspired to become Secretary of Defense, convinced that effective national defense must be based on close relations between the military and civilian science and technology.[2]

As World War II drew to a close, Bush and his senior OSRD colleagues had apparently believed that a new agency to support university research and a peacetime science policy could be established. But by 1947, Bush had abandoned hope that the Congress would ever establish the National Research Foundation (by that time renamed the National Science Foundation), which was his principal recommendation in *Science—the Endless Frontier*. Bush's report envisioned the NRF as the sole federal agency supporting research in universities and other nonprofit institutions. That this did not happen was due in large measure to the five-year lapse between *Science—the Endless Frontier*'s transmission to President Truman in July 1945 and the creation of the National Science Foundation in May 1950, a lapse due in large measure to Truman's veto of legislation creating the NSF on grounds that it appropriated funds to a non- government National Science Board.

Maintaining close lines of communication between civilian scientists and the military departments was a less difficult political problem than linking science with government more broadly. In view of the long history of science- and technology-based contributions to warfare, defense is the one area in which direct government involvement in science has always been regarded as legitimate. *Relation of the Federal Government to Research* tacitly recognizes the primacy of national defense by placing it at the head of a list of twelve functional categories of significant federal activity in both the natural and social sciences. More recent enumerations of federal science activities (contained, for example, in appendices to the president's annual budget request to the congress) maintain that convention, in part because since World War II, even during relatively lean

[1]This content is available online at <http://cnx.org/content/m34585/1.1/>.

[2]G. Pascal Zachary, *Endless Frontier: Vannevar Bush, Engineer of the American Century* (Cambridge, MA: MIT Press, 1999).

periods of federal support for military research and development, national defense (rechristened national security) has dominated federal R&D expenditures.[3] However, the R&D budget of the Department of Defense is heavily weighted towards development, with its relatively minuscule budget for basic research having been reduced in recent years by comparison. Civilian science- and technology-related agencies account for the bulk of federal research expenditures, with the National Institutes of Health accounting for approximately 50 percent.

Virtually from the beginning of the history of the United States as an independent nation, enterprising individuals in the executive branch have recognized that a liberal approach to federal involvement in science for defense purposes could be used to justify broader non-defense federal involvement. A classic example is President Thomas Jefferson's national defense argument for the Lewis and Clark Expedition, positing that an overland route from the western boundary of the newly acquired Louisiana Purchase to the Pacific Ocean was essential for both commercial and long-range defense considerations.[4] Subsequent geographical, geological, botanical, and ethnographic surveys of the Western lands, along with coastal surveys and oceanic and polar expeditions, were similarly justified.

The military also provided an initial safe haven for federal intrusion into astronomical observation, standard-setting, meteorology, medicine, public health, and—more recently—nuclear energy, computers, and solid-state electronics. Many scientific capabilities nurtured and legitimized in military departments were eventually spun off to civilian- oriented cabinet departments or new, independent agencies. Some examples: the Coast and Geodetic Survey (1878),[5] the U.S. Geological Survey (1879),[6] the Weather Bureau (1890),[7] the National Bureau of Standards (1902),[8] and the Public Health Service (1912).[9] And the first federal organization to provide support for basic research in universities was the Office of Naval Research, by act of Congress in 1946.

Congress saw clear advantages to having non- military federal organizations responsible for scientific research. For one thing, the arrangement gave Congress more oversight into the activities of the non-military bureaus.

6.2 Impacts of Military Crises

Generally, military considerations sparked by actual or potential crises have been responsible for repeated attempts to strengthen institutional links between government and non-government science. The National Academy of Sciences was established during the Civil War and chartered to provide advice to the federal government when requested.[10] However, until the late 1940s, such requests were rare. The National Research Council was established in an attempt to revitalize the NAS system during World War I.[11] Precedents established by Vannevar Bush's World War II OSRD underlay much of the postwar debate about the institutional details of U.S. science policy and the conceptual framework for a national science policy.

[3] In fiscal year 2007, the following seven federal organizations accounted for over 95 percent of the federal R&D budget: Department of Defense (DoD), 49.6 percent; Department of Health and Human Services (HHS), 25.7 percent; National Aeronautics and Space Administration (NASA), 7.1 percent, Department of Energy (DoE), 7.1 percent; National Science Foundation (NSF), 3.5 percent; U.S. Department of Agriculture (USDA), 1.8 percent, and Department of Homeland Security (DHS), 0.9 percent. (National Science Board, *Science and Engineering Indicators–2008* 1 (Arlington, VA: National Science Foundation, 2008), 4.22-25.

[4] Dupree, *op. cit.*, 24-29.

[5] Ibid., 203.

[6] Ibid., 208-11.

[7] Ibid., 192.

[8] Ibid., 281.

[9] Ibid., 291.

[10] Ibid., 263.

[11] The National Research Council and its constituent bodies, the National Academy of Science, the National Academy of Sciences, and the Institute of Medicine, are chartered by the U.S. Congress to undertake studies at the request of executive branch agencies and congressional committees. Studies produced by panels convened by these bodies have a justifiably excellent record for maintaining their objectivity, despite their sponsor. Beginning in the 1970s, the NAS began to acquire an endowment so that it could undertake studies on its own initiative. Members of NRC panels and those of its parent organizations receive no honoraria for their participation.

The first permanent White House-level science advisory committee—the Scientific Advisory Committee to the Office of Defense Mobilization (SAC/ODM)—was created in 1951 in reaction to the military crisis in Korea.[12] Dwight D. Eisenhower made it the President's Science Advisory Committee (PSAC) in November 1957, one month after the Sputnik launch.[13]

These post-Civil-War events were usually seized upon by proponents of a more broadly based government-science relationship. Invariably, they were rebuffed, except for their success in launching the National Advisory Committee for Aeronautics (NACA) in 1915, with federal government and private sector members joining to promote development of civilian and military aviation.[14] NACA was chartered to operate research facilities and award contracts to non-federal organizations, and in 1940, was chaired by Vannevar Bush.

6.3 Interlocking Organizations

Bush established a tradition of ubiquity that was to be maintained for many years. From 1940 to 1947, he served variously (and often simultaneously) as chair of the National Research Defense Council, the Office of Scientific Research and Development, and NACA, and was president of the Carnegie Institution. Well into the 1960s, many key individuals served similarly. Lee DuBridge, President of the California Institute of Technology, served as director of the Radiation Laboratory during World War II, a charter member of the National Science Board, chair of the Science Advisory Committee to the Office of Defense Mobilization, charter member of the President's Science Advisory Committee, and as the first of two science advisors to President Richard M. Nixon. Detlev Bronk, President of Johns Hopkins University, was elected President of the National Academy of Sciences in 1950, served as a charter member and later chairman of the National Science Board, and was for a time a leading contender to become the first director of the National Science Foundation. James B. Conant, president of Harvard University, served concurrently as chairman of the National Research Defense Council after it was absorbed into the Office of Scientific Research and Development in June 1950, was the first chairman of the National Science Board, and was a member of the General Advisory Committee to the Atomic Energy Commission. Following his World War II service as director of the Los Alamos Laboratory, J. Robert Oppenheimer became director of the Institute for Advanced Study at Princeton. During those Princeton years, and preceding his banishment from government in 1954, he served concurrent terms as a member of the Science Advisory Committee to the Office of Defense Mobilization and chairman of the General Advisory Committee to the Atomic Energy Commission.

6.4 After the Crisis Has Passed

The federal government tended to lose interest in science after a given military crisis had passed. The NRC, for example, was created in 1916 on the initiative of a group of activists within the National Academy of Sciences. California Institute of Technology astronomer George Ellery Hale conceived of it as a privately managed organization, composed of leading scientists from government, industry, and academia, that would place the country's scientific resources at the disposal of the federal government.[15] Hale's proposal was accepted by President Wilson, and by the time the United States entered the war in April 1917, the NRC had assembled a small staff in Washington.

Because the government had no ready mechanism to support private institutions, initial funding for staff operations came from the Carnegie Corporation and Rockefeller Foundation. (Even by the war's end, those sources still provided more support for administrative funding than did government.) Research was funded by giving non-government NRC scientists military commissions—an expedient making it difficult for the NRC to maintain independence from the military bureaucracy. In May 1918, Hale and a group of NAS leaders

[12]William A. Blanpied (ed.), *Impacts of the Cold War on the Formulation of U.S. Science Policy* (Washington, DC: American Association for the Advancement of Science), xxvii-xxviii.

[13]Detlev W. Bronk, "Science Advice in the White House," in William T. Golden (ed.), *Science Advice to the President* (New York: Pergamon Press, 1980), 256.

[14]Dupree, *op. cit.*, 283-87.

[15]Ibid., 309-15

(including John Merriam) convinced Wilson to issue an Executive Order establishing the NRC permanently within the NAS. But a general reaction against the war and particularly against entanglement in foreign affairs swept the country after 1919, leading a congressional committee to reject an NRC proposal to establish a central institute of physics.[16] Most of the prominent NRC scientists returned to their universities soon after the armistice, and the military scientific bureaus reverted to the relative lethargy of the first years of the century. R&D budgets for military bureaus were relatively insignificant until World War II.

The OSRD's World War II arrangement for placing civilian scientific resources at the disposal of military departments owed a great deal to the NRC's World War I experience and to Vannevar Bush's experience as NACA chairman. OSRD director Bush had learned that only an organization within government could effectively mobilize scientific resources for national defense. The OSRD owed a great deal of its effectiveness to Bush's insistence that priorities be established by civilian scientists within the organization rather than by the military bureaus. Another significant innovation was Bush's decision to permit scientists and engineers to work in familiar surroundings as far as was possible, rather than granting them temporary military commissions and employing them in military research facilities.

Figure 6.1: Research and development leading to the first nuclear weapons were carried out at the Los Alamos Laboratory in New Mexico. Photo by the author.

The most famous example was the Manhattan Project, overseen but not managed directly by OSRD; another was the Radiation Laboratory at MIT, where scientists from throughout the country worked on highly classified projects to develop successive generations of radar.

[16] Ibid., 326-30

As World War II neared its end, Bush built on this foundation by working to ensure that science-government relations would remain strong—perhaps even stronger—in peacetime. Hence his "invitation" to Roosevelt's senior advisers to request the report that would become *Science—the Endless Frontier*.

6.5 Organizational Arrangements

The OSRD came to be so highly regarded by the military that it commenced an effort to ensure continued access to civilian science when Bush announced his intention to begin liquidating the Office in 1944. Most of those arrangements rested on the assumption that adequate links could be maintained through part-time committees composed of eminent scientists. The Research Board for National Security (RBNS) was established in 1944 and housed (presumably as a temporary expedient) within the National Research Council.[17] Composed of equal numbers of civilian scientists and military officers, the RBNS was to have both advisory responsibilities and budgetary authority to support research projects outside of government, mainly in university laboratories. When the Bureau of the Budget killed the RBNS in 1946, it was replaced by the Research and Development Board (RDB) after consolidation of the armed services into the Department of Defense in 1947.

[17] Daniel J. Kevles, "The National Science Foundation and the Debate Over Postwar Research Policy, 1942-45," *Isis* 68, No. 1 (March 1977), 4-26

Figure 6.2: Left to right: Premier Joseph Stalin, President Franklin Roosevelt, and Prime Minister Winston Churchill at Yalta in 1945. Courtesy of the Franklin D. Roosevelt Presidential Library.

Chaired successively by Bush, Karl Compton, and William Webster, the RDB consisted of civilian scientists serving part-time in a purely advisory capacity. Dissatisfaction with that arrangement led to the 1951 establishment of the Scientific Advisory Committee in the White House's Office of Defense Mobilization.

After 1940, the concept of a defense-oriented science policy was advanced independently of the debates about a more comprehensive, unitary science policy, and the imperative for such a defense- oriented policy may have hindered realization of the more comprehensive vision. However, the conceptual divergence between those policies may not have been so clear-cut in the late 1940s. At least until 1950, few clear distinctions were made between the military benefits and the broader social benefits presumed to be derivable from science. If, as was widely acknowledged by 1945, the ability of the United States to develop the military technologies that had helped turn the tide in Europe had been critically dependent on access to civilian science, then continued access would be essential to national defense in the postwar era. That is, in the wake of Hitler's impending defeat, national defense was regarded as one of the paramount social benefits that science could confer.

The central policy problem faced by Bush after World War II was how to assure government access to non-government science within a framework that would preserve the constitutional imperatives for presidential control and accountability while allowing science to flourish unhampered by what most scientists perceived as a heavy-handed federal bureaucracy.

6.6 The Korean War

When North Korean army crossed the line of demarcation between North and South Korea in June 1950, the possibility of direct confrontation between the United States and either the Soviet Union or the People's Republic of China led the White House to engage William T. Golden, a New York City financier and philanthropist, to study whether the OSRD should be reconstituted. Golden spent seven months interviewing military experts and prominent civilian scientists,[18] and concluded that the nation's leading scientists were opposed to creation of an OSRD-type organization. Instead, he proposed a presidential science advisory system, recommending to Truman that he appoint a full-time science advisor.

However, General Lucius Clay, Deputy Director of the White House Office of Defense Mobilization, objected, and Truman followed his advice in creating a Scientific Advisory Committee to the Office of Defense Mobilization (SAC/ODM), with the promise that its director would enjoy access to the president. This installation made it clear that national defense would henceforth be one of the leading determinants of U.S. science policy, and signaled to American scientists and engineers that an effective U.S. science policy depended upon direct access to the president.

The five-year struggle to create a National Science Foundation ended on May 10, 1950, when Truman signed the National Science Act of 1950 into law. North Korean troops crossed the 38th parallel barely six weeks later. In November, the National Science Board—the governing body of the NSF—disavowed any intention to engage in military research, although a few of its members seemed to have had second thoughts in January 1951. Congressional appropriations for the new agency for fiscal year 1952, the first full year of its existence, amounted to $3.5 million, slightly more than a quarter of what the Bureau of the Budget had requested. With a military crisis at hand, the promise of basic research that led to the creation of the NSF seemed a secondary priority, at best.

[18] Blanpied, *op. cit.*, xvii-xx.

Chapter 7

The Science-Government Compact: 1945-1950[1]

We have no national policy for science. The Government has only begun to utilize science in the Nation's welfare. There is no body within the Government charged with formulating or executing a national science policy. There are no standing committees of the Congress devoted to this important subject. Science has been in the wings. It should be brought to the center of the stage—for in it lies much of our hope for the future.

—*Science—The Endless Frontier*, 1945

There must be a single point close to the President at which the most significant problems created in the research and development program of the Nation as a whole can be brought into policy discussions.

—*A Program for the Nation*, 1947

Scientific research daily becomes more important to our agriculture, our industry, and our health.

—Harry S. Truman, 1948

In the wake of World War II, there was widespread acknowledgment of the contributions organized science had made to the allied victory, and scientists emerged from their ivory towers to be hailed as national heroes. President Truman praised the war efforts of physicists in a statement released immediately after the bombing of Hiroshima, saying, "But the greatest marvel is not the size of the enterprise, its secrecy, or its cost, but the achievement of scientific brains in putting together infinitely complex pieces of knowledge held by many men in different fields of knowledge into a workable plan."[2] Secretary of War Henry Simpson was more effusive and personal: "No praise is too great for the unstinting efforts, brilliant achievements and complete devotion to the national interest of scientists in this country."

[1] This content is available online at <http://cnx.org/content/m34582/1.1/>.

[2] *New York Times* (August 7, 1945).

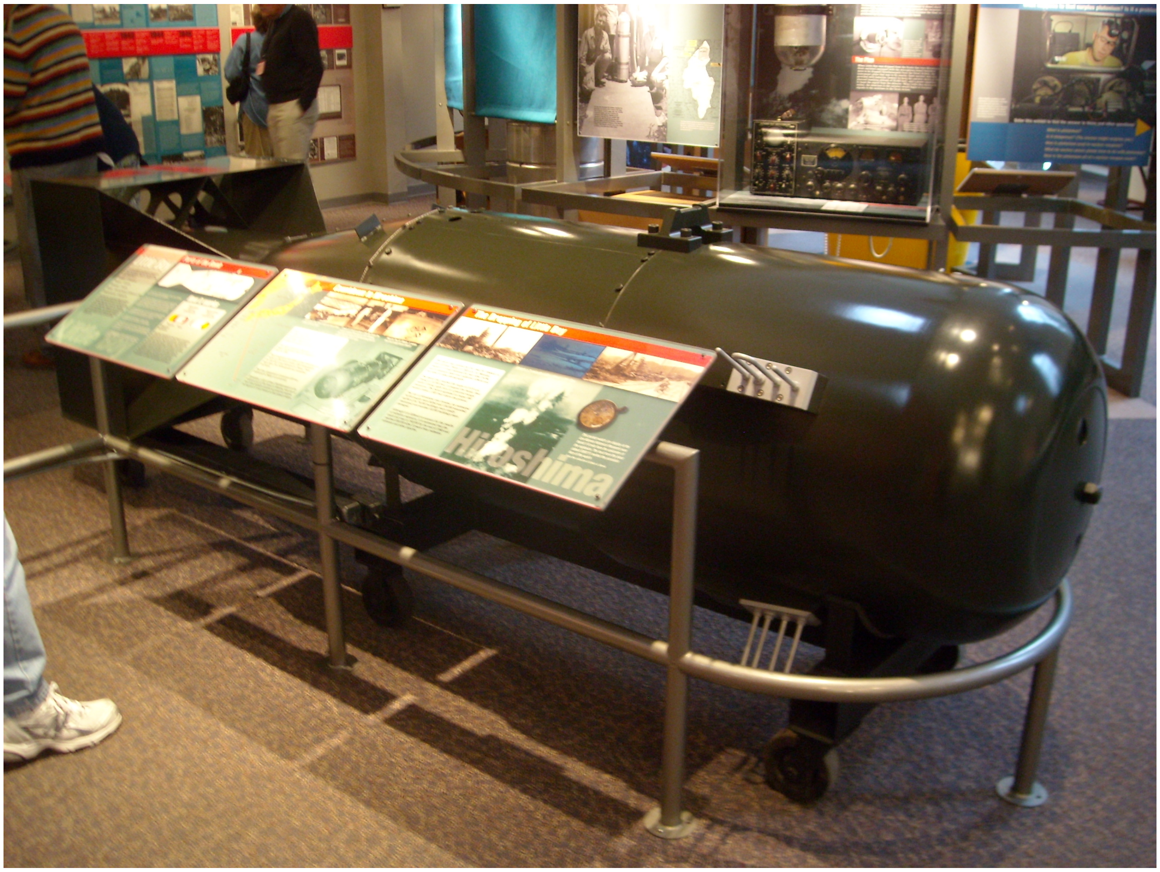

Figure 7.1: A model of Little Boy, the nuclear bomb that obliterated Hiroshima on August 6, 1945, on display at the Los Alamos National Laboratory. Photo by the author.

Science became a media darling as well. The August 12 Sunday *New York Times* featured a report by Richard Lewis on Albert Einstein, who "explained the principles of nuclear energy and did so in a manner simple enough that even I could understand what he was talking about." The same edition noted that Princeton University planned a series of weekly radio broadcasts on issues of current scientific interest featuring "university scientists who helped develop the atomic bomb." The magazine titled its lead article "We Enter a New Era—the Atomic Age," and an accompanying photo essay featured brief biographies of Marie and Pierre Curie, Albert Einstein, Niels Bohr, and Ernest Lawrence.

The front page of the August 15 *Times*, announcing the surrender of Japan, also reported on "Secrets of Radar Given to the World," explaining that the OSRD had finally been permitted to release the full story of what Sir Stafford Cripps, a member of wartime British Prime Minister Churchill's inner circle, was quoted as calling, "the greatest invention of the war." General David Sarnoff, President of the Radio Corporation of America, flatly asserted, "If a statesman believes that his country's interest would be better served by isolation than by participation in a world security organization, let me suggest that he debate this question with a scientist rather than a politician."[3] And the *Times*, after acknowledging the singular scientific achievement of the bomb, asked editorially, "Is this to be the end? Are we to lapse into the old more or less nationalistic pursuit of science when great issues are at stake? Why can't there be more international cooperation in

[3] *New York Times* (August 8, 1945).

dealing with arthritis, cancer, hormones, vitamins, or for that matter the whole field of science?"

As a result, by the end if 1945 the notion of linking U.S. science with national social and economic objectives seemed a less partisan issue than it had during the late 1930s. Since science-based technology had contributed demonstrably to military success, it was almost self-evident that science could be mobilized to provide peacetime benefits, contributing to national security and domestic prosperity. As Roosevelt put it, "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life."[4]

Postwar optimism about the promise of science was part of a broader, nationally shared conviction that the United States had both the material resources and the moral authority required to assure domestic health and prosperity and maintain a beneficent world order. William D. Carey, who had come to the Bureau of the Budget in 1942 with a master's degree from Harvard's Littauer School of Government, later recalled:

> *You have to think of the atmosphere. This was post war, most of the world in ashes, the U.S. riding very, very high, dreaming great dreams—the Full Employment Act, United Nations arrangements, Point IV, the Marshall Plan. And then, along in parallel, there was to be a new age of science, of creativity. This was all to be part of a great strategic thrust toward the good society: high employment, unlimited opportunities, superb education, civil rights. And so we come to the institutional arrangements.*
>
> *And the opportunities presented themselves. The atmosphere was that we had a new world, and all would go well. There was a very short window of idealism and optimism that closed very abruptly. Out of that, the progression of the institutional arrangements that followed were cast in instrumental terms—in terms of national needs.*[5]

A striking example of postwar optimism about the efficacy of science-based knowledge for policy-making was the establishment of the Council of Economic Advisers (CEA) in the Executive Office of the President as part of the Employment Act of 1946. The most obvious example of a comparable foreign policy initiative was the Marshall Plan, implemented in 1948.

The genesis of the CEA is already implicit in arguments, advanced in the 1937 *Report of the President's Committee on Administrative Management*, that specialized knowledge and objective data are prerequisites for effective governance. That proposition was also explicit in Vannevar Bush's 1940 plan for a National Defense Research Committee and its successor, the Office of Scientific Research and Development. The assumption that in peacetime science merited at least special political consideration, if not special access to the president, underlay creation of the Atomic Energy Commission[6] in 1946 and the National Science Foundation in 1950. And to a remarkable extent, that assumption was accepted by the Bureau of the Budget and the Congress.

All of this momentum notwithstanding, there was little consensus about how to achieve even broadly shared goals. Even before Pearl Harbor, there had been discernible conservative reaction against the economic and social innovations of the New Deal. Within a few months of Truman's taking office, a congressional coalition of Republicans and Southern Democrats was mounting an effective challenge to his attempts to further Roosevelt's domestic agenda. The November 1946 mid-term elections returned Republican majorities to both Houses of Congress for the first time since 1930, and the party seemed poised to recapture the presidency in 1948, for the first time in sixteen years.

The evolution of science policy between the end of World War II and the invasion of South Korea in June 1950 was conditioned by the volatile domestic and international political environment of those years. There

[4]Vannevar Bush, *Science—the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research.* Washington, DC: National Science Foundation (July 1945, reprinted May 1980), 3.

[5]Author's interview with William D. Carey, December 1986.

[6]In 1975, the Atomic Energy Commission was absorbed into the newly-created Energy Research and Development Administration (ERDA), which also incorporated bureaus from the Departments of Commerce and the Interior. In 1977, ERDA was absorbed into the new Department of Energy (DoE).

was no consensus about how science could best serve the national interest, or even what national interest outside of national defense science was supposed to serve.

Few at the time denied that science could have significant potential impact on a wide range of enduring national problems. Yet traditional political interests identified with the principal areas of potential impact (agriculture, health, and national defense, for example) were reluctant to relinquish control to the putative guardians of a broad science policy. Moreover, the would-be guardians themselves could not agree on terms under which science could accept federal support. Political passions triggered by the novel proposition that government could legitimately support non-government research obscured the larger issue of how government could establish a broad policy to link that research with essential national objectives.

Appropriate links between science and specific areas of national concern, then, were considered piecemeal in debates over the charters and prerogatives of individual agencies, including the Department of Defense, Atomic Energy Commission, and National Institutes of Health. Much of what passed for a broader debate about national science policy was concerned with the scope and authority of a proposed new agency, originally called the National Research Foundation and later the National Science Foundation, which was envisioned as the single federal entity empowered to channel federal funds to non-government research, particularly in universities. This vision was never realized; in the five years between its proposal and creation, other agencies began supporting university research.

7.1 "Science—the Endless Frontier"

7.1.1 Genesis

The outlines of a broad debate about post-war science policy began emerging in 1943, when West Virginia Democratic Senator Harley M. Kilgore introduced the Science Mobilization Act,[7] which included several provisions for organizing and focusing postwar science and technology resources. Included in the Act was creation of an Office of Scientific and Technological Mobilization, an independent federal agency coordinating all federal science and technology agencies and providing assistance for basic and applied research in government laboratories, small businesses, and universities. The office was to be overseen by a board and advisory committee, each comprised of representatives from science and technology, industry, small business, labor, agriculture, and consumer interests.

In 1944, Kilgore drafted a new bill, renaming the federal science agency the National Science Foundation. Because Kilgore's emphasis had shifted entirely to postwar science-government relations, hearings on the bill were postponed until the end of the war in Europe.

[7] Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942-45," *Isis* 68 (1977), 5-26.

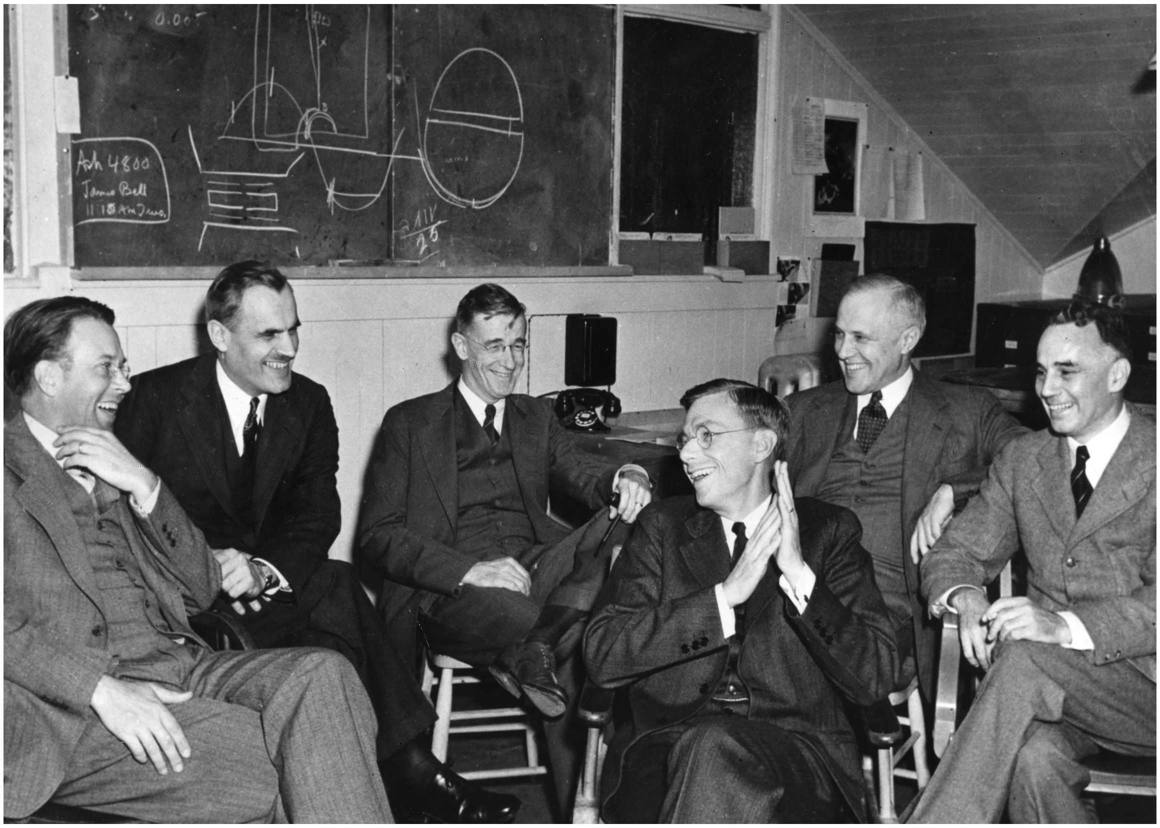

Figure 7.2: Left to right: Ernest Lawrence, Karl Compton, Vannevar Bush, James B. Conant, Arthur Compton, and Alfred Loomis at the University of California, Berkeley, 1940. Courtesy of the Lawrence Berkeley Library.

By that time, the Vannevar Bush-led scientific establishment was preparing a counterproposal, in the form of a report entitled *Science—the Endless Frontier* (often referred to as the "Bush report"). Officially transmitted to Truman on July 5, 1945, the report came in response to a November 1944 Roosevelt letter to Bush, in which the President emphasized that "the research experience developed by the Office of Scientific Research and Development and by the thousands of scientists in the universities and private industry, should be used in the days of peace ahead for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living."[8]

Roosevelt's letter had raised four questions concerning the declassification of wartime research results; the organization of a program for medicine and related science; government aid to research activities by public and private organizations; and a program for discovering and developing scientific talent.

Although *Science— the Endless Frontier* included several recommendations intended to strengthen existing research capabilities in bureaus within the Departments of Agriculture, Commerce, and the Interior, its centerpiece was the recommended creation of a National Research Foundation, which would be "a focal point within the Government for a concerted program of assisting scientific research conducted outside of Government."[9] In addition to awarding scholarships and fellowships, the foundation would furnish "the

[8]Bush, *op. cit.*, 3.
[9]Ibid., 31.

funds needed to support basic research in colleges and universities." Additionally, it would "coordinate where possible research programs on matters of utmost importance to the national welfare. . .formulate a national policy for the Government toward science. . .sponsor the interchange of scientific information among scientists and laboratories both in this country and abroad. . .ensure that the incentives to research in industry and the universities are maintained."[10]

An Act establishing the National Science Foundation was signed into law in May 1950. Although its approach to federal support for science was much closer to the Bush than to the Kilgore concept, the scope and authority of the National Science Foundation were considerably diminished from what either *Science—the Endless Frontier* or the Kilgore legislation had envisioned. Indeed, the National Science Foundation that finally emerged in 1950 was a bit player among other more established, more powerful agencies. In particular, Bush's hope that defense research would be included in the National Science Foundation's charter was not realized. While medical research was not explicitly excluded, the legislative history of the National Science Foundation Act of 1950 implied that Congress preferred all such research to be conducted and supported by the National Institutes of Health.

7.1.2 Enduring Contributions

The Bush report laid down the boundaries for most subsequent debates about the relations between science and government. As such, it remains one of the cornerstones of U.S. science policy. It made four enduring contributions to the conceptualization of science policy in the United States: it asserted that, except for national defense, the proper concern of science policy ought to be the support, as opposed to the utilization, of science; it advanced the proposition that basic research should be the principal focus of federal support for science, again with the exception of national defense; it argued that mechanisms for the support of research must be consistent with the norms of the practitioners of that research; and it suggested that universities, as the principal sites for the conduct of basic research and the exclusive sites for advanced education, literally defined whatever national research system could be said to exist in the United States.

Although the arguments underlying those propositions have more often been honored in the breach than in the observation, the propositions themselves have achieved the status of an unassailable ideal against which actual and proposed policies can be measured.

Science—the Endless Frontier assigned to its proposed National Research Foundation the responsibility to "coordinate where possible research programs on matters of utmost importance to the national welfare." However, it made no recommendations about how government ought to identify relevant goals, assign scientific priorities that might contribute toward their achievement, or support or otherwise facilitate the conduct of research intended to benefit the national welfare. The report was reasonably specific about coordinating defense-related research, but it did not consider how, or even whether, strategies could be devised to link research with non-defense objectives.

Thus the report defined the central problem for science policy as assuring that the available pool of new knowledge would remain adequate to the needs of those in the best position to use it effectively, as well as to train new generations of scientists and engineers to identify and make use of it. Government had a legitimate role in aiding the quest for new scientific results, but attempts either to direct research toward specific ends or to facilitate the utilization of existing research for non- defense purposes would be counterproductive.

By 1944, the U.S. science establishment realized that the private sources of support sustaining university research prior to 1940 would be inadequate in the postwar era, particularly since destruction of the great pre-war scientific centers of Europe would require the United States to generate much of the world's new scientific knowledge. Bush and his colleagues seized the opportunity to advance the proposition that the best way for government to assure that science would benefit the public interest would be to leave scientists free to pursue their *own* interests. Central to that vision was the idea that universities defined science's center of gravity in the United States; the politically conservative Bush and most of his establishment colleagues were philosophically opposed to government support or control of non-defense-related science in industry, as that would constitute unacceptable government intervention in the marketplace.

[10] Ibid.

Academia, according to Bush and his colleagues, was therefore the sole non-defense sector where federal research support could legitimately be contemplated. Yet any arrangement that made federal support for university research contingent upon proof of relevance to social or economic objectives was anathema. Moreover, government support carried the risk of federal intrusion on traditional scientific norms, the most critical being university autonomy. In the words of the report to Bush by the Committee on Science and the Public Welfare chaired by President Isaiah Bowman of Johns Hopkins University, "We do not believe that any program [of government support] is better than no program—that an ill-advised distribution of funds will aid the growth of science." In order to be fruitful, "scientific research must be free— free from the influence of pressure groups, free from the necessity of producing immediate practical results, free from the dictation of any central board." [11]

At least since the time of Francis Bacon in the sixteenth century, it has been an article of faith that the advancement of science depends upon self-governance by peer communities. The 1935 proposal of Karl Compton's Science Advisory Board had foundered in part because it sought to insulate government support for university research from government control by channeling funds through the privately controlled National Research Council. The more politically astute Bush embedded the Baconian norm into the charter of a government agency that would be virtually free from government control. Fiscal and administrative authority was to be vested in a part-time, presidentially appointed group of approximately nine private citizens. In the 1950 legislation, the size of this group was increased to twenty-four and designated as the National Science Board, to be composed primarily of eminent scientists and other individuals with "distinguished records of public service."[12] According to the original Bush formulation, this part-time board was to have had complete authority to appoint and discharge the director of the foundation and the heads of its operating divisions. The principal responsibility of those divisions, also to be comprised of eminent scientists, was to be dispersal of research funds according to their own (and the board's) interpretation of scientific merit. The board itself was to have additional responsibilities for coordination and oversight of the entire federal research establishment so that the foundation would serve as the "focal point within the Government for a concerted program of assisting scientific research conducted outside of government."

7.2 The National Science Foundation

7.2.1 Congressional Debates

On July 19, 1945, two weeks after *Science—the Endless Frontier* had been transmitted to Truman and the same day it was released to the public, Senator Warren Magnuson (D-WA), by prior arrangement with Bush, introduced legislation to create a National Research Foundation essentially along the lines envisioned by the Bush report.[13] Wilbur Mills (D-AK) introduced simultaneous legislation into the House of Representatives. Four days later, Harley Kilgore, angry that he had not been privy either to the centerpiece recommendation of *Science—the Endless Frontier* or to Bush's arrangement with Magnuson, reintroduced into the Senate his legislation creating a National Science Foundation. To a remarkable extent, the National Science Foundation Act that President Truman signed into law on May 10, 1950, accepted the original concept in *Science—the Endless Frontier* of an independent, self-governing agency with the authority to allocate public funds for research priorities and directions determined by the governors themselves. But two provisions of the act departed significantly from Bush's original formulation. First, an amendment introduced by Congressman Oren Harris (D-AK) limited annual appropriations for the National Science Foundation to $500,000 during the first year and $15 million thereafter.[14] Second, the act specified that the president, rather than a presidentially appointed National Science Board, would appoint (and therefore have the authority to discharge) the foundation's director. A proposed amendment to protect the prerogative of the National Institutes of

[11] Ibid., 80

[12] *National Science Foundation Act of 1950*, Public Law 81-507 (64 Stat 149), Section 4c.

[13] This summary of the legislative history of the National Science Foundation Act is drawn primarily from J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945-57* (Washington, DC: National Science Foundation, 1983), 25-106.

[14] The $15 million limitation was removed in 1953.

Health to support all biomedical research in the United States by prohibiting the newly created NSF from doing so failed to pass the Senate. However, the legislative history of the act would be interpreted so as to preclude the NSF from supporting biomedical research.

Harris' motion to place a ceiling on the foundation's annual appropriations is notable as one of the few proposed amendments incorporated into the final Act of Congress. Other amendments proposed and defeated during the five-year debate included provisions that would have compelled the National Science Foundation to direct a specific portion of its research funds to finding cures for specific diseases or to reserve up to 25 percent of those funds for geographical distribution rather than for disbursement on the basis of scientific merit.

By the time the legislation was being considered by the eighty-first Congress, elected in November 1948, anti- communist hysteria was mounting, resulting in proposed amendments to require loyalty oaths and even prior investigation by the FBI for all prospective recipients of federal research funds. Both of these amendments were defeated.

A sticking point in the debate over the Bush and Kilgore plans for the NSF was the degree of direct presidential control of the foundation. Twice before May 1950, creation of the agency floundered on this issue. In June 1946, the Senate passed a bill that would have vested administrative authority in a presidentially appointed administrator advised by an external board. That bill expired in July when the more conservative House of Representatives declined to take up the measure. In July 1947, the Republican- controlled eightieth Congress enacted legislation that would have vested ultimate administrative authority and fiscal responsibility in a part-time, presidentially appointed National Science Board, but the act was pocket vetoed by Truman on the grounds that no president could delegate his constitutional responsibility for the expenditure of public funds to a part-time board that would have a direct interest in the dispersion of those funds. The act that was finally signed into law defined the foundation as consisting of a twenty-four– member National Science Board and a Director. The president retained the right to appoint the director, subject to the advice and consent of the Senate. But the board retained policy guidance over the foundation, including the authority to approve the disbursement of all research funds. Additionally, the act gave the board various broad oversight responsibilities, including a mandate to periodically evaluate science and engineering in the United States.

7.2.2 Divisions within the Scientific Community

The protracted debate over the NSF brought to the fore deep ideological and political divisions within the scientific community.[15] In November 1945, the group of scientists who had been closely associated with Bush's wartime activities formed a Committee Supporting the Bush Report under the chairmanship of Isaiah Bowman, President of Johns Hopkins University, who had also chaired the Bush committee on Science and the Public Welfare.[16] Politically conservative in its orientation, this group steadfastly opposed presidential appointment of the NSF director. One month later, Harold Urey and Harlow Shapley, both liberals, established the more broadly based Committee for a National Science Foundation, many of whose members were openly sympathetic to the Kilgore proposition that science ought to be directed to explicit national goals. In 1946, following the failure of the House to take up the Senate- approved NSF bill, the two groups proceeded to attack each other bitterly and often publicly. Following Truman's veto of the NSF Act of 1947, a third group, the Intersociety Committee for a National Science Foundation, succeeded in calming the divisive political passions and negotiating with the Bureau of the Budget and Congress the compromise that paved the way for the bill's passage.

[15] The use of the term "scientific community" here and elsewhere in the text is something of an oversimplification. Certainly, few social scientists were consulted during the course of the debates over the National Science Foundation. More significantly, Bush was seemingly insensitive to the fact that the biological sciences were composed of many more areas of expertise than the biomedical sciences. Thus, it is by no means clear how many scientists outside of Bush's hard-core proponents in the mathematical, physical, and engineering scientists were even passively interested in the debates of the late 1940s.

[16] England, *op. cit.*, 36-42.

7.3 Support for University Research

7.3.1 Roles of New and Invigorated Agencies

By the time the National Science Foundation was created in May 1950, three federal agencies—the Office of Naval Research (ONR), the Atomic Energy Commission (AEC), and the National Institutes of Health (NIH)—were already providing substantial support for university research. The $15 million appropriations ceiling attached to the NSF Act by Congressman Harris has been interpreted as an effort to save the legislation from defeat by assuring congressmen who remained unconvinced about the need for yet another agency to support basic research that the new foundation would not inordinately burden the federal budget.[17]

Shortly after its creation in 1946, the AEC[18] began supporting university basic research in nuclear science even though it had been envisioned primarily as assuming control of military nuclear resources. Similarly, the ONR began supporting basic research in universities with no obvious short-term military applications. Several important precedents for project selection established by the ONR were carried over as operating procedures of the NSF after 1950, in large measure because the first NSF director, Alan Waterman, had previously been chief scientist at ONR.

The case of the NIH was—and remains—unique. At the end or World War II, it was still a relatively small agency, most of whose research focused on problems with obvious applications. Along with most of the Public Health Service, it was viewed with suspicion if not hostility by many non-government medical scientists, including W.W. Palmer of Columbia University, Chairman of the Bush's Medical Advisory Committee.[19]

In 1948, the National Institute of Health was renamed the National Institutes of Health, and reorganized in subdivisions corresponding to major human disorders. By that time it was reconciling many of its differences with the non-governmental medical establishment and had initiated a substantial extramural program to support research in university medical schools through an innovative contracts system.[20] Much of that research, conducted to obtain knowledge of fundamental biological and physiological processes that might conceivably have eventual medical applications, qualified as basic research according to criteria set forth by *Science—the Endless Frontier.*

In 1950, during final House debate on the National Science Foundation Act, an amendment was introduced that would have preempted the NSF from any assaults on the NIH's turf. Although defeated, the debate over it highlights the favor with which the NIH's basic research programs were regarded. The NIH rarely distinguished, at least publicly, between its legislated mandate to improve the health of the American public and its aspirations to be the principal supporter of basic medical research. Just as significant, it required no national defense rationale to justify its support.

7.4 The Scope of Science, According to Bush

Bush tended to define the sciences in terms of the mathematical, physical, engineering, and medical disciplines that had been an integral part of his wartime system and for which he could lay some justifiable claim to being a spokesman. Nathan Reingold has remarked on Bush's curious blind spot regarding the non-medically–oriented biological sciences.[21] Representatives of those disciplines were conspicuously absent from the four committees whose deliberations and reports provided the basis for *Science—the Endless Frontier.* Because the non- medical biologists had played virtually no part in Bush's wartime system, they felt little or no obligation to support his version of a National Research Foundation; in particular, they were much less adamant about the question of presidential control.

[17] Author's interview with Elmer Staats, January 1986.

[18] Creation of the AEC, which vested control of nuclear energy in a five-member civilian commission, represented a defeat for Bush and Conant at the hands of younger scientists who had advocated continued military control.

[19] Nathan Reingold, "Vannevar Bush's New Deal for Research: or, The Triumph of the Old Order," *Historical Studies in the Physical Sciences* 17 (1987), 299-344.

[20] National Academy of Sciences, *Federal Support of Basic Research in Institutions of Higher Learning* (Washington, DC: National Research Council, 1964).

[21] Reingold, *op. cit.*

If Bush's neglect of the biological sciences was an unfortunate oversight, exclusion of the social sciences was deliberate. Bush's letter transmitting *Science—the Endless Frontier* to President Truman stated that "in speaking of science he [President Roosevelt] clearly had in mind the natural sciences, including biology and medicine, and I have so interpreted his questions. Progress in other fields, such as the social sciences and the humanities, is likewise important; but the program for science presented in my report warrants immediate attention."[22] The question of whether the social sciences should be explicitly mentioned as qualifying for federal research support in legislation creating the foundation was debated over the next five years, and they were excluded from the National Science Foundation Act of 1950.[23]

Bush and his senior colleagues believed that inclusion of the social sciences would complicate and delay formulation of a relatively straightforward compact between science and government. But their antipathy may also have been rooted in their distrust of government bureaucracies and New Deal-style planning and management. The social sciences had been instrumental in the proliferation of new agencies during the early New Deal and had legitimized the concept of planning and control at the presidential level. Since social scientists were identified with what many conservatives viewed as alarming controls on private activity, Bush and his colleagues might well have regarded their explicit inclusion in the National Research Foundation as inconsistent with the insulation of that new agency from the federal bureaucracy. A number of conservative congressmen also opposed inclusion of the social sciences on the grounds that it could lead to centralized planning by government, if not to Soviet-style regimentation.

The markedly different approach to science policy of practicing scientists and those few social scientists with any interest in that topic was also a perennial ground for distrust. Social scientists on Frederic Delano's Science Committee of the National Resources Committee had been responsible for torpedoing the 1934 proposal of Karl Compton's Science Advisory Committee (on one of whose committees Bush—then Dean of Engineering at MIT—had served) to support scientific research in universities. Thereafter, the social science-dominated Science Committee of that body had produced, beginning in 1938, the successive volumes of *Research—a National Resource*, which gave co-equal status to the social and natural sciences. The landmark Delano committee report had been the first official government document to recognize the symbiotic relationship between the federal and non-federal research enterprises and to argue that federal responsibility for science extended beyond the government's own scientific bureaus. However, to the non-government scientific establishment, the solutions it proposed for a more coherent national science policy were overly bureaucratized and threatening to the autonomy of academic science.

7.5 The Steelman Report

During the years of debate over the National Science Foundation, a second federal science-promotion effort was under way. In October 1946, Truman issued an executive order establishing the President's Scientific Research Board and charged it to prepare an overview of current and proposed research and development within and outside of government. The prime mover behind the executive order was probably James R. Newman, formerly of the Office of War Mobilization and Reconversion, who had been in the vanguard of the successful battle to assure civilian control of atomic energy.[24]

[22]Bush, *op. cit.*, 1.

[23]The National Science Foundation Act of 1950 authorized the foundation "to initiate and support basic scientific research. . .in the mathematical, physical, medical, biological, and other sciences." The social and behavioral sciences were explicitly included in that formulation by means of a 1968 congressional amendment of the original act as a result of hearings before a subcommittee of the House Committee on Science and Technology.

[24]England, *op. cit.*, 63.

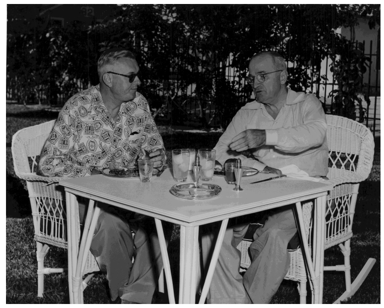

Figure 7.3: President Truman and John Steelman in Key West, November 1951. *Paul Begley, United States Navy, Courtesy Harry S. Truman Presidential Library.*

Chaired by John R. Steelman, Director of the Office of War Mobilization and Reconversion, the Scientific Research Board was comprised of the heads of all cabinet departments and other federal units with substantial research and development responsibilities. Steelman was directed to submit a report:

> *setting forth (1) his findings with respect to the Federal research programs and his recommendations for providing coordination and improved efficiency therein; and (2) his findings with respect to non-Federal research and development activities and training facilities, a statement of the inter-relationship of Federal and non-Federal research and development, and his recommendations for planning, administering and staffing Federal research programs to insure that the scientific personnel, training, and research facilities of the Nation are used most effectively in the national interest.*[25]

Bush was a statutory member of the board in his capacity as OSRD Director,[26] but took little or no part in its deliberations and dismissed its efforts will ill-concealed contempt on the grounds that Steelman (who had a Ph.D. in economics and had been a university professor prior to joining the government as a labor relations specialist during the late Roosevelt years) had no understanding of science. No doubt Bush, who had enjoyed easy access to Roosevelt, was also piqued by his exclusion from the inner circles of the Truman White House. Steelman, in contrast, was becoming increasingly influential. With the liquidation of the emergency Office of War Mobilization and Reconversion in December 1946, he was designated The Assistant to the President, in effect the first White House chief of staff.

But more than personal pique was involved. The thrust of Bush's *Science—the Endless Frontier* was that support for basic research in universities ought to be the central focus of science policy; the Steelman board regarded university research support as just one aspect of a more complex situation. *Science—the Endless Frontier* was based on the reports from four committees of non-government scientists; the Steelman board was composed entirely of government officials. Bush and the scientific establishment also suspected that the Steelman board wanted to preempt military domination of post-war science policy, and that it was expected "to promote the right kind of science foundation."[27]

Despite the distaste of scientific elders for the Steelman exercise, the resulting five-volume report, entitled *Science and Public Policy* and commonly referred to as the Steelman report, ranks as a seminal achievement. *A Program for the Nation*, its first volume, was transmitted to the president on August 27, 1947, exactly three

[25]John R. Steelman, "A Program for the Nation," *Science and Public Policy: A Report to the President* 1 (Washington, DC: Government Printing Office, August 27, 1947), 69.

[26]The OSRD was liquidated at the end of 1947, much to the relief of Bush, who had originally proposed that since it was a temporary, emergency agency, it should be phased out after the end of the war in Europe.

[27]England, *op. cit.*, 63; note 8, 375.

weeks after his pocket veto of the National Science Foundation Act of 1947.[28] Its principal recommendation was to nearly double the national (federal, plus industry and other sources) R&D budget to approximately $2.1 billion annually by 1957 through a "planned program of expansion" that would require greater increases in public than in private spending. Thenceforth, federal R&D expenditures should be equal to at least one percent of Gross National Product (GNP).[29]

In contrast to the Bush report, which based its few cost estimates on prewar basic research expenditures, the Steelman report explicitly recognized a link between R&D expenditures and national income.[30] It also set explicit 1957 distribution targets by sector: 20 percent for basic research, 14 percent for health and medicine, 44 percent for non-military development, and 22 percent for military development. The report included charts which extrapolated desired federal R&D expenditures through 1957 and the desired numbers of scientists through that same year.

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[28] The succeeding volumes of the report were the following: vol. 2, *The Federal Research Program*; vol. 3, *Administration for Research*; vol. 4, *Manpower for Research*; vol. 5, *The Nation's Medical Research*.

[29] This appears to have been the first use in an official public document of the now familiar R&D/GNP (later R&D/GDP) ratio.

[30] Steelman, *op. cit.*, 26.

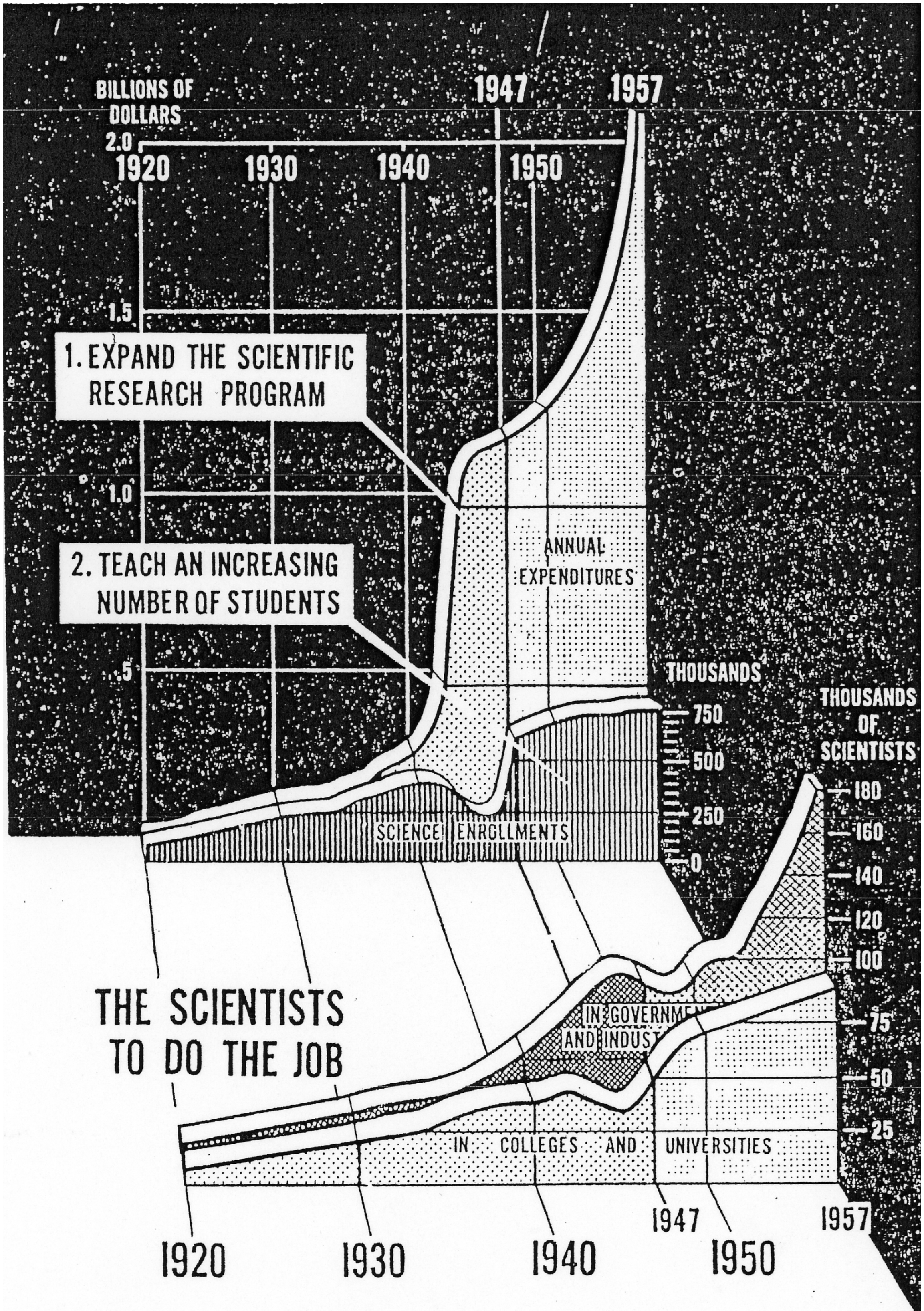
BILLIONS OF DOLLARS
2.0
1.5
1.0
.5
1920
1930
1940
1947
1950
1957
1. EXPAND THE SCIENTIFIC RESEARCH PROGRAM
2. TEACH AN INCREASING NUMBER OF STUDENTS
ANNUAL EXPENDITURES
SCIENCE ENROLLMENTS
THOUSANDS
750
500
250
0
THOUSANDS OF SCIENTISTS
180
160
140
120
100
75
50
25
THE SCIENTISTS TO DO THE JOB
IN GOVERNM
AND INDUST
IN COLLEGES AND UNIVERSITIES
1920
1930
1940
1947
1950
1957

Figure 7.4

The Bush report had recommended strengthening federal non-defense applied research programs, but paid little attention to the entire government system. In contrast, the Steelman report recognized the growing complexity and influence of the federal scientific enterprise on the entire national effort: "The Federal program for scientific research and development exerts its influence in many major areas, and it is a direct influence not only upon the scientific activities of the country as a whole, but upon the national economy. Its very scope makes the formulation of policy and administration difficult, and its operation within the structure of the Federal Government raises questions of balance in its programs."[31]

In order to increase the effectiveness of the federal effort, the report recommended that: "A central point of liaison among the major research agencies to assure the maximum interchange of information...must be provided.... There must be a single point close to the President at which the most significant problems created in the research and development program of the Nation as a whole can be brought into policy discussions."[32]

Science—the Endless Frontier and *A Program for the Nation* were in accord in singling out basic research as the principal area for concerted federal action. Indeed, the latter report recommended that the largest percentage increases in federal expenditures during the next decade should be in that area. (In contrast, it recommended that expenditures for military development ought to increase more slowly than for other sectors.) Much of its rhetorical justification for government research support was reminiscent of *Science—the Endless Frontier*, and no doubt drew upon it for inspiration. More concretely, *A Program for the Nation* proposed creation of a National Science Foundation that would have been more munificently endowed than Bush proposed.[33] It was also considerably bolder in recommending "a program of Federal assistance to universities and colleges...in the matters of laboratory facilities and scientific equipment,"[34] and by asserting the need "to assist in the reconstruction of European laboratories "as a part of our program of aid to peace-loving countries."[35]

Despite its unequivocal endorsement of government support for basic research and its broader concept of the scope and authority of a National Science Foundation, the report drew the ire of the scientific establishment by recommending that the foundation be headed by a presidentially appointed director "assisted by a part-time advisory board of distinguished scientists and educators similarly appointed."[36] Half the members of the advisory board would have been drawn from within government and half from outside. Moreover, it recommended that the foundation be established within the Executive Office of the President (EoP) rather than as an independent agency. Indeed, there was some sentiment on the Steelman board that the president should simply establish a National Science Foundation within the executive office by means of an executive order rather than having to rely on the congress to create the organization.[37] Since the report's recommendations were also opposed by the military and by conservative congressmen opposed to central planning, it went nowhere. (It is interesting to note, however, that actual R&D expenditures through the 1950s far exceeded the report's targets.)

On September 13, 1948, President Truman addressed the centennial anniversary meeting of the American Association for the Advancement of Science (AAAS).[38] In history's first public presidential speech calling for a national science policy, Truman suggested that it be based on five key Steelman recommendations:

> *First, we should double our total public and private allocations of funds to the sciences....*
>
> *Second, greater emphasis should be placed on basic research and on medical research.*

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[31] Steelman, *op. cit.*, 45.
[32] Ibid., 61.
[33] Bush, *op. cit.*, 40
[34] Ibid., 31.
[35] Ibid. The Steelman report was released during the months that Congress was debating the proposed Marshall Plan for economic recovery assistance to Europe.
[36] Ibid., 34
[37] England, *op. cit.*, 80
[38] Harry S. Truman, "Address to the Centennial Anniversary AAAS Annual Meeting (1948)," in Albert Teich, ed., *Science and Technology Policy Yearbook 1999* (Washington, DC: American Association for the Advancement of Science, 1999).

Third, a National Science Foundation should be established.

Fourth, more aid should be granted to the universities, both for student scholarships and for research.

Fifth, the work of the research agencies of the Federal Government should be better financed and coordinated.

7.6 Science and International Relations

Scientists have long regarded international communication and cooperation as essential to the advancement of science. In the immediate aftermath of World War I, several international scientific unions were created, including the International Union of Pure and Applied Physics (IUPAP) and the International Astronomical Union (IAU). Almost always, national academies of sciences became the adhering bodies to these organizations. In the early 1930s, the existing scientific unions created an umbrella organization, the International Council of Scientific Unions (ICSU). By the end of the twentieth century, approximately forty disciplinary scientific unions had been created under the umbrella of what had come to be called the International Council of Science.

Since the end of late 1940s, the U.S. government, along with Europe, Japan, China, and India, has regarded science as a significant part of international relations. Even prior to World War II, there was some advocacy for federal support for international scientific activities. *Relation of the Federal Government to Research* recommended: "International cooperation in scientific research now exists on a large scale. It could be encouraged to the great advantage of the Nation if the Federal Government would adopt the practice which is common among the Governments of other nations of according official recognition and, wherever necessary, financial support to international gatherings of scientists."

Science—the Endless Frontier also provided a rationale for federal support of international science:

International exchange of scientific information is of growing importance. Increasing specialization of science will make it more important than ever that scientists in this country keep continually abreast of developments abroad. In addition, a flow of scientific information constitutes one facet of general international accord which should be cultivated.

The Government can accomplish significant results in several ways: by adding in the arrangement of scientific congresses, in the official accrediting of American scientists to such gatherings, in the official reception of foreign scientists of standing in this country, in making possible a rapid flow of technical information, including translation service, and possibly in the provision of international fellowships. Private foundations and other groups partially fulfill some of these functions at present, but their scope is incomplete and inadequate.[39]

The most significant attempt at international scientific cooperation was the Baruch Plan, presented to the United National Atomic Energy Commission on June 14, 1946, by Bernard Baruch, a New York financier and informal advisor to the Roosevelt and Truman administrations. The plan was drafted under the auspices of a committee headed by David Lilienthal, Chairman of the Atomic Energy Commission (AEC) and a small group of scientists headed by J. Robert Oppenheimer. It proposed worldwide sharing of nuclear technologies and strict sanctions against uncooperative nations. Specifically:

The [International Atomic Energy] Commission shall proceed with the utmost despatch and enquire into all phases of the problem, and make such recommendations from time to time with respect to them as it finds possible. In particular the Commission shall make specific proposals:

[39] Bush, *op. cit.*, 22

a. *For extending between all nations the exchange of basic scientific information for peaceful ends;*

a. *For control of atomic energy to the extent necessary to ensure its use only for peaceful purposes;*

a. *For the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction;*

a. *For effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.* [40]

With the Soviet Union's rejection, the Baruch Plan died.

Relation of the Federal Government to Research and *Science —the Endless Frontier* both recommended that the federal government support US scientists' travel to scientific meetings abroad. The Steelman report went considerably further, suggesting that science could be an effective tool of diplomacy, and recommending:

US scientists should be supported by the federal government to travel to European research facilities to assist in restoring the viability of those facilities which had been devastated by World War II;

The federal government should support foreign students to study science and engineering in US universities;

The federal government should assign competent scientists to its principal foreign embassies; and

The United States be prepared to cooperate in scientific research with non-European countries, including specifically Japan, China, and India as the developed their scientific resources and talent—and also be cognizant of the competition that this would entail.[41]

The Steelman report was transmitted to President Truman two months after announcement of the Marshall Plan, and thus was consistent with the administration's vision of international cooperation.

7.7 Emergence of the Bureau of the Budget

The Steelman Report's premise that formulation of national science policy ought to proceed from an analysis of national resources and objectives also reflected the perspective of the Bureau of the Budget (BoB), whose influence on science policy became more pronounced during the five-year National Science Foundation debate. Harold Smith, who served as BoB Director from May 1939 to June 1946, regarded the agency as the principal institutional guardian of policy. Accordingly, he sought to provide the president with sound advice on pending legislative proposals based on careful and objective staff work. As a result, Smith succeeded in building within the BoB the capability of analyzing executive and congressional proposals for their consistency both with administrative policies and the long-term, constitutional and institutional prerogatives of the presidency.[42]

By late 1943, it was becoming clear to Smith that the federal government would be more extensively involved with science during the postwar era. The role of the BoB would be to assure that any expanded scientific responsibilities would be integrated into the federal structure in accordance with sound principles of

[41] Steelman, *op. cit.*, 38-41

[42] Larry Berman, *The Office of Management and Budget and the Presidency, 1921-1979* (Princeton, NJ: Princeton University Press. 1979), 13-15.

administrative management, including the preservation of presidential authority. Transformation of wartime government research installations to peacetime uses would obviously require advanced planning. Accordingly, Don K. Price, a protégé of Louis Brownlow's who was detailed to the BoB from the Coast Guard and who was dispatched in 1944 to familiarize himself with the Manhattan Project installations, became the principal advocate within the BoB for civilian control of atomic energy.[43]

In 1944, Smith grew wary of the Research Board for National Security (RBNS) on the grounds that it would be too far removed from presidential control.[44] He therefore took steps to assure that it would be quietly starved of funds. Later, he convinced Truman to withhold support for a measure introduced by Senator Harry S. Byrd (D-VA) to establish the RBNS as an independent agency on the grounds that federal science policy ought to be implemented coherently rather than piecemeal.[45] In 1945 testimony before a Senate committee, Smith said, "The President, and the Bureau of the Budget in his Executive Office, need scientific advice... The proposed foundation can fulfill a valuable function in supplying such advice. It will need to be given...authority to call on the scientific bureaus of the Government for information, and the duty of making recommendations to the department heads and the president on their programs."[46]

He also asserted, with respect to the organization and management of the foundation, "I feel it is my duty to keep the scientists from making a mistake in the field of public administration... An agency which is to control the spending of public funds in a great national program must be part of the regular machinery of government. If the Government is to support scientific research, it should do so through its own responsible agencies, not be delegating the control of the program and turning over the funds to any non-governmental organization."

The tension between the BoB's desire to establish a National Science Foundation as an essential component of the federal scientific enterprise and its concern for administrative conformity and presidential prerogatives persisted. Because of those concerns, the BoB remained closely involved in attempting to shape successive versions of NSF legislation to meet the demands of the scientific establishment, the shifting congressional leadership, and the administration itself. William D. Carey, who had come to the BoB in 1942 from Harvard's Littauer School of Government and had been assigned to help organize the Atomic Energy Commission in 1946, emerged as the principal advocate, within the BoB, for a National Science Foundation. Possibly because of his closer association with senior scientists such as Bush and Conant on the matter of the AEC, Carey did not share his colleagues' concern over the presidential control issue. Rather, he considered the NSF Act of 1947 workable from BoB's perspective, despite the fact that control was to be vested in a part-time, presidentially-appointed board rather than the president himself. For that reason, he vigorously (though privately) dissented from BoB's advice that President Truman veto the National Science Foundation Act of 1947.[47]

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[43]Author and Trudy Solomon interview with Don K. Price, October 1981.

[44]Daniel J. Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944-46," *Technology and Culture* 16, #no. (Jan. 1975), 20- 45.

[45]Despite the fact that Vannevar Bush had been instrumental in creating the defunct RBNS within the National Research Council, he also opposed Byrd's measure, since he regarded the RBNS as a temporary expedient whose functions would ultimately be incorporated into his proposed National Research Foundation.

[46]England, *op. cit.*, 30

[47]Ibid., 81-82.

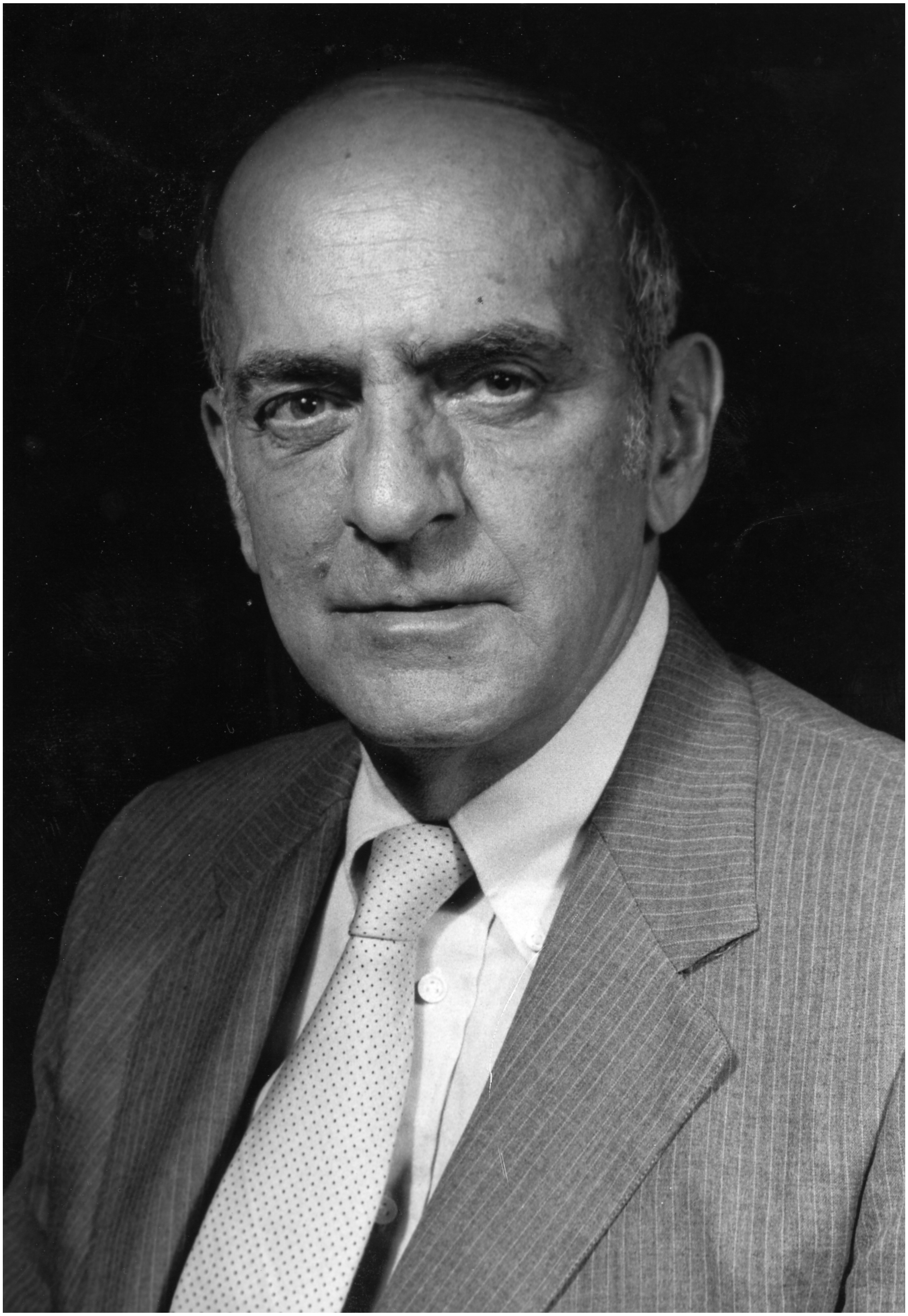

Figure 7.5: William D. Carey, ca. 1980. Courtesy of the American Association for the Advancement of Science.

Despite its decisive intervention in killing the 1947 legislation, the BoB remained committed to establishing a National Science Foundation. Over the next three years, Carey and Elmer Staats, among others, played important roles in negotiating successive compromises that ultimately paved the way for the National Science Foundation Act of 1950. During those years, close and enduring relations were established between the BoB and the broadly based scientific communities, particularly through the Intersociety Committee for a National Science Foundation.

By 1950, largely through the efforts of Staats and Carey, BoB had become the principal advocate for science within government, as well as guardian of such scientific prerogatives as autonomy and open communication, and such constitutional imperatives as presidential and congressional responsibility and accountability. The BoB assumed that role largely by default. In 1947, the Steelman report had recommended, "The Bureau should...continue to take initiative in the allocation of research functions among Executive agencies. The organization of the Bureau should be strengthened for a more effective performance of this function and to provide the Bureau with a means of taking an overall view of the research and development programs."[48]

However, the report also noted, "The Bureau of the Budget is not and should not be charged with the task of developing a broad scientific research program for the nation." That task, presumably, would fall within the purview of a National Science Foundation. But two years later there still was no National Science Foundation, and the BoB was reluctantly filling the resulting void.

BoB did not assume an activist role on behalf of science and government solely to achieve a workable arrangement through which government could support research in universities. From the outset, it sought to incorporate into the NSF responsibility for other functions envisioned by *Science—the Endless Frontier*, particularly coordination of "research programs on matters of utmost importance to the national welfare," and formulation of "a national policy for the Government toward science."

As President Truman recognized explicitly when he created the Steelman board, it was becoming clear as early as 1946 that government would be involved with science through a multiplicity of agencies, including such new ones as the ONR and AEC, expanded programs in old-line agencies such as the Department of Agriculture and National Bureau of Standards, the rapidly expanding National Institutes of Health, and a National Science Foundation.

By that time, the BoB had also become sufficiently converted to the principal arguments of *Science—the Endless Frontier* to concede that relations between science and government could prosper only if it sought advice and guidance from non-governmental scientific leadership on how to effect discipline within the *de facto* federal R&D budget[49] and coherence within the federal research establishment. In the opinion of Carey and his colleagues, the twenty-four–member National Science Board would be the obvious entity to help in the promised formulation of a "national policy of the Government toward science" as envisioned by *Science—the Endless Frontier*.

The BoB may have assumed that, having taken a strong initiative to create a foundation that would support scientific research in a manner that would preserve a large measure of scientific autonomy, the National Science Foundation (particularly the National Science Board) would in turn provide direct, continuous assistance in helping coordinate the proliferating federal science and technology enterprise. But it was destined for disappointment, in part because the outbreak of the Korean War six weeks after presidential approval of the National Science Foundation Act radically changed the science policy environment in the United States. Even after 1953, when a truce had been established in Korea, Alan T. Waterman, the first NSF Director, declined to have the National Science Board exercise its congressionally mandated authority to oversee and evaluate R&D programs in agencies other than the NSF.[50] A skillful Washington bureaucrat, Waterman feared that the still-small agency he headed would be crushed by the larger, more established federal R&D organizations. On March 17, 1954, President Dwight Eisenhower issued an executive order,

[48]Steelman, *op. cit.*, 63.

[49]Then as now there exists no explicit R&D budget in the sense that the president's annual budget request to the Congress includes such a budget. Rather, the requested federal R&D budget consists of the aggregate of the requests of all federal organizations with responsibilities for R&D expenditures.

[50]In 1956, Waterman was nominated and confirmed for a second six-year term as NSF Director. As the expiration of that second term approached, he was granted a two-year extension, which required the Congress to exempt him from the statutory retirement age of 68 for federal employees.

drafted by Carey, directing the National Science Board to carry out its congressionally mandated oversight and evaluation responsibilities.[51] Waterman and the board managed to ignore this as well.

[51] The text of this executive order appears in England, *op. cit.*, 353- 55.

Chapter 8

The Early Cold War: 1950-57[1]

And then you had Korea. And everybody woke up! Everybody woke up!! The world was not going to be perfect—ever!!! And rationalization for the pursuit of science and advanced education began to turn toward the umbrella of national security.

—William D. Carey, 1986

Their attitude is that when the crisis comes, the organization will spring up virtually automatically around the science leaders who will come to the fore spontaneously.

—William T. Golden, 1951

8.1 Militarization of the Cold War

The Korean crisis resulted in a fragmentation of U.S. science policy just as the Truman administration was putting it in place. Because the war focused the attention of the late Truman and early Eisenhower administrations on relatively short-term military applications, divergence between defense- and non-defense science policies widened, and support for the latter was undercut. The science policy debates of the late 1940s had frequently involved areas of vital national interest, such as national defense, public health, agriculture, and effective mechanisms for bringing scientific results to bear on them. Such issues were encompassed by what Harvey Brooks was later to call science-for-policy.[2] Although *Science–the Endless Frontier* had focused primarily on policy-for-science, it also envisioned its proposed National Research Foundation as playing a pivotal role in science-for-policy. One result of the Korean War was to legitimize, if only tacitly, the divorce of science-for-policy and policy-for-science, thus relegating the post-World-War-II hope of formulating a coherent national science policy to at least temporary oblivion.

The Korean crisis brought on immediate expansion of federal defense appropriations. In July 1951, President Harry Truman called upon the Congress for an immediate $11.3 billion emergency defense appropriation, both to increase the American military presence in Korea and to prepare for what might become a wider conflict.[3] By the end of fiscal year 1951, additional supplementary appropriations had raised the total defense budget to $48 billion. For fiscal year 1952, Truman requested and Congress budgeted $60 billion for defense.

Federal R&D budgets reflected this militarization trend. In fiscal year 1952, total federal R&D expenditures were approximately $2 billion, with defense-related R&D appropriations having doubled to $1.3 billion in just two years.

The presumably non-defense–oriented National Science Foundation was established scarcely six weeks before the outbreak of the Korean War; had the invasion of North Korea occurred six weeks or more earlier,

[1] This content is available online at <http://cnx.org/content/m34586/1.1/>.

[2] Harvey Brooks, *The Government of Science* (Cambridge, MA: MIT Press, 1968).

[3] William A. Blanpied, *Impacts of the Early Cold War on the Formulation of US Science Policy* (Washington, DC: American Association for the Advancement of Science, 1995), xviii.

the National Science Foundation Act of 1950 likely would not have passed. And given the tenor of the country for years after, the Foundation might never have been established; from the beginning of the Korean War to the fall of the Berlin Wall in 1989, national defense effectively drove national science policy, with the military services (until the Vietnam War controversies) providing financial support for university basic research.

8.2 The Golden Consultancy

A central question faced by the White House during the latter half of 1950 was whether the Korean crisis would be a prelude to a more widespread crisis and, if so, whether the U.S. government was in a position to mobilize its superior science-based military technologies to cope with it. Various arrangements had been attempted since 1944 to maintain civilian scientific input into national defense planning. Among these was the Board for Research and Development (RDB), established in 1947 as a civilian advisory group in the Pentagon and chaired successively by Vannevar Bush, Karl Compton, and William Webster. In 1948, the RDB established a Committee on Plans for Mobilizing Science under the chairmanship of Irvin Stewart, President of the University of West Virginia and a wartime associate of Bush's at the OSRD.[4] *Organizing Scientific Research for War*, a 1950 Stewart committee report to the President, concluded that existing institutional arrangements were not effective and were in any event largely irrelevant to the current and possibly expanding national defense emergency.[5] The committee's recommended solution was to reconstitute a central coordinating and operating body whose director would have direct access to the president, on the model of the OSRD.

That October, Truman designated William T. Golden as a special consultant to the White House, charging him to "review...the organization and conduct of scientific research and development activities in the Department of Defense and related agencies and the organization of the Government for the promotion of scientific activities generally during the emergency period," and to submit an informal report, with recommendations, on feasible and appropriate means to improve coordination and oversight.[6] Among the factors leading Truman to believe such a review was necessary were the conclusions and recommendations of the Stewart report, evidence of mounting congressional concern about military preparedness, and "the approaching activation of the National Science Foundation."

[4]The evolution of defense-related science policy has been reviewed by Herbert E. York and G. Allen Greb, "Military Research and Development: a Postwar History," *The Bulletin of the Atomic Scientists* 33 (January 1977), 12-25.

[5]Irvin Stewart, *Organizing Science for War* (Boston: Little Brown and Company, 1948).

[6]Blanpied, *op. cit.*, xx.

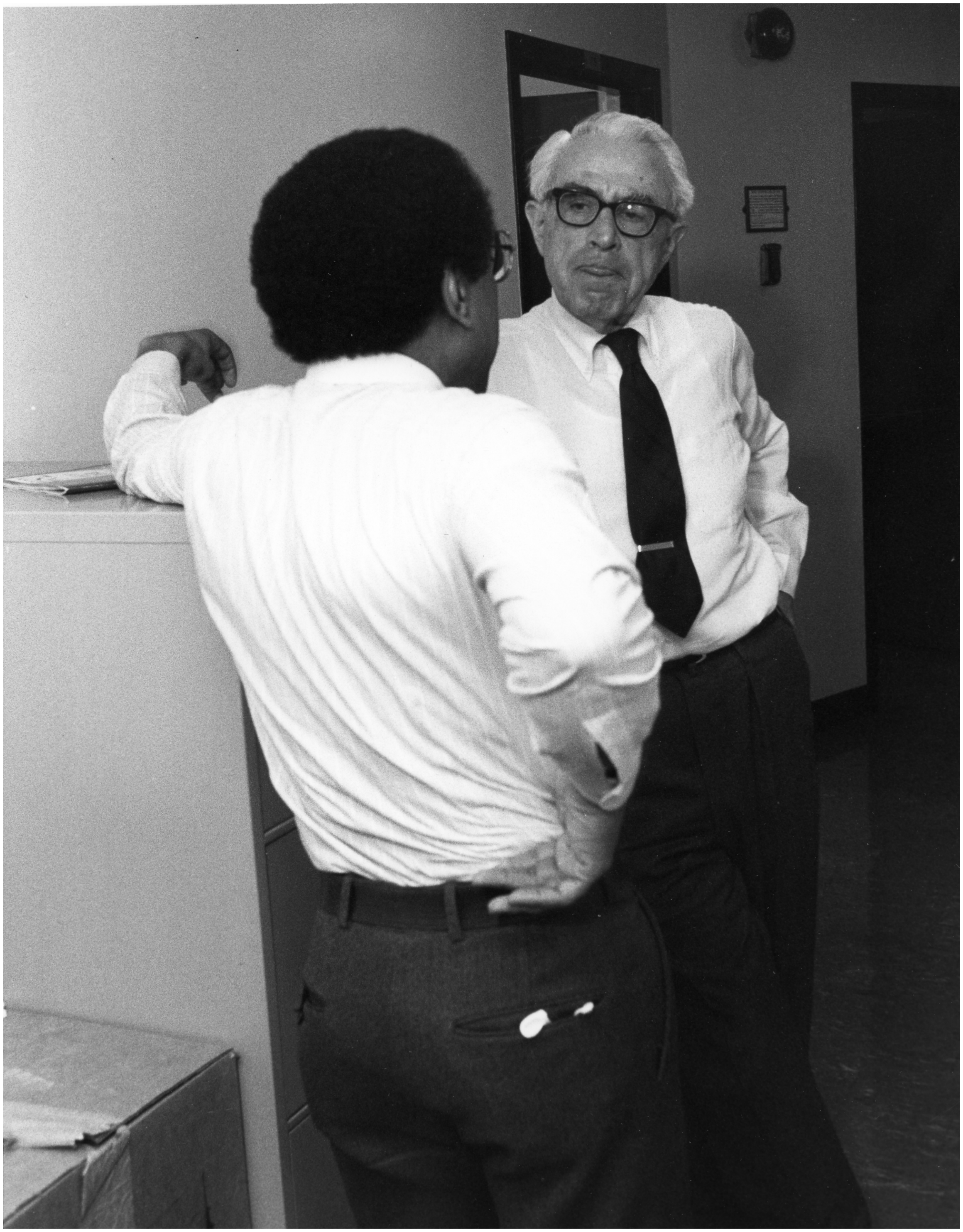

Figure 8.1: William T. Golden in 1982, speaking with Walter Massey, back to the camera. Courtesy of the American Association for the Advancement of Science.

Golden, a Wall Street investment banker, had served with the Navy Department in Washington during World War II as a "dollar a year man" and afterwards had helped organize the AEC. From October 1950 through April 1951, he conducted extensive interviews with the scientific leadership in universities and government, as well as with policy-level officials in both the AEC and the Pentagon. His initial focus was on the relatively narrow question of how to improve the effectiveness of the Pentagon's Joint Board for Research and Development, but the scope of his discussions inevitably turned to the broader questions of whether a completely new institutional arrangement was required to mobilize science for defense and what role the National Science Foundation should play in defense preparations.

Regarding the latter question, the general consensus appeared to be that NSF should avoid defense research entirely. Golden believed that that view was shared by at least three prominent board members he interviewed: James B. Conant, President of Harvard and Chairman of the NSB; Lee DuBridge, President of the California Institute of Technology; and Detlev Bronk, President of both the Johns Hopkins University and the National Academy of Science. It was also shared by Alan Waterman, the Scientific Director of the Office of Naval Research, who in March 1951 was to be nominated by the president as the first NSF Director. However, the full board did not share that consensus, and DuBridge, Bronk, and Waterman also appear to have had second thoughts, primarily because Golden's proposed solution to the larger question of scientific mobilization threatened to preempt the effectiveness of the foundation and the NSB.

As to the question of a more effective institutional arrangement to mobilize science for defense, the recommendation of the Stewart committee to reconstitute OSRD as an operational organization at the White House level was rejected by virtually all of Golden's interlocutors (including Stewart himself). "Their attitude," Golden wrote following an October 25 meeting with Stewart, DuBridge, and James Killian of MIT, "is that when the crisis comes, the organization will spring up virtually automatically around the science leaders who will come to the fore spontaneously."[7] The problem, then, was how to smooth the way for that promised "spontaneity."

To that end, in a December 18 memorandum to the president, Golden urged "the prompt appointment of an outstanding scientific leader as Scientific Adviser to the President." The functions envisioned for this official would be:[8]

a) To inform himself and keep informed of all scientific research and development programs of military significance within the several independent Government departments so engaged.

b) To plan for and stand ready promptly to initiate a civilian Scientific Research Agency, roughly comparable to the Office of Scientific Research and Development (OSRD) of World War II.

c) To be available to give the President independent and comprehensive advice on scientific matters, inside and outside the Government, particularly those of military significance.

The memorandum concluded by urging, "Plans for such an OSRD-type 'Scientific Research Agency' should be developed promptly and the agency itself should be established in a modest way as soon as the first appropriate projects selected, evolving thereafter in accordance with opportunity and the then prevailing degree of urgency."

The newly appointed NSB's short-lived but vocal opposition to the presidential science advisory concept created momentary consternation at BoB, where it had been assumed that scientific leadership solidly backed the idea. Indeed, as already noted, three of the most prominent board members—Conant, Bronk, and DuBridge—had been instrumental in helping shape the concept. Moreover, DuBridge and Bronk were among the candidates being mentioned for the post.

The NSB's first meeting, on December 13, 1950, took place less than a week before Golden sent his recommendation to Truman. Aside from a perfunctory meeting with the president, the principal business transacted was election of a chairman (Conant) and an executive committee (chaired by Bronk), and selection of an ad hoc committee to draw up a list of candidates for the directorship.[9]

At its second and third meetings, the NSB devoted considerable attention to the defense research and presidential science advisory issues. Minutes of the second meeting, held on January 3, 1951, record that

[7] Ibid., 14.
[8] Ibid., 65-67.
[9] Minutes of the National Science Board (unpublished).

"it was the sense of the meeting that given a continuation of international tensions [defense research] might be one of the most important concerns of the Foundation for some time to come."[10] However, a decision to create a Division of Defense Research was deferred pending appointment of a director. The minutes give no hint about discussion of the probable appointment of a presidential science advisor. In the course of a January 5 meeting at BoB with Golden, Elmer Staats, and William Carey, Conant reported that the board was opposed to such an appointment, as the adviser would undercut its own prerogatives and authority. Evidently the issue of NSF's role in defense research was regarded as critical since, as Golden noted after the meeting, "somehow, NSF needs a national defense label to get appropriations and keep its Board happy."[11]

By mid-February, Truman had rejected Golden's recommendation to appoint a science advisor, largely because of the objections of General Lucius Clay, Deputy Director of the Office of Defense Mobilization.[12] Instead, he had decided to establish a Science Advisory Committee to that office—SAC/ODM. In an internal memo, BoB assured itself that the NSB was satisfied with a February 14 briefing by Staats on that outcome, even though it was almost certainly a disappointment to both BoB and the scientific leadership.

There is evidence that this outcome dampened the enthusiasm of several candidates for the NSF directorship. Bronk, who had headed the board's list, withdrew his name, in part on the grounds that he could serve more effectively as president of NAS during the Korean crisis. Eventual director Alan Waterman, originally ranked seventh on the list of candidates, had doubts at first about accepting because of the possible exclusion of NSF from defense-related research.[13] His and the NSB's hesitation in this regard were at least partially allayed by Waterman's appointment as a statutory member of SAC/ODM.

Comparative budget figures suggest that Waterman's concerns were well founded. In December 1950, BoB estimated that the U.S. government's total funding for basic research was on the order of $100 million for fiscal year 1951, with the lion's share going to the Department of Defense (DoD) and the Atomic Energy Commission (AEC). Moreover, the Pentagon's share was projected to increase substantially. BoB estimated that DoD's fiscal year 1952 budget for research and development would be $1.25 billion, more than double its fiscal year 1950 level of $500 million. By contrast, the Harris amendment to the NSF Act of 1950 limited the foundation's fiscal year 1951 appropriations to $500,000, and thereafter to $15 million annually. At its February 1951 meeting, the National Science Board set tentative fiscal year 1952 targets for research support and fellowships at $9 million and $2 million respectively. A month later it revised those respective targets to $7.5 million and $6.5 million.[14]

The BoB seems to have hoped to enhance the status and impact of the NSF by transferring some basic research projects to there from the ONR and the AEC. But Waterman himself had opposed such transfers when he'd been chief scientist at ONR. Reporting on a November 29, 1950, meeting, Golden noted that: "As to the NSF, he [Waterman] feels it should, by policy, not engage in any military work.... There would be a few projects which ONR might turn over to the NSF but these would probably be less than 10 percent of its total and it would want to take on other projects in their stead.... His remarks were remarkably similar to those expressed by Ken Pitzer, the AEC Director of Research, when I asked him essentially the same question."[15]

One month after nominating Waterman as NSF Director, Truman announced formation of SAC/ODM under the chairmanship of Oliver Buckley, Chairman of the Board of Bell Telephone Laboratories.[16] SAC/ODM's membership included non-government scientists and the heads of several civilian government agencies, including Waterman as director of NSF. By that time, it was reasonably clear that the Korean War was unlikely to escalate into a larger military crisis. But it was also clear to all but a few optimists (first and foremost General Douglas MacArthur) that the war itself would drag on for some time, with inconclusive results.

[10] Ibid.

[11] Blanpied, *op. cit.*, 43

[12] Ibid., xxviii

[13] J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945-57* (Washington, DC: National Science Foundation, 1982), 142-43.

[14] The remaining budget line items were for administration, publications and translations, travel to attend foreign conferences, and a survey of national research needs.

[15] Blanpied, *op. cit.*, 24.

[16] Ibid., xxix.

Perhaps more significant was the war's effect on the American public, which became preoccupied with what it saw as a worldwide Communist menace. J. Robert Oppenheimer was the most prominent—but by no means the only—scientist punished for perceived Communist leanings when his security clearance was revoked because of pre-World-War-II associations. Other scientists were driven from positions in universities, government, and industry because of similar allegations regarding former political ideals or allegiances. The inhibiting effects of this brief episode of national paranoia on scientists who might have participated in the national science debate have yet to be thoroughly understood.

Figure 8.2: J. Robert Oppenheimer (right) and Nobel Laureate Niels Bohr at the Institute for Advanced Study, date unknown. Courtesy of the Niels Bohr Archives, AIP Segre Visual Archives.

In any event, the Oppenheimer scandal, the Korean War, the successful tests of thermonuclear devices by the United States in 1952 and the Soviet Union in 1953, and the 1957 Sputnik launch kept science policymakers focused almost entirely on national defense. Thus the 1950s saw only a fraction of the interest and growth in non-defense–related science policy-making that was seen in the postwar 1940s. Moreover, by mid-1951 all the principal government line agencies (or their predecessors) that today provide the institutional structure for U.S. science policy had been established, with the exception of NASA and such technically-oriented regulatory agencies as the Environmental Protection Agency (EPA).[17]

[17] The impact of the advisory structures to these new agencies, which included both social and natural scientists, has been described by Shiela Jasanoff in *The Fifth Branch: Science Advisers as Policy Makers* (Cambridge: Harvard University Press, 1990).

Thus from an institutional perspective, the 1951-1957 period was a time of moderate growth and consolidation—at least on the civilian science side—rather than innovation. It was also a period in which science policy was about support for science rather than the impact of science on government or society. The ostensibly mission-oriented ONR, AEC and NIH gradually expanded their support for university-centered basic research (related only tenuously to their missions) until by 1957 the availability of such support was taken for granted. Wholly or already only partially non-defense national laboratories managed by universities or university consortia became a significant factor in the institutional structure of American science. Although the AEC contracted with the University of California to establish a second weapons laboratory at Livermore, California, in 1952, within a few years its original laboratory at Los Alamos began relaxing some of its stringent security restrictions and establishing several small projects of a more civilian character. During this same period, the AEC's Brookhaven National Laboratory, managed by the Associated Universities, Inc., emerged as one of the principal sites for the pursuit of the study of elementary particles.

The newly activated National Science Foundation and a relatively passive National Science Board sought and found a safe niche for themselves among supporters of university-centered basic research in those hard science disciplines or sub-disciplines that had yet to identify another willing and forthcoming federal patron. By August 1953, Waterman had succeeded in convincing the Congress to abolish the NSF's $15 million annual appropriations ceiling. Congress also was dragged reluctantly into support of "big science" by means of a $2 million supplemental appropriation for U.S. scientific participation in the International Geophysical Year, a sixty-seven–nation program intended to allow scientists from around the world to take part in a series of coordinated observations of various geophysical phenomena. In June 1955, the NSF received an additional $10 million for that same purpose, and in August 1957 another $27 million.

The transition from the Truman to the Eisenhower administration was marked by the effort to educate a new generation of federal officials about the need for government support of scientific research outside government. While most non-defense–oriented science agencies endured threatened and actual budget cuts during the early Eisenhower years, they managed to survive and—even before Sputnik—to prosper.

8.3 Organization of Defense-Related R&D

Appropriately, the most significant institutional innovations of the period pertained to defense-related R&D. Creation of SAC/ODM in April 1951 helped improve coordination and oversight, as did the appointment, a year earlier, of a Pentagon "missile czar" with direct access to the Secretary of Defense and the authority to review and establish priorities for guided missile R&D programs throughout the three military branches.[18] Assistant Secretary of the Air Force Trevor Gardner, the first missile czar, resigned in 1956 over Eisenhower's decision to cut the missile program budgets in all three of the armed services.

This trend toward unification of defense R&D continued throughout the Eisenhower administration. In 1953, the Defense Department established the offices of Research and Development and of Applications Engineering, both headed by civilians at the Assistant Secretary level, and abolished the part-time civilian Joint Research and Development Board. For its part, SAC/ODM demonstrated its potential to contribute significantly to defense analysis, if not to policy formulation more broadly, through the work of its Technology Capabilities Panel, established in 1954 under the chairmanship of MIT president James Killian. Two years later, the Defense Department established a separate, independent Institute for Defense Analysis (IDA), to provide continuing advice on advanced R&D to the department's policy-level officials.

By the spring of 1951, *Science—the Endless Frontier*'s proposed unitary solution to the problem of linking scientific research with government was a dead letter. The infant NSF had been excluded from mainstream national defense research and preempted by default from medical- and nuclear-oriented research by the National Institutes of Health and the Atomic Energy Commission. As a result, Waterman decided that the most feasible survival strategy for the foundation would be to become the principal federal patron for university basic research and graduate education in the natural science disciplines.[19] Thus began the retreat

[18] York and Greb, *op. cit.*

[19] NSF was explicitly mandated (some would say ordered) to support the social sciences as a result of hearings held in 1960 before a committee of the House of Representatives which led to amendments to the NSF Act of 1950.

of the National Science Foundation and the National Science Board from the policy responsibilities and prerogatives envisioned by *Science—the Endless Frontier*, authorized by the National Science Foundation Act of 1950 and reiterated by Eisenhower in his 1954 executive order.

8.4 Science and International Relations

A clear example of the use of science for international diplomacy was the Atoms for Peace program, announced by President Eisenhower in a speech before the General Assembly of the United Nations on December 8, 1953.[20] The president stated, "I feel impelled to speak today in a language that in a sense is new—one which I, who have spent so much of my life in the military profession, would have preferred never to use. That new language is the language of atomic warfare." He went on to state that advances in the field of nuclear energy could yield significant benefits and that the United States proposed to make use of them as a means to foster world peace. The program supplied equipment and information to schools, hospitals, and research institutions within the United States and throughout the world.

American participation in the International Geophysical Year was charged to a U.S. National Committee (USNC) appointed in March 1953. The core USNC was made up of sixteen members; its five working groups and thirteen technical panels eventually drew in nearly two hundred additional scientists. The technical panels pursued work in aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, longitude and latitude determination, meteorology, oceanography, rocketry, seismology, and solar activity. In addition, a technical panel was set up to attempt to launch an artificial satellite into orbit around the earth.

8.5 A Fading Vision

The late Truman and early Eisenhower years were characterized by a divergence of responsibilities for science policy formulation and implementation on the one hand, and the support and facilitation of scientific research on the other. Science policy was taken seriously by the White House and Congress primarily because of its national defense implications, with a concomitant though often only dimly understood acceptance of the need to provide modest levels of support to the university basic research system, in the event that its services would again be required in a time of national crisis. The launching of Sputnik I by the Soviet Union on October 4, 1957, widely perceived as just such a crisis, ushered in a period now regarded as the golden age of U.S. science policy.

[20] http://en.wikipedia.org/wiki/Atoms_for_Peace (<http://en.wikipedia.org/wiki/Atoms_for_Peace>) "December_8".

Chapter 9

The Golden Age: 1957-67[1]

The President needs help!
—Louis Brownlow, 1937

In holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.
—Dwight Eisenhower, January 17, 1961

9.1 The Shock of Sputnik

As has been recounted by several of the principal participants,[2] an October 15, 1957, meeting with the Scientific Advisory Committee to the Office of Defense Mobilization had been on President Eisenhower's calendar for weeks when the Soviet Union launched Sputnik on October 4. Within days, Congress, the press, and the public were raising serious questions about the adequacy of U.S. science, technology and education. According to Donald Hornig, later science advisor to President Lyndon Johnson, "the degree to which the press and public reacted was totally unexpected and showed an unanticipated understanding of the relation between scientific and technological stature and world power."[3]

"Our name was mud," recounted I.I. Rabi, Nobel Laureate in Physics at Columbia University and part-time Chairman of SAC/ODM.[4] "I advised him [the president] in the presence of the committee that what he needed was a man whom he liked, who would be available full time to work with him right in his office, to help by clarifying the scientific and technological aspects of the decisions which must be made from time to time. He would be part of his brain, so to speak. President Eisenhower readily agreed." James R. Killian carried Rabi's proposal one step further by urging "that there be a strong Science Advisory Committee reporting directly to the President who could back up his Adviser."[5]

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[1]This content is available online at <http://cnx.org/content/m34605/1.1/>.

[2]See, e.g., David Z. Beckler, "The Precarious Life of Science in the White House," in Gerald Holton and William A. Blanpied eds., *Science and Its Public: The Changing Relationship* (Dordrecht and Boston: D. Reidel Publishing Company, 1976), 115-34.

[3]Donald Hornig, "The President's Need for Science Advice: Past and Future," in William T. Golden ed., *Science Advice to the President* (New York: Pergamon Press, 1980), 43.

[4]I.I. Rabi, "The President and his Scientific Advisers" in Golden, *op. cit.*, 22.

[5]James Killian, "The Origins and Uses of a Scientific Presence in the White House," in Golden, *op. cit.*, 29.

Figure 9.1: Danish Nobel Laureate Niels Bohr accepting the Atoms for Peace Award from President Dwight Eisenhower ca. 1958. Left to right, Lewis Strauss, Arthur Compton, Bohr, Eisenhower, and James Killlian, Jr. Courtesy of the Niels Bohr Archives, AIP Segre Visual Archives.

Eisenhower was quick to react. In a November 7 nationwide broadcast, he announced Killian's appointment as his full-time Special Assistant for Science and Technology—a position that became commonly known as the Presidential Science Advisor. On November 27, he announced the reconstitution of SAC/ODM and its re-designation as the President's Science Advisory Committee (PSAC), consisting solely of non-government scientists and chaired by the president and his science advisor. With the creation of PSAC, the scientific community received what it had long sought: special access to the president.

9.2 U.S. and Soviet Missile Programs

The U.S. government had been seriously interested in unmanned rocket technology since late 1944, when several V2 rockets designed by Wernher von Braun were fired at London. Following the surrender of Germany, von Braun and several of his engineers were brought to Ft. Bliss, Texas, where they worked with the U.S. Army developing and testing rockets. In 1950, von Braun and his team moved to the Redstone Arsenal near Huntsville, Alabama, where they developed the Army's Jupiter ballistic missile.[6]

In 1954, Eisenhower, concerned that the United States was vulnerable to surprise attack by the Soviet

[6] "Dr. Wernher von Braun: First Center Director, July 1, 1960-Jan. 27, 1970," MSFC History Office, http://history.msfc.nasa.gov.

Union, requested that SAC/ODM conduct a study to assess that threat and recommend feasible countermeasures. SAC/ODM convened a Technology Capabilities Panel (TCP) chaired by Killian,[7] and the president formally approved its recommendation to develop a high-altitude spy plane, later known as the U2, which could undertake reconnaissance flights over the Soviet Union and China. Mindful that such a spy plane might be shot down,[8] the TCP also recommended that an earth satellite be developed for reconnaissance.[9] Meanwhile, a committee of the National Academy of Sciences (NAS), charged with planning American participation in the International Geophysical Year, forwarded to NSF director and SAC/ODM member Alan Waterman a proposal to develop and launch a small scientific satellite during the IGY. The Eisenhower administration approved the recommendation on the grounds that the launching of a satellite traveling above the atmosphere would validate its open-skies policy—namely, the right of all nations to launch satellites that would fly over other countries. On July 29, 1955, Eisenhower publicly announced that the United States planned to launch "small unmanned Earth circling satellites as part of U.S. participation in the International Physical Year."[10]

Thus the Eisenhower administration committed itself to a two-track satellite program: the highly secret spy-satellite system and the open IGY system. Interservice rivalries, however, impeded both efforts. Out of three competing rocket programs—the Navy's Vanguard, the Army's Redstone (headed by von Braun), and the Air Force's Atlas—the Vanguard won out, then failed twice in attempting to launch the IGY satellite.

Meanwhile, the Soviet Union was proceeding with its own plans to develop and launch earth satellites. On May 20, 1954, the Soviet Council of Ministers charged Sergey P. Korolev's Scientific Research Institute Number 88 with developing an Intercontinental Ballistic Missile (ICBM) capable of carrying a nuclear warhead to the United States.[11] Shortly thereafter, Korolev requested authority to form a research department to study and "develop various aspects of this problem [development of an earth satellite]." On April 16, 1955, the Soviet daily *Pravda* announced that an Interdepartmental Commission of the Soviet Academy of Sciences had been charged with building an "automatic laboratory for scientific research in space." Realizing that they could not complete the project prior to the end of the IGY, the Soviets opted to develop smaller, simpler satellites that would contain no instrumentation except a radio that could beam periodic signals to the earth. Hence the successful launching of Sputnik 1, followed a month later by the launch of Sputnik 2, carrying the dog, Laika.

One month after that—on December 6, 1957—a Vanguard rocket attempting to launch the United States' first satellite exploded after takeoff. Finally, on January 31, 1958, Explorer I was successfully launched by an Army Jupiter rocket.

9.3 PSAC

Conditions were clearly ripe in post-Sputnik 1957 for the establishment of an effective presidential science advisory system. The Bureau of the Budget, frustrated at the continuing refusal of the National Science Board to coordinate policy as legislated by the National Science Foundation Act and reiterated by Executive Order in 1954, was intent on establishing an alternative mechanism in the White House or the Executive Office of the President.[12] And Eisenhower was predisposed to having an expert, non-governmental body to counterbalance the Pentagon.

PSAC members were appointed for four-year rotating terms. Virtually all charter members had had extensive experience working with the federal government during World War II, and most were well acquainted with one another.[13] They comprised a remarkably elite, homogeneous group. Among the sixteen members

[7] R. Cargill Hall, "Sputnik, Eisenhower and the Formation of the United States Space Program," *Quest* 14, No. 4, 34.

[8] In fact, in 1960 a U2 piloted by Gary Powers was shot down over the Soviet Union, an event resulting in an international furor and cancellation of a planned meeting between President Eisenhower and Soviet Secretary-General Nikita Khrushchev.

[9] Hall, *op. cit.*

[10] Ibid., 35

[11] Ibid., 34.

[12] Author interview with Elmer Staats, December 29, 1986 (unpublished).

[13] The charter members of PSAC were: Robert F. Barker, California Institute of Technology (physics); William D. Baker, Bell Telephone Laboratories (physical chemistry); John Bardeen, University of Illinois (physics); Lloyd W. Berkner, Associated

(including Killian), nine came from private Eastern universities (three from MIT, two from Harvard, one each from Cornell, Columbia, and the Rockefeller University); one from the Associated Universities, Inc., a consortium of Eastern universities which that managed the Brookhaven National Laboratory; two from the California Institute of Technology, and one from the University of California, Berkeley.[14] The remaining four came from Bell Laboratories (two), Land Polaroid, and Shell Oil. Ten were physicists, two physical chemists, two engineers, and one a biophysicist.

9.4 Accomplishments During the Eisenhower Administration

The expansion of the institutional base for space science and technology was one of PSAC's two major achievements during the Eisenhower administration. In July 1958, Congress enacted the National Aeronautics Act of 1958—essentially an Eisenhower administration bill based on PSAC's recommendations—which created NASA and a nine-member Space Council under the chairmanship of the president. The Act's most significant policy departure established civilian control over an area with clear defense implications, somewhat along the lines of the Atomic Energy Act of 1946. NASA was given explicit authority and resources to enter into contracts and award grants to non-government investigators, including investigators in both industry and universities.[15]

The second immediate response to Sputnik was the National Defense Education Act (NDEA) of September 1958, which constituted the most sweeping legislation for direct federal aid to education since the Morrill Act of 1862 had established the national land grant college system.[16] NDEA provisions included aid to elementary and secondary school instruction in mathematics, science, and foreign language; student loans; and graduate fellowships in science and engineering. Responsibility for administering the act was assigned primarily to the Department of Health, Education, and Welfare. It also provided a basis for expanding several National Science Foundation education programs, which had been initiated on a relatively modest scale as early as 1954. By the end of the 1950s, science education had become recognized as a legitimate though uncertain component of the U.S. science policy system, with the NSF's science education budget steadily growing.

In both the Eisenhower and Kennedy administrations, PSAC pressed the case for federal responsibility for science education. Its May 24, 1959, report, *Education in an Age of Science*, extended the argument of *Science—the Endless Frontier* for federal scholarships and fellowships in science by making a case for federal involvement at all educational levels. *Scientific Progress, the Universities, and the Federal Government* (the Seaborg report), released on November 15, 1960, argued that since the federal government had a legitimate role in the support of basic research in universities, it should provide institutional support to research universities in addition to project contract and grant support to individual university investigators.[17] The report led to the creation, five years later, of NSF's Centers of Excellence program.

Another PSAC study, issued in May 1959, established a not altogether felicitous precedent. Entitled *A Proposed Federal Program in Support of High Energy Accelerator Physics*, it made an important contribution

Universities, Inc. (physics); Hans W. Bethe, Cornell University (physics); James H. Doolittle, Shell Oil Co. (aeronautical engineering); James B. Fisk, Bell Telephone Laboratories (physics); Caryl B. Haskins, Carnegie Institution of Washington (genetics, physiology); Charles C. Lauritsen, California Institute of Technology (physics); James R. Killian, Jr., Massachusetts Institute of Technology (administration); George B. Kistiakowsky, Harvard University (physical chemistry); Edwin H. Land, Polaroid Corp. (physics); Edward M. Purcell, Harvard University (physics); Isador I. Rabi, Columbia University (physics); H.P. Robertson, California Institute of Technology (mathematical physics); Jerome B. Wiesner, Massachusetts Institute of Technology (electrical engineering); Herbert York, Livermore Laboratory (physics); and Jerrold R. Zacharias, Massachusetts Institute of Technology (physics); Bacher, Fisk, Haskins, Land, Lauritsen, Rabi, and Zacharias were carryovers from SAC/ODM. David Z. Beckler served as executive secretary to SAC/ODM from the Truman administration and as executive secretary of PSAC until it was abolished by President Richard Nixon in January 1973. William T. Golden, ed., *Science Advice to the President* (New York: Pergamon Press, 1980), viii-ix.

[14]All members of SAC/ODM and PSAC, with their affiliations and terms of service, are given in Golden, ibid., vii-ix.

[15]Prior to and after World War II, NACA did award a few contracts, but these were considered exceptional.

[16]A. Hunter Dupree, *Science in the Federal Government* (Cambridge: The Belknap Press of Harvard University, 1957), 169, 170.

[17]A similar argument made by the Steelman report in 1947 had been largely ignored, possibly because of the scientific establishment's indifference—and even hostility—to the Steelman board itself.

to policy-for-science by helping to establish set priorities in what was already becoming an expensive field of basic research. However, by arguing for federal support of an exclusively academic sub-specialty, it left itself open to the charge of being, in David Z. Beckler's words, "an island of academia within the White House"—a charge that would return to haunt PSAC during the Nixon administration.

During the Eisenhower and Kennedy years, PSAC made its most substantial impact in national defense. Among eight major PSAC actions singled out by Beckler, six are unambiguously defense-related.[18] One study led to the Defense Reorganization Act of 1958, which authorized the position of Assistant Secretary of Defense for Research and Development; a parallel recommendation engendered the Defense Advanced Research Projects Agency (DARPA). The remaining five were: major improvements in the long-range ballistic missile program; the acceleration of ballistic missile early-warning capabilities; major advances in technical capabilities for antisubmarine warfare and photographic intelligence-gathering; recommendations that led directly to the establishment of the Arms Control and Disarmament Agency early in the Kennedy Administration; and assessment of the desirability and technical feasibility of a nuclear test ban, which led to the successful consummation of the atmospheric test ban treaty during the Kennedy Administration.

The preponderance of national security issues on PSAC's agenda clearly illustrates the overriding importance of national defense to the conceptualization of science policy in the Eisenhower administration, and to a somewhat lesser extent in the Kennedy administration. The memoirs of General Robert Cutler, who headed the National Security Council and actively assisted PSAC in maintaining its ready access to the president, recall his many productive interactions with the committee.[19]

PSAC (or, at any rate, Killian and his successors George Kistiakowsky and Jerome Wiesner) seems to have understood that its privileged position was a function of the expectation that it could make substantial contributions to national defense. However, PSAC and the science advisors also made effective use of their access to the president to broaden the national science policy agenda. Although several PSAC reports called for support for basic research at universities and national laboratories, science for national defense was still the committee's principal *raison d'être*. Its access to the president on matters of national defense helped PSAC convince him to support a more broadly defined science policy.

9.5 The Kennedy Years

PSAC exerted similar influence during the Kennedy Administration. Kistiakowsky resigned as Special Assistant for Science and Technology but retained his PSAC membership. He was succeeded by MIT electrical engineer Jerome Wiesner, a charter member of PSAC. Among the members who had served for at least a year under Eisenhower, twelve remained on the committee, and one former member was immediately reappointed by Kennedy, who appointed five new members, bringing the total membership to eighteen.[20] Princeton now boasted two members and Columbia and Rockefeller universities none. Eleven members came from Eastern universities and three from California universities (Stanford, the California Institute of Technology, and the University of California, Berkeley). One came from a Midwestern university (John Bardeen of the University of Illinois), one from a national laboratory (Alvin Weinberg of Oakridge), and two from industry (Emanuel Piore of IBM and Walter Zinn of Combustion Engineering, Inc.). In June 1961, there were seven physicists, two physical chemists, one biophysicist, one geophysicist, two chemists, one biochemist, one microbiologist, two engineers (including Wiesner), and one mathematician.

In view of the continuity of PSAC's membership and the fact that Wiesner had been a member of the Cambridge academic circle encouraging Kennedy's presidential ambitions, it is not surprising that the

[18]Beckler, *op. cit.* Beckler's non-defense items are the creation of NASA and the establishment, in March 1959, of the intergovernmental Federal Council for Science and Technology (FCST).

[19]Robert Cutler, *No Time for Rest* (Boston: Little Brown, 1966).

[20]The five new members were: Paul M. Doty, Harvard University (biochemistry); Edwin R. Gilliland, Massachusetts Institute of Technology (chemical engineering); Franklin A. Long, Cornell University (physical chemistry); Colin M. MacLeod, New York University (Microbiology); and Frank Press, California Institute of Technology (geophysics). Additionally, four members were appointed by President Eisenhower in 1960 to replace four whose terms had expired: Harvey Brooks, Harvard University (physics); Donald F. Hornig, Princeton University (chemistry); Alvin M. Weinberg, Oak Ridge National Laboratory (nuclear physics); and Walter H. Zinn, Combustion Engineering, Inc. (physics). Golden, *op. cit.*

presidential advisory system continued to function effectively. The organization and agenda of the Arms Control and Disarmament Agency, established by Act of Congress in September 1961, was largely set by Eisenhower administration PSAC reviews. Glenn T. Seaborg, a Nobel Laureate chemist from the University of California, Berkeley, and an Eisenhower-era PSAC member, was appointed chairman of the Atomic Energy Commission in February 1961. He and Wiesner, with strong PSAC support, played essential roles in the events leading to the 1963 Nuclear Test Ban treaty.

President Kennedy's confidence in PSAC is evidenced by its tremendous productivity. The committee was a virtual report machine. Two early assignments resulted in reports entitled *Research and Development in the New Development Assistance Program* (May 24, 1961) and the *Report of the Ad-Hoc Panel on Environmental Health* (June 6, 1961). PSAC also maintained interest in science education and manpower (*Meeting Manpower Needs in Science and Technology*, December 12, 1962) and the special requirements of specific academic disciplines (*Strengthening the Behavioral Sciences*, April 20, 1962). PSAC also took on policy issues impinging on the direct interests of powerful non-defense federal departments with its reports on *Science and Agriculture* (January 29, 1962), and *Science and Technology in the Department of State* (February 27, 1962). Those two reports are evidence of a decided shift in operating philosophy, mirroring the style of Kennedy, who wanted his staff to be far more openly involved in the affairs of cabinet departments and agencies than did Eisenhower.[21] Whereas both of Eisenhower's special assistants (Killian and Kistiakowsky) viewed their mandate strictly in terms of offering advice to the president and his senior advisers on issues with which he was directly and immediately concerned, Wiesner sought to oversee and to some extent coordinate the activities of the entire federal science and technology system. He assumed several functions (among many others) that the BoB had long been trying to force on a reluctant National Science Board.

In September 1962, at the strong recommendation of Senator Henry Jackson (D-WA), Wiesner's staff was reorganized as the Office of Science and Technology (OST) and transferred from the White House to the Executive Office of the President (EoP), partly on the grounds that that move would institutionalize the presidential advisory system and partly on the grounds that the staff had become too large to fit easily into the White House organization itself. The establishment of the OST within the EoP made the science advisor accountable not only to the president but also to congress, since the director of OST required Senate confirmation and the activities and budgets of all EoP units were subject to congressional oversight; one reason for establishing OST was to quell congressional resentment about its denial of access to the presidential science advisory system.[22] Wiesner's access to the president was further reduced after the appointment of McGeorge Bundy as Director of the National Security Council. Although relations between the president and his science advisor remained cordial, his national security advice and participation was sought less frequently—a circumstance that also restricted his ability to bring other science- and technology-related issues to the president's attention.

9.6 Significance of the Presidential Science Advisory System

Because frequent changes in control of the White House and Congress bring just-as-frequent changes in national priorities, making it all but impossible to develop a consistent science policy, federal institutional arrangements are all-important in helping determine the most significant national issues and coordinating priorities on the president's agenda. Before SAC/ODM, BoB had carried out these functions by default (and reluctantly) through the annual budget process. But SAC/ODM had little direct access to the president except during occasional crises, as when Eisenhower turned to it for advice on defense against intercontinental ballistic missiles. The creation of PSAC and the appointment of a full-time science advisor put the requisite institutional mechanism in place at the highest levels of government.

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[21] Wells, *op. cit.*

[22] Ibid., 204

9.7 Science and International Relations

Two public reports prepared by PSAC during the Kennedy Administration—*Research and Development in the New Development Assistance Program* and *Science and Technology in the Department of State*—demonstrate the president's interest in, and PSAC's growing awareness of, the international ramifications of U.S. science policy. International relations, to which the Vannevar Bush report had paid scant attention, had been increasing in importance for several years. The Bowman Committee Report (chaired by Isaiah Bowman, president of Johns Hopkins University), one of the four committee reports that Bush appended to *Science—the Endless Frontier*, had devoted only two out of one hundred twenty-two pages to International Scientific Cooperation.[23] Its internationally-oriented recommendations, intended to contribute to science for the public good, were: that the U.S. government provide adequate support for international scientific expeditions, as was to happen in the 1956-57 International Geophysical Year, which brought a substantial temporary increase in the National Science Foundation budget; that the U.S. government should provide support for American attendance at international scientific conferences, primarily those organized under the auspices of the International Council of Scientific Unions; that fellowships be offered for American scientists to study abroad and a selected number of European scientists to study in the United States; and that the Department of State post scientists abroad to a selected number of American embassies.

A science counselors program along the lines suggested by the Bowman Committee report was implemented within two years. The State Department also appointed a scientific adviser, whom William T. Golden visited during his October 1950-April 1951 interviews commissioned by the Bureau of the Budget.[24] Golden reported that this scientist felt isolated—a complaint that was to be voiced repeatedly by subsequent scientific advisers to the State Department.

In 1947, the Steelman report had asserted the need "to assist in the reconstruction of European laboratories as a part of our program of aid to peace-loving countries."[25] It also recommended that science counselors be appointed to key American embassies abroad. Thus, by implication, it asserted that international relations should be an integral component of a science policy based on science for the public good.

In the early 1950s, a working group organized under the non-governmental International Council of Scientific Unions (ICSU) began planning for the International Geophysical Year. In the United States, the National Science Foundation became the principal supporter of U.S. involvement in the IGY. Until 1957, NSF's budgets for research and education had been approximately equal. Beginning with the two-year special appropriation the agency received for the IGY, its research budget exceeded its education budget for the first time. The special IGY appropriations were regarded as a temporary funding spike. However, because of the national consternation occasioned by Sputnik, NSF's budget for fiscal year 1959 was 250 percent greater than it had been two years earlier. NSF had finally asserted itself as one of the principal supporters of basic research in the United States.

Early in the Kennedy administration, U.S. Ambassador to Japan Edwin Reischauer suggested that Kennedy negotiate with Japanese Prime Minister Tanaka to establish three bi-national committees: one on economic affairs, one on cultural affairs, and one on science and technology. With the establishment of the last, the NSF and the Japan Society for the Promotion of Science were named implementing agencies for the two countries. To that end, the NSF established an office in the American Embassy in Tokyo, which facilitated visits of American scientists to the country for short-term workshops to explore areas of mutually beneficial cooperative research projects. Although development of such projects was slow at first, it soon accelerated as the benefits of collaboration became increasingly evident.

Following the shock of Sputnik and the related widespread conviction that something was seriously lacking in American education, the 1958 National Defense Education Act authorized the NSF to develop programs to improve science education first at the secondary school and later at the undergraduate level. Among the projects initiated by NSF were six-week summer institutes for high school and college teachers held on

[23] Vannevar Bush, *Science—the Endless Frontier* (Washington, DC: Government Printing Office, 1945), 113-14.

[24] William A. Blanpied, ed., *Impact of the Early Cold War on the Formulation of U.S. Science Policy* (Washington, DC: American Association for the Advancement of Science, 1995).

[25] John R. Steelman, "A Program for the Nation," Volume 1 of *Science and Public Policy: A Report to the President* Washington, DC: Government Printing Office, August 27, 1947), 31.

university campuses. During the early 1960s, India decided to try similar institutes, and asked the U.S. Government to send qualified scientific educators to serve as consultants. In 1964-65, these programs were implemented by university educators under contract with the U.S. Agency for International Development (USAID). In 1966, USAID requested that NSF take over the program. By 1970, the program had spawned longer-term projects, such as curriculum development, and numerous American scientists and engineers were developing collaborative research projects with their Indian counterparts.[26] This effort would end in 1971, when India shut the program down following the Indo-Pakistan War and the Nixon administration's open tilt toward Pakistan.

Another science-related foreign policy initiative of the Kennedy administration in India survived, however. The United States accepted the Indian invitation to "adopt" one of five new Indian Institutes of Technology, and the U.S. adopted IIT/Kanpur. Under contract with USAID, the United States assembled a consortium of American universities led by MIT to send scientific experts to IIT/Kanpur, which would develop into one of the premier institutes of higher education in India. The American effort in India was part of a broader program focused on developing countries as a means of countering Soviet influence in the Third World.

9.8 Congressional Initiatives

Both houses of Congress took steps in reaction to Sputnik to improve their oversight of executive-branch science policy, particularly with respect to space. In July 1958, the Senate established a Committee on Aeronautical and Space Sciences, and the House of Representatives established a Committee on Science and Astronautics. (In 1973, the latter committee would be renamed the Committee on Science and Technology.) Possibly because of its broader substantive scope, the House committee proved to be the more effective over the years in helping to shape national science policy.[27]

The post-Sputnik surge of public interest and concern about science led to another abortive attempt to establish a unitary, institutional federal base for the development and implementation of American policy. Senator Hubert H. Humphrey (D-MN) introduced legislation to establish a cabinet-level Department of Science and Technology that would have included the NSF, AEC, NASA, and the National Bureau of Standards. Humphrey's legislation failed in large measure because of opposition by the scientific establishment.

Following the creation of the Office of Science and Technology, Congress gained a measure of access to the presidential science advisory system. Although relations between the science advisor, OST, and the corresponding congressional oversight committees remained cordial throughout the remainder of the Kennedy administration, Congress—particularly the House of Representatives—continued to assert its own independent perspective. A series of hearings beginning in October 1963, organized by the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics under the chairmanship of Emilio Q. Daddario (D-CT), sought to "identify problems in the Government-science relationship and to assign priorities for dealing with them."[28] Their principal lasting result was to establish the House Committee on Science and Astronautics, and particularly its Subcommittee on Science, Research, and Development, as an effective participant in the development of U.S science policy. In 1965, the subcommittee began a series of hearings focused on the NSF, which led to the first substantive amendments in 1968 to the NSF Act of 1950. The most significant outcomes of these hearings explicitly included the social sciences among disciplines qualifying for NSF support, and gave the NSF authority to support applied as well as basic research.

[26]The author served as US consultant to a summer institute for college teachers at Sagar University in 1967 and was the resident physicist on the staff of the Liaison Group for Science Education attached to the American Embassy in Delhi from July 1969 to August 1971.

[27]U.S. House of Representatives, *Towards the Endless Frontier: History of the Committee on Science and Technology, 1959-79* (Washington, DC: U.S. Government Printing Office, 1980).

[28]U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, *Towards a Science Policy for the United States.* Committee Report, 91st Congress, 2nd Session, October 1970.

9.9 National Research and Development Expenditures

In 1967, total R&D expenditures were estimated at $23.3 billion (or $97.7 billion in 2000 constant, inflation-adjusted dollars), with private industry accounting for $8.1 billion (34.9 percent) of the total, the federal government $14.6 billion (62.9 percent of the total), colleges and universities $.2 billion (0.9 percent of the total), and other sources—including non-profit organizations—contributing the balance. The PSAC-recommended space program accounted for a large portion of the increase in spending.

Nineteen sixty-five marked a little-recognized turning point in national R&D expenditures. During that year, federal R&D expenditures were approximately 51 percent of the national total, with expenditures by private industry approximately 25 percent. Thereafter, federal R&D expenditure would decline relative to those of industry.

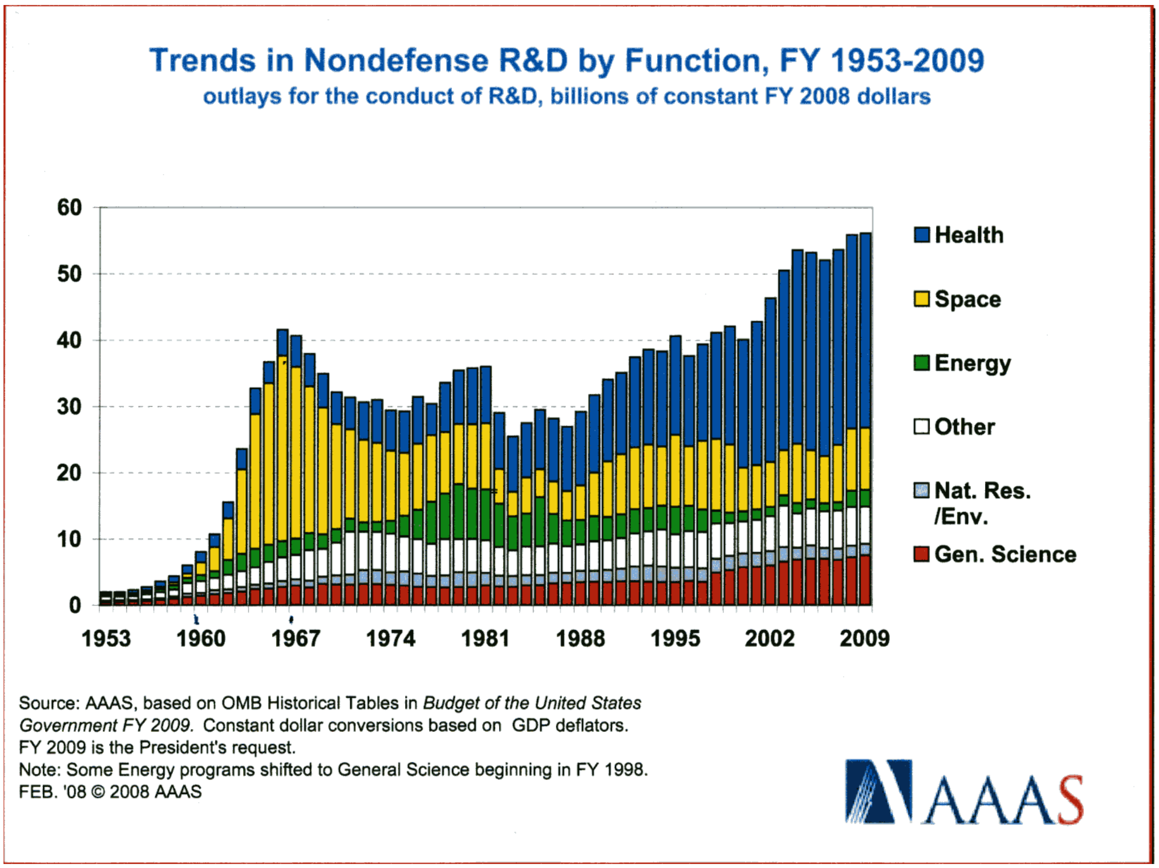


Figure 9.2

9.10 The Early Johnson Years

By 1967, it was becoming clear that the presidential science advisory system no longer enjoyed the same level of influence with President Lyndon Johnson that it had during the Eisenhower and Kennedy administrations. What was not clear then (and is still a matter of debate) is whether the system's eclipse was a temporary phenomenon due primarily to the personality and operating style of the president, or whether it was symptomatic of deeper structural problems. One obvious reason for PSAC's earlier influence was the compatibility between Presidents Eisenhower and Kennedy, who had chosen their science advisors themselves. In contrast, Princeton Chemistry Professor Donald Hornig, who became science advisor to Johnson in 1964, had never met the president prior to his appointment. Hornig had been a member of PSAC since 1960 and was invited by Kennedy to become his new science advisor one week before Kennedy's assassination. Johnson confirmed that invitation in January 1964. Hornig, according to his own recollections, never became close to the president, even though he served as his science advisor through 1968.[29]

PSAC did manage to maintain its continuity after Johnson became president. Sixteen Kennedy appointees served into the Johnson years; among them, four were reappointed by Johnson. Of the thirty-three who served on PSAC during the Johnson years, twenty were physical scientists (twelve of them physicists), four were engineers, four represented biology and medicine, and the remainder were scattered among other disciplines. In February 1968, Herbert Simon, an economist, became the first social scientist to be appointed to PSAC.

Hornig's recollections of his tenure as science advisor are notable for their wit and candor.[30] Although he was never close to the president or fully accepted by his praetorian guard, his OST became fully operational during the Johnson administration. At its peak, OST employed twenty full-time professionals, and retained over two hundred part-time consultants. Despite (or perhaps because of) its impressive staff capabilities, the focus of the science advisory system changed under Johnson. During the last two years of the Kennedy administration, PSAC issued several reports concerned with national defense issues. From 1964 through 1968, it issued twelve reports, none concerned with defense. (Hornig, however, recalls that many PSAC contributions never went to the president or were part of formal reports. Rather, they were transmitted informally to Department of Defense officials.)

Certainly, PSAC anticipated many non-defense–related science-policy debates to come. In 1963, barely a year after publication of Rachel Carson's *Silent Spring*, PSAC issued a report on *The Use of Pesticides*. Of the twelve public reports it issued during the Johnson and first Nixon administrations, four were devoted to environmental problems. But it is questionable if either president took these reports seriously, or ever even saw them.

Although Hornig had little direct access to the president, OST had a considerable influence on government through informal contacts with executive agencies at the staff level, through presidential messages to the Congress, and through R&D budgets. If presidential access was denied to PSAC and the science advisor, access by OST staff to other units of the EoP and to the pertinent line agencies seems to have been better under Johnson than even during the golden years of the Eisenhower and Kennedy administrations.

Hornig has lamented that during his tenure the OST staff was often more concerned with establishing and nurturing contacts in the EoP and throughout the executive branch in their own specialties than in supporting the broad-gauged, PSAC-based system whose original intent was to provide policy for issues on the presidential agenda. From a different perspective, OST was beginning to master the art of dealing within the federal bureaucracy, even as the science advisor and PSAC were losing influence on the president. An intriguing though largely unanswered (or even unasked) question concerns the extent to which the interests of PSAC and the OST staff began diverging during the Johnson years. Also rarely asked is the question of whether the U.S. science community had come to equate special access to the president with a coherent national science policy.

[29] Hornig, *op. cit.*
[30] Hornig, *op. cit.*

Chapter 10

Crisis or Expanding Agenda? 1968-1974[1]

Presidents, in my judgment, need to show more interest in what the specific results of medical research are during their lifetime, during this administration. I am going to show an interest in the results.
—Lyndon Johnson, 1966
For $18 billion per year, there ought to be something to say at least once a week.
—Lyndon Johnson, 1968

10.1 Years of Chaos

From 1968 through 1974—characterized in a subsequent congressional report on science policy as "crisis" years[2]—the scientific communities, the presidential science advisory system, the principal federal R&D agencies, the Bureau of the Budget (renamed the Office of Management and Budget in 1970), and Congress struggled to accommodate the science-government relationship to an expanding, shifting, and often bewildering national agenda.

In 1967, federal R&D expenditures, which had risen steadily since 1945, began to decline both in terms of constant dollars and as a fraction of the total federal budget, and would not begin to increase again until 1976. PSAC and OST, whose influence declined during the later years of the Johnson administration, were abolished in January 1973, at the beginning of the second Nixon administration. Edward David, Nixon's second science advisor, had been forced to resign and leave Washington a month earlier.[3] White House disaffection with science was driven by outspoken public opposition by several PSAC members in congressional testimony to the antiballistic missile (ABM) and the civilian supersonic transport (SST), among other administration initiatives; PSAC also had come to be regarded by the president and his senior advisors as a lobbyist for science.[4] And the scientific establishment came to be visibly identified with opposition to the Vietnam War; the war largely reversed the assumption among many scientists and members of the public that science in the service of the national defense was a public good.

National political turmoil aside, there was also a nationwide decline in the technological optimism that had been pervasive in the United States since World War II. The fulfillment of John Kennedy's promise to put a man on the moon by the end of the 1960s proved a hollow achievement in 1969, with the July 20 moon landing a remarkable achievement with no long-term benefit. Back on earth, the idea that technological "progress" can have unanticipated negative consequences began to take hold. The 1963 publication of Rachel

[1] This content is available online at <http://cnx.org/content/m34587/1.3/>.
[2] U.S House of Representatives Science Committee, *A History of Science Policy in the United States 1940- 85*, a Report to the Congress by the House Committee on Science, 1987.
[3] David convened a short meeting of the OST staff in December 1972, informing them that he would leave Washington the next day and that the president would make public his decision to abolish the presidential advisory system shortly after his inauguration on January 20, 1973.
[4] David Z. Beckler, "The Precarious Life of Science in the White House," in Gerald Holton and William Blanpied, eds., *Science and its Publics: The Changing Relationship* (Boston: D. Reidel Publishing Company, 1976), 115-134.

Carson's *Silent Spring*, which documented the long-term environmental damage wreaked by DDT, was a watershed event in that respect. A subsequent cascade of similar revelations led to the creation of new regulatory agencies (including the Environmental Protection Agency and the Consumer Protection Agency) during the Johnson and Nixon administrations.

The era was also marked by an erosion of confidence in the "technological fix" (the idea that a ready technological solution could be found for any social problem) and the "technological imperative" (the idea that any innovation that can be pursued must be pursued). Doubts about the efficacy of technological fixes lay at the heart of opposition to the ABM system and the SST, the latter also opposed by several PSAC members. Further, people began doubting Vannevar Bush's *laissez faire* assumption that the best way for government to effect economic and social progress was through support of undirected basic research in universities, and further doubts about the social efficacy of basic research arose as part of the resistance to Johnson's Great Society.

Finally, as more Americans came to regard the Vietnam War as unwinnable and an inordinate drain on the country's human and financial resources, the idea that national defense could be regarded as a public good lost credence, and science for the public good was seen as something separate from science for national defense. Pressured by faculty and students, many universities gave up their contracts with the military, student radicals slapped the "war criminal" label on scientists doing research for the military, and the number of students seeking careers in science and engineering dropped significantly.

10.2 The Great Society

Lyndon Johnson is often regarded as having been opposed to science, in part because of the decline in federal R&D expenditures and PSAC's influence during his administration. But he professed strong support for science; it was academia he distrusted, particularly what he regarded as the elitist East Coast university establishment that he felt exerted undue influence over his predecessor. Johnson was also skeptical about the validity of *Science—the Endless Frontier*'s premise that social and economic benefits would follow automatically if adequate research support for universities was forthcoming.

Figure 10.1: Donald Hornig, science advisor to Lyndon Johnson, and his predecessors. Left to right: Hornig, James Killian, Jr., George Kistiakowsky, H. Heffner (a senior OST staff member), and Jerome Wiesner.

As Senate majority leader, Johnson had been one of the first congressional advocates for a strong space program. As president, he regarded science as essential to his Great Society, but felt that the American academic community was reluctant to back him. And indeed it was: when Johnson signed the Medicare bill into law, for example, he said that he expected to see specific medical benefits flow from government support for research in the biomedical sciences. The speech caused a furor in the academic community, which considered it an unwarranted intrusion into scientific prerogatives; in academe's view, Johnson committed the unforgivable sin of assigning a higher priority to applied than to basic research.

When Johnson turned to PSAC, he found its members to be primarily academic scientists who were ill-equipped to provide useful advice. Herbert Simon, a Carnegie Mellon University economist, was the only social scientist on PSAC during the Johnson Administration. Only two other social scientists ever served on PSAC: James Coleman, a sociologist from Johns Hopkins University and, later, the University of Chicago, served from 1971 through the abolition of the presidential advisory system in January 1973. Daniel Patrick Moynihan, a Harvard University economist and later Senator from New York, also served from early 1971 through the demise of PSAC. While it is true that social scientists exerted a more decisive influence during the Johnson administration than at any time since the early New Deal, that influence was exerted largely outside of science policy.

Additionally, PSAC had little input into Johnson's national defense priorities, the Department of Defense being perceived as more competent to deal with such issues. Moreover, Johnson's personal interest in defense matters focused less on strategic issues than on the bewildering guerilla war in Vietnam, for which PSAC had no ready solutions. Worse, in Johnson's eyes, PSAC members represented the academic community, which was among the most vociferous critics of the Vietnam War.

10.3 Decline of Federal Research Support

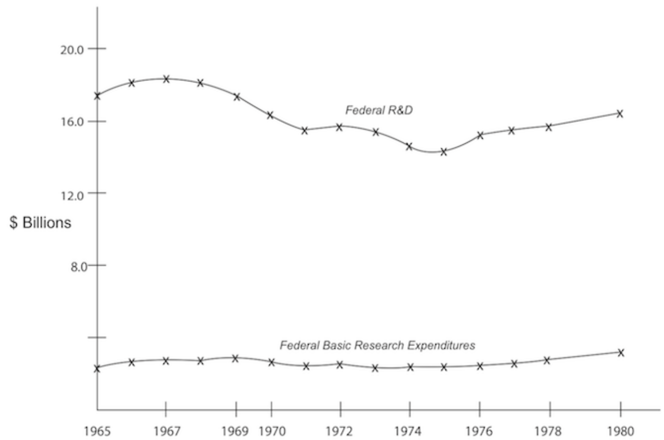
Since creation of the Office of Naval Research in 1946, the military had been among the most important supporters of university basic research. That support declined significantly in the early 1970s, partly because of the political activism of university scientists during the Johnson and Nixon years.

Another important factor was the "Mansfield amendment" to the fiscal year 1970 Department of Defense Appropriations Act. Sponsored by Senator Mike Mansfield (D-MT), with the strong support of Senator William Fulbright (D AK), it banned military support of university research that did not directly relate to specific military objectives, the rationale being that the Department of Defense had too much money for R&D and was monopolizing too much research, including basic research in mathematics and physics, to the detriment of the civilian science and technology agencies. Although the Mansfield amendment expired at the end of fiscal year 1970, the department remained reluctant to support university basic research for many years.

Total federal R&D expenditures measured in terms of constant dollars, which had increased continuously since World War II, peaked during fiscal year 1967 and thereafter declined through fiscal year 1976; constant-dollar federal expenditures for basic research peaked during fiscal year 1969 and declined through fiscal year 1975 (Fig. 2).[5] Much of the decline in basic research expenditures was due to declining appropriations in three agencies: the Department of Defense, whose constant-dollar basic research expenditures declined by 30 percent between their peak 1970 value and their 1975 low point; NASA, whose constant-dollar research expenditures were cut in half between 1969 and 1976; and the Atomic Energy Commission (and its successor, the Energy Research and Development Administration [ERDA], then the Dept. of Energy [DoE]), whose expenditures for basic research were reduced by 36.8 percent between 1967 and 1974.[6]

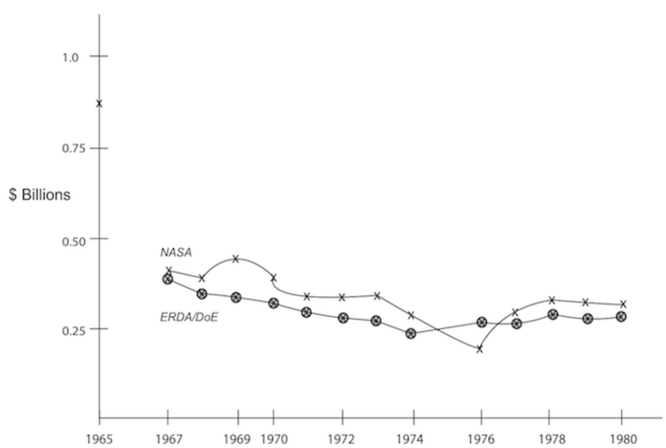
[5] Analysis based on data from *Science and Engineering Indicators* during the years in question, and on James E.Katz, *Presidential Politics and Science Policy* (New York: Praeger Publishers, 1978).

[6] Federal programs in several cabinet departments, primarily the Departments of Commerce and Interior, were combined into the Energy Research and Development Agency (ERDA), along with the AEC, in 1974; ERDA and several additional cabinet-level bureaus were further combined into the Department of Energy in 1976.



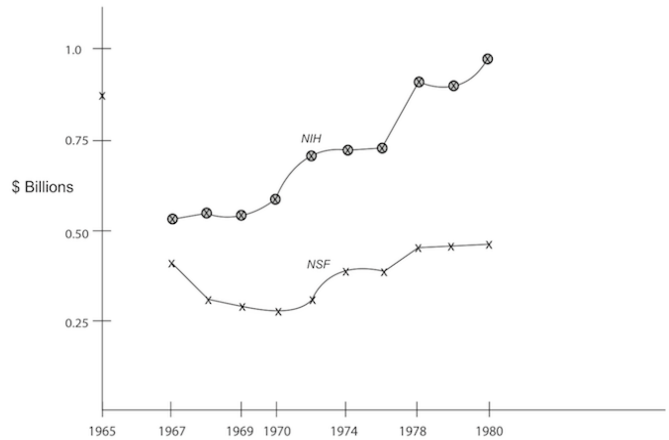
Federal R&D and Federal Basic Research Expenditures in Constant Dollars. The upper set of data are for total R&D, the lower for basic research. Source: Katz

Figure 10.2



Basic Research Expenditures for NASA and ERDA/DoE. The data for NASA are Xs, those for ERDA/DoE are circles. Source: Katz

Figure 10.3



Basic Research Expenditures for NIH and NSF. Source: Katz

Figure 10.4

Only in the last case can reductions be attributed directly to presidential displeasure. The Department of Defense reductions were caused by the Mansfield Act. NASA's were a small part of drastic reductions in its total budget after the successful moon landing in July 1969; the Nixon administration, Congress, and the general public lost interest in manned space research after that event.

The one agency that may have suffered most from Johnson's displeasure was the National Science Foundation, whose constant-dollar budget fell from $414 million in fiscal year 1967 to $269 million in 1970, and thereafter began to rise again, although slowly. Reductions in NSF's budget resulted from decisions made by the Johnson administration, the Nixon administration, and congressional actions. During the five-year period from 1965 through 1969, the Bureau of the Budget reduced NSF's budget request by an average of more than 15 percent; during those same year, Congress reduced that request by an additional 12 percent on average. Comparable average reductions during the Kennedy administration were 8 and 18 percent, respectively.

Only the National Institutes of Health were spared the budget axe during these years, with their basic research budget increasing continuously, except during fiscals years 1971 and 1973.

10.4 Shifting Support Patterns, Shifting Perceptions

During the Vietnam era, the academic community believed that the science-government compact forged in the late 1940s and nurtured through the Truman, Eisenhower, and Kennedy administrations was being abrogated by the federal government. Certainly, the pluralistic research support system, accepted by default after Vannevar Bush's proposal of a single federal basic research support agency failed to materialize, was seriously weakened during the Johnson and Nixon years.[7] According to the pluralistic concept, the fact

[7] The pluralistic system permitted scientists and engineers to submit funding proposals to more than one federal organization. For example, NASA, the Department of Energy, and the National Science Foundation all supported (and still support) research in the mathematical, physical, and engineering sciences; basic research in the biological sciences was (and is) supported by the National Institutes of Health, the National Science Foundation, and the Department of Agriculture.

that more than one federal agency provided funds for university basic research assured a fair hearing in Washington for any good idea advanced by a competent investigator. An important corollary was that the National Science Foundation, whose primary mission was to support meritorious basic research, would act as a "balance wheel" to assure an equitable distribution of basic research support among scientific disciplines. The decrease in federal support during the Johnson and Nixon administrations, along with congressional fragmentation, undercut this balance-wheel concept.

In fiscal year 1967, the National Science Foundation ranked second among the five principal federal agencies supporting basic research, preceded by the National Institutes of Health and followed, respectively, by NASA, the AEC/ERDA/DoE, and the Department of Defense. A year later, the NSF ranked last, where it remained until fiscal year 1972, when it again moved into second place. Meanwhile, the basic research budgets of NASA, the AEC and the DoD continued to decline. As these agencies cut back or eliminated specific basic research programs, the pressure on the National Science Foundation to pick up support increased beyond its means to do so.[8]

During the heyday of pluralism, its beneficiaries were primarily the academic physical sciences. Biomedical investigators relied heavily on the National Institutes of Health and—in the case of those engaged in non-medically relevant research—the National Science Foundation. Yet despite tense moments occasioned by President Johnson's threat to redirect the NIH's budget towards applied research, the agency continued to prosper even as government support for more broadly-based basic research declined. And academically-based biomedical scientists quietly increased their political strength relative to the once dominant physical scientists.

The shock evident among academic scientists at the revelation that basic research was neither a protected nor sacrosanct component of the federal budget provides a measure of their political naïveté. There was a considerable uproar over the politicization of science policy in 1971, when Nixon withdrew his nomination of Cornell University chemist Franklin Long as director of the NSF because of Long's opposition to the anti-ballistic missile. Although the administration ultimately backed down, Long refused the nomination, showing how dismayed the science community was over the blurring of the boundary between politics and scientific research.

[8]For example, rocks from the moon gathered by expeditions supported by NASA were distributed to several universities—but without financial support for their analysis. Thus, the affected geologists turned to NSF for support.

Figure 10.5: President Lyndon Johnson and physicist Edward Condon in the White House. Courtesy AIP Emilio Segre Visual Archives.

The schism between the Department of Defense and academia was also abetted by a government-wide shift toward targeted research at the expense of the kind of undirected basic research favored in *Science—the Endless Frontier*. Even the National Science Foundation, while remaining the strongest supporter of university basic research, established a Research Applied to National Needs (RANN) program in 1971. Although RANN never amounted to more than 13 percent of the agency's budget, its mere existence was a significant departure from Vannevar Bush's vision.

10.5 The Nixon Years

By the time the presidential science advisory system was dismantled in January 1973, government leadership for national science policy was already shifting from the executive to the legislative branch, specifically to the House Subcommittee on Science, Research and Development. Reacting to the changing political environment for science, the subcommittee held extensive hearings between July and September 1970 to review the previous twenty-five years of science policy. One recommendation was to strengthen the presidential science advisory system. Another called for a national science policy to be formulated by the administration, transmitted to Congress, "maintained as a public law," and "incorporated into the operations of every department or agency which utilizes science and technology in its mission."

During the same period, Congress, concerned about its dependence on the executive branch for scientific advice and analysis, moved to strengthen its own capabilities, creating the Office of Technology Assessment (OTA) in 1972. The OTA legislation also established an oversight committee consisting of five senators (among them Edward M. Kennedy).

While Richard Nixon appointed a White House Task Force on Science Policy within a few months of his inauguration in January 1969, he apparently gave little credence to its recommendation to strengthen PSAC and OST. Like Johnson, Nixon preferred applied to basic research, and his science and technology initiatives generally lay outside the PSAC framework. In his January 1971 State of the Union message, he announced a $100 million War on Cancer program that emphasized his desire for practical results. In July, he announced a new program centered on the Domestic Council to stimulate new technologies. And in March 1972, he transmitted a special message to the Congress urging renewed emphasis on science and technology, but primarily for targeted programs outside of academia.

Nixon appointed eighteen new PSAC members, excluding his two science advisors. Cal Tech President Lee DuBridge, who had been among the leading scientists engaged in defense-related research during World War II and was SAC/ODM chairman under Truman and Eisenhower, was sworn in as Nixon's science advisor on inauguration day. Immediately, he became actively engaged "in problems important to the president: environmental quality, including a major oil spill in California, for which Nixon very publicly made a show of giving DuBridge responsibility for reviewing the situation and recommending corrective actions."[9] But DuBridge also was known to have been openly opposed to the SST and was further tainted in Nixon's eyes by his image as a dyed-in-the-wool member of the academic community, which along with PSAC came to be regarded by the White House as a special-interest lobby. So DuBridge was forced to resign after two years, to be replaced by Edward David, an engineer from Bell Laboratories—the first nonacademic nonscientist to be appointed presidential science advisor. Nixon reinforced the message about his science agenda at David's swearing-in ceremony, when he described his new advisor as "a very practical man."

[9] William G. Wells, Jr., "Science Advice and the Presidency: a View from Roosevelt to Ford," in William T. Golden (ed.), *Science Advice to the President* (New York: Pergamon Press, 1980), 209.

Figure 10.6: In the Rose Garden following the searing in of Edward David, Jr., as President Nixon's second science advisor, Sept. 14, 1970. Left to right: David, President Nixon, Ann David, Nancy David, and Lee DuBridge. Individuals in the second row are members of the President's Science Advisory Committee. The name of the judge who swore in David is not known. Courtesy of Edward E. David, Jr.

The gradual diminution of the science advisory system was accelerated after the November 1972 elections, when the president abolished both the PSAC and the OST.

In some respects—aside from its being at political odds with presidents Johnson and Nixon—PSAC's demise can be attributed to the overall growth of science and science policy-making throughout the federal bureaucracy. As science and technology policy capabilities in the DoD and other cabinet departments and agencies increased (thanks in part to recommendations of PSAC itself), Johnson and Nixon had many more sources of advice, particularly with regard to national defense. By the time IBM physicist Richard Garwin—the most outspoken critic of presidential science policies—took the PSAC helm in 1969 (after having previously served from 1962-1965), PSAC was already on the political outs with Nixon and all but dead. In January 1973, Nixon accepted the resignations of the last of the committee members and appointed NSF Director H. Guyford Stever his science advisor. Stever often joked about his second job. When asked whether he ever saw the president, he responded, in essence: "Certainly! I see him twice a day. Once in the morning when he walks in front of my window from his living quarters to the Oval Office, and once in the evening when he returns." By then, it was abundantly clear to the scientific establishment that there no longer was a good working relationship between academic science and the White House.

The abolition of PSAC and OST inspired further congressional science-policy initiatives. These activities intensified with the ascension of Gerald Ford to the presidency after Nixon's resignation. Ford was more than willing to work closely with his former colleges, and was also perceived as being friendly toward science.

The House Science and Technology Committee was now the only science-policy game in town. The scientific establishment began looking to it to restore its special access to the president. Other groups, both scientific and non-scientific, looked to it to further their own interests and to confirm their beliefs in how relationships between science and government ought to be structured. Thus began a series of maneuvers and hearings in both houses of Congress that culminated three years later with the National Science and Technology Policy, Organization, and Priorities Act of 1976, the first and only official statement of a comprehensive national science policy ever enacted by the United States Government.

Chapter 11

Resurrection? 1974-76[1]

The government has gone through decades of ad hoc situations, arrangements regarding science and technology that have not been based on any firm policy but have responded merely to current crisis. The result has been a marked inconsistency in utility and effect. In some cases things have worked well; at other times they have worked poorly.

—Legislative History of the OSTP Act, 1977

11.1 The OSTP Act

On May 11, 1976, President Gerald Ford signed into law the National Science and Technology Policy, Organization, and Priorities Act of 1976 (PL 94-282, often referred to as the OSTP or Science Policy Act).[2] An attempt at major reform, the act articulated guidelines for a national science policy; established the Office of Science and Technology Policy (OSTP) within the Executive Office of the President; designated the OSTP director as science advisor to the President; provided for a President's Council on Science and Technology (PCST) and a federal science and technology survey; and vested, in OSTP, several specific functions intended to ensure a more coherent presidential approach to national science policy.

The act represents the most comprehensive attempt ever undertaken by the federal government to formulate a national science policy. Congress envisioned using science both for the public good and as a tool for governance. Notably, the new law eliminated responsibility for defense-related science policy from the OSTP's portfolio, although that had been included in an earlier Senate version of the act.

The new law was the culmination of almost three years of congressional and executive attempts to restore the direct access of science to the president that Nixon had terminated in 1973. Congress hoped once and for all to end the *ad hoc* approach to science policy that had been a consistent feature of federal behavior for nearly all the nation's history.

Passage of the act came after three years of strenuous effort to undo the damage Nixon had done. In July 1973, thirteen months prior to Nixon's resignation, the House Committee on Science and Technology, at the initiative of chairman Olin Teague (D-TX) and the strong support of Republican Charles Mosher (R-OH), the ranking minority member, began holding hearings on federal planning, policy, and organization for science.[3] Nixon's elimination of the science advisory system gave the committee license to range more freely over the matter of federal organization, policy, and planning for science.

Witnesses during the first phase of hearings were primarily government or former government officials. They included H. Guyford Stever (NSF director and science advisor to Nixon); his senior staff members;

[1]This content is available online at <http://cnx.org/content/m34589/1.1/>.

[2]Public Law 94-282, 90 Stat. 459.

[3]U.S. Senate, Committee on Commerce, Science and Transportation and the Committee on Human Resources, *A Legislative History of the National Science and Technology Policy, Organization, and Priorities Act of 1976*, 95th Congress, 1st session, April 1977, 883-84.

seven members of the National Science Board; Edward David, Jr., the last White House science advisor; and William D. Carey, formerly a presidential-level appointment in the Bureau of the Budget during the Johnson administration and future Executive Officer of the American Association for the Advancement of Science (AAAS).

The more extensive second phase of the hearings, held in June and July 1974, was limited almost exclusively to testimony from non-government witnesses.[4] They included such well-known industrial scientists as Chauncey Starr, president of the Electrical Power Research Institute; such prominent representatives of university-based science policy study groups as Brewster Denny of the Graduate School of Public Affairs of the University of Washington; all six former presidential science advisers; and the presidents of the National Academy of Sciences (NAS) and the National Academy of Engineering.

The NAS had asserted its interest in federal science policy during the fall of 1973 when it established an adhoc committee on Science and Technology in Presidential Policy Making. Chaired by James Killian, Dwight Eisenhower's first science adviser, and staffed by David Beckler, Executive Secretary of SAC/ODM from early in the Eisenhower administration and of PSAC throughout its lifetime, the NAS panel was virtually a shadow presidential advisory system. Its report recommending that the former presidential advisory system be revived was released in June 1974, just before the second phase of congressional hearings.

[4] Ibid.

Figure 11.1: NSF Director and Science Advisor H. Guyford Stever testifying before the House Committee on Science, July 1973.

In March 1975, congressmen Teague and Mosher introduced a bill proposing passage of the National

Science Policy Act of 1975. Its principal features: establishment of a national science policy; appointment of a five-member Advisory Council on Science and Technology, rather than a single science advisor, in the Executive Office of the President; creation of a cabinet-level Department of Research and Technology Operations to include NASA, ERDA (the Energy Research and Development Authority, which in 1977 became the principal component of the Department of Energy), the NBS, NSF, and NOAA (the National Oceanic and Atmospheric Administration); and creation of a Science and Technology Information and Utilities Corporation. Hearings on the bill were scheduled for June.

Five days after his swearing in, new president Gerald Ford asked Guyford Stever to stay on as NSF Director and presidential science advisor, and to schedule a meeting to discuss reestablishment of a more effective presidential science advisory system.[5] Ford wanted the presidential advisory system reestablished by congressional action rather than by executive order. Stever noted that some of the offices in the Executive Office of the President, including OMB, were opposed to reinstitution of the system, but their opposition proved ineffective.

In December 1974, Ford directed Vice President Nelson Rockefeller to examine relations between science and the presidency. The following June, Rockefeller, meeting in conference with the House Committee on Science and Technology, indicated that the president preferred a less complex science policy organization than that in the Teague-Mosher bill. He urged that the committee consider a White House bill that would do little more than establish an Office of Science and Technology Policy in the Executive Office of the President, designate its director as the president's science advisor, and outline the functions of the office in general and flexible terms. Such a bill was quickly introduced, so as to allow hearings simultaneous with those on the Teague-Mosher bill.

Hearings on the two bills led to a compromise bill passed by the House in October. It established a national science policy and an OSTP with a larger staff and greater number of functions than envisioned by the White House. The proposed cabinet-level department was eliminated on the grounds that overcentralization of the federal R&D system would be cumbersome and counterproductive, and a proposed Science and Technology Information and Utilities Corporation was eliminated on the grounds that it needed further study. The bill replaced both with a Science and Technology Survey Committee that would assess the effectiveness of the government's science and technology efforts in the context of broad-based national needs.

In June, the magazine *Science* predicted that cordial relations between the House committee and the White House would help get a new presidential science advisory system in place by year's end. The Senate, however, had other ideas. Edward Kennedy, chairman of the Science Subcommittee of the Committee on Labor and Public Welfare, developed a strong interest in federal biomedical research policy, to the growing consternation of that community.[6] Kennedy suggested that the public, because of its sizeable investment in biomedical research, was entitled to a more substantial voice in research priorities and directions. He declared that public input was required not only for financial reasons but because of potential ethical and safety issues as well.

In October 1975, Kennedy convened committee hearings on what he called the OSTP Act. The Senate hearings featured testimony from a wider range of witnesses than had testified before the House; they included, in addition to the usual suspects, representatives of public interest groups, state and local governments, and non-university–oriented education groups. The Kennedy subcommittee bill, considerably more complex than the House measure, was passed by the Senate on February 4, 1976. The bill established a policy office in the Executive Office of the President, which it designated as the Office of Science, Engineering, and Technology Policy. The director of that office, who was to serve as the president's science advisor, was designated as a member of the Domestic Council and a statutory adviser to the National Security Council, despite pleas from the White House to leave such arrangements flexible.

The administration also objected to provisions requiring the policy office to transmit to the Congress periodic, five-year investment forecasts and to prepare annual priority options for the OMB. It also opposed

[5]H. Guyford Stever, "Science Advice: Out of and Back into the White House," in William T. Golden, ed., *Science Advice to the President* (New York: Pergamon Press, 1980), 61-63.

[6]News and Comment, *Science* (June 20, 1975), 1187-89.

creation of a new federal-state science advisory committee and an accompanying provision to provide up to $200,000 to each state. Further, the White House opposed the bill's establishment of an interagency Federal Coordinating Committee on Science, Engineering, and Technology (FCCSET) to replace the Federal Committee on Science and Technology (FCST), which had been established in 1959 and had survived the demise of PSAC. FCST consisted of the secretaries of all cabinet departments with science and technology responsibilities, and the heads of NASA and NSF. The ostensible objectives of FCST and FCCSET, as envisioned by the Congress, was to exchange information and coordinate programs, but neither functioned effectively, in part because the heads of the departments and independent agencies rarely attended meetings themselves.

Finally, the administration objected to a proposed new PSAC-like committee called the President's Committee on Science, Engineering, and Technology.

When finally signed into law, the OSTP Act was closer to the Senate than the House version. Provisions regarding the relationship between the director and the Domestic Council and National Security Council were eliminated, as was the provision of grants to the states. A federal-state advisory committee was established, as were FCCSET and a President's Committee on Science and Technology (PCST). PCST was temporary, extendable after two years at the president's pleasure, and assigned the specific task of carrying out the federal science and technology survey originally in the House bill.

Finally, the bill mandated that a five-year science and technology outlook and annual science and technology report be sent to Congress.

Figure 11.2: Left to right: former Congressman (D-CT) and at that time Director of the Office of Technology Assessment Emilio Daddario, Congressman Charles Mosher (R-OH) and Senator Edward Kennedy (D-MA).

The bill was an attempt at accommodating a plethora of conflicting and overlapping interests, including those of the scientific establishment (exemplified by the National Academy of Sciences), with its insistence on special access to the president; federal line agencies (and their constituents) intent on preserving their turf; science-related interest groups and populist scientific organizations such as the AAAS; state and local governments; educational organizations; and groups concerned with equity for women and minorities. While the act accommodated most of these interests, at least on paper, it failed to resolve the perennial problem of unifying defense and non-defense science policy. It granted no explicit authority of the OSTP director over defense R&D, and included no statutory relationship between OSTP and the National Security Council.

11.2 Congressional Fellows

During the interregnum between the Nixon administration's expulsion of the presidential science advisory system and its restoration, while the act was being debated in congress, professional scientific societies had moved more boldly into the political arena. In 1974, the American Association for the Advancement of Science (AAAS) obtained funding for seven Congressional Fellows; the American Physical Society (APS) obtained funding for two more. The fellows (generally junior university faculty members) were assigned to the staffs of congressmen or committees for a year. Within a few years, several other professional scientific societies were also sponsoring Congressional Fellows.

11.3 AAAS Science Policy Forum

During deliberations over the bill, the AAAS undertook a pilot project analyzing presidential R&D budgets, culminating in a two-day meeting in June 1975. Scientists came from all over the country to participate. Speakers included Stever, several prominent congressmen and congressional committee staff, representatives of key federal agencies, and scholars expert in science policy. The AAAS decided to make the R&D Budget Colloquium an annual event, and within a few years it had grown into the annual AAAS Science Policy Forum. These annual colloquia were instrumental in introducing working scientists to the complex politics of science policy.

11.4 Defining and Implementing a National Science Policy

Title I of the OSTP Act consists of sets of explicit principles and goals underlying a national science policy, areas (including national defense) to be included in such a policy, and procedures for implementation.

According to the legislative history of the act, "Title I is a statement of national science policy—but it is not the invention of the Committee. It represents an analysis of much testimony and research on the subject. The main issue has not been the Title's but whether or not Congress should attempt such a policy statement. Some people have thought it feasible; others have not.... The government has gone through decades of ad hoc situations, arrangements regarding science and technology that have not been based on any firm policy but have responded merely to current crisis. The result has been a marked inconsistency in utility and effect. In some cases things have worked well; at other times they have worked poorly."[7]

The act states at the outset that it is: "An Act to establish a science and technology policy for the United States, to provide for scientific and technological advice and assistance to the President, to provide a comprehensive survey of ways and means for improving the Federal effort in scientific research and information handling, and in the use thereof."[8]

The first section of Title I (Section 101) provides a list of six reasons that led Congress to determine that the United States government needs a science policy, followed by thirteen priority goals for linking the science and technology resources of the nation to national goals and needs. The six principles that are to define U.S. science policy are: "(1) those of foreign policy, (2) a healthy national economy, (3) the special needs of food and energy, (4) the national security in its broadest sense, (5) the national health, and (6) a satisfying total environment, natural and man-made, urban and rural."[9] The six modes of implementation are: "Central planning and coordination; information management, publicly supported science and technology; division of responsibility with the States, local governments, and private entities; allocation of public effort to science and technology in relation to competing activities; and the assurance of information to Congress about the totality of the science and technology effort."[10]

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[7]Congressional Research Service, *National Science and Technology Policy Issues 1979: Implementation of the National Science Policy Act, Part II*, April 1979, p. 89.

[8]PL 84 282, *op. cit.*

[9]Legislative History, *op. cit.*, 908.

[10]Ibid., 910.

The Act makes no mention of OSTP or its director, who would also serve as the president's science advisor, until Title II, where the director's responsibilities include chairing an Intergovernmental Science, Engineering and Technology Advisory Panel (ISETAP) to advise on the science and technology needs of state and local governments; and submitting to Congress a biennial *Five Year Outlook on Science and Technology* and an *Annual Science and Technology Report*.

Title III requires the president to establish a President's Committee on Science and Technology (PCST), charged with conducting an extensive science, engineering and technology survey.

Without a doubt, the OSTP act is the most far-sighted, comprehensive statement of national science policy goals and principles ever to be enunciated by any branch of the federal government. But there is also little doubt that the attempt to legislate a national science policy and to define the science advisor's responsibilities in terms of its implementation undermined both the objectives of requiring the White House to conceptualize science policy in broader terms and assuring effective presidential access to the official designated to advise the president on implementation of the grand strategy.

Although the OSTP Act became law approximately six months prior to the November 1976 presidential election in which Ford would be defeated by Jimmy Carter, Ford gave every indication that he would remain faithful to Congress' intentions. In July, he nominated Stever as OSTP Director, and Stever moved rapidly during the next five months to implement the provisions of the new act. Philip Smith, who had served as his executive assistant at NSF, moved with Stever to the Executive Office of the President as assistant director of OSTP. The OSTP negotiated contracts with two consulting firms to plan preparation of the first *Five-Year Outlook* and the first *Annual Science and Technology Report to the Congress*. The Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP), the Federal Coordinating Committee on Science, Engineering, and Technology (FCCSET) were activated, as was the President's Council on Science and Technology (PCST).

By the end of his term, Ford was beginning to think in strategic terms about linking science and technology investments to national goals[11] just as Congress had intended. Ford also took pride in having reversed the downward trend in federal R&D expenditures that had started in 1967. Between fiscal years 1968 and 1975,[12] total federal R&D expenditures, as measured in constant 1972 dollars, declined from $18.1 billion to $14.5 billion.[13] During the two fiscal years in which the Ford administration presented its budget request to Congress, total R&D investments were $15.1 and $15.4 billion respectively. These upward trends were to continue throughout the subsequent Carter administration, reaching $16.5 billion in fiscal year 1980. Federal expenditures for basic research, which had declined from $2.93 billion in fiscal year 1968 to $2.54 billion in fiscal year 1975, rose to $2.60 billion in fiscal year 1976, $2.72 billion in fiscal year 1977, and to $3.13 billion in fiscal year 1980.

On August 13, 1976, the day after Stever was sworn in as science advisor, Ford nominated Simon Ramo as chairman of PCST. Nine more PCST members were named in October. At the first two committee meetings, responsibilities for each of the thirteen components of the congressionally mandated federal science and technology survey were assigned to the members, and six additional meetings were scheduled for 1977.

On March 16, 1977, the *pro forma* resignations of all PCST members were accepted by the new Carter administration. Thereafter, PCST and the survey it was supposed to carry out were dead letters, as was the idea that the executive and legislative branches could cooperate closely in implementing a national science policy. This was to be among several early indications that the Carter administration's implementation of the OSTP Act would be halfhearted at best.

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[11] Ibid, 212.

[12] Federal fiscal years began on July 1 until 1975, after which they began on October 1.

[13] Science Indicators reports.

Chapter 12

The Carter and Reagan Years: 1977-89[1]

The fact that the President in reorganizing the science advisory apparatus decided not to make use of a formal outside group such as the President's Committee on Science and Technology has come under some criticism.

—Frank Press, 1980

Quite simply, basic research is a vital underpinning for our national well-being.

—George A. Keyworth, 1984

Too many scientists have only one mode of discussing federal funding for science–and that's to predict disaster unless they get more.

—George A. Keyworth, 1985

12.1 Reorganization Plan No. 1

New President Jimmy Carter waited two months after his 1977 inauguration to designate MIT geophysicist and former PSAC member Frank Press as new OSTP Director. The appointment won high praise from the science community.[2]

Carter was more intent, however, on reducing the size and complexity of the White House bureaucracy than he was on nurturing science policy. In the first Executive Office reorganization plan he submitted to Congress in July, the number of office units was reduced from seventeen to ten. While OSTP survived, its staff was cut from thirty-two to twenty-two, leading Olin Teague (D-TX), chairman of the House Committee on Science and Technology, to ask whether the office was capable of coordinating a vastly expanded federal R&D system as envisioned by Congress when it passed the OSTP Act in 1976.

The reorganization plan abolished or downgraded most of the functions of OSTP that Congress hoped would give the White House a long-range, comprehensive view of national science policy. Of the three external committees mandated by the Science Policy Act, only the Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP) was left intact. The Federal Coordinating Committee for Science, Engineering, and Technology (FCCSET) was removed from the OSTP and made a sub-cabinet–level committee chaired by the science advisor—a move that congressional critics felt reduced its effectiveness.

More significantly, Carter abolished The President's Committee on Science and Technology, eliminating its annual federal science and technology survey, and transferred responsibility for the biennial *Five-Year Outlook on Science and Technology* and the *Annual Science and Technology Report to the Congress* to the National Science Foundation. Congressional critics questioned whether NSF had sufficient authority among other agencies to produce reports reflecting the original intent of the Congress.[3]

[1] This content is available online at <http://cnx.org/content/m34590/1.1/>.

[2] Philip Boffey, "Frank Press, Long-Shot Candidate, May Become Science Adviser," *Science* (February 25, 1977).

[3] The author was director of NSF's Office of Special Projects from 1979 through 1983 and in that capacity was responsible for preparing both the *Five-Year Outlook* and the *Annual Report*. In preparing the first *Outlook*, released in 1980, NSF awarded a

Because committees in both the Senate and House had been intimately involved in reinstating a presidential science advisory system, OSTP's operations were subject to close congressional scrutiny during Press's tenure. By July 1978, he and/or senior staff members appeared sixteen times before congressional committees.[4] Press's performance was also subject to frequent comment in the science press, by academic science policy specialists, and by members of the scientific establishment. The establishment sources were usually supportive, if only because they were relieved OSTP had survived Carter's surgery, and in part because Press himself was a science establishment member in good standing.

Figure 12.1: President Jimmy Carter and Frank Press in the Oval Office. Courtesy AIP Emilio Segre Visual Archives, Press Collection.

Although Press had a good relationship with Carter, he once noted that he was merely a member of

contract to the National Academy of Sciences (NAS) to produce a portion of the report dealing with trends in several important disciplines. The NAS published this portion of NSF's report separately under the title, *Five-Year Outlook*. On at least one occasion when testifying before a Senate oversight committee, Press referred to the Academy's publication as the *Five-Year Outlook*, making no mention whatsoever of the more comprehensive report prepared by NSF.

[4]Congressional Research Service, *op. cit.*

a group serving the president's inner circle rather than a member of the circle itself.[5] He and his staff maintained close liaisons with other EoP units, including the National Security Council and the Office of Management and Budget. Press participated in the White House senior staff meetings and cabinet meetings, and was assigned a leading role in several domestic policy reviews on science-related topics. Congressional critics were unimpressed with these arrangements, lamenting the loss of interest by the OSTP in strategic vision or the building of a coherent, long-term national science policy.

12.2 Carter's Attitude Towards Science

During his single term, Carter presided over increasing federal R&D budgets (particularly basic research budgets), and occasionally declared his intention to reverse the damage done to the science-government relationship by Nixon. During the swearing-in of NSF director Richard C. Atkinson, for example, he remarked, "So this is a morning when we are taking a great step forward in recementing the relationship between science and knowledge, the probing of new areas of human comprehension on the one hand, and the political application of that knowledge on the other, for the benefit of all mankind and womankind." [6]

Yet Carter also abolished many if not most Science Policy Act provisions—particularly those having to do with accountability to Congress—regarded as critically important by various congressional committees and Ford administration figures. In the words of one seasoned Congressional Research Service analyst, "Dr. Press has made it clear that attention to the President's needs and desires is his primary objective and that of his office. In concentrating on this, he has sometimes neglected other aspects of his job which involve accountability to the Congress and the people of the Nation. These are also important."[7]

Carter made more impressive scientific advances in the international arena. In 1979, the National Science Foundation and the U.S. Geological Survey negotiated a cooperative agreement for earthquake studies with their counterpart agencies in China, permitting the exchange of scientists in those specialties between the two countries.[8] A year later, on the occasion of the historical visit of Chinese Premier Deng Xiaoping and a delegation including several senior Chinese science officials, the U.S. State Department and Chinese Ministry of Foreign Affairs forged an umbrella agreement permitting all U.S. R&D agencies and their Chinese counterpart agencies to negotiate Memoranda of Understanding to initiate and support collaborative projects; a second agreement opened enrollment in American university graduate programs to Chinese students.

12.3 Press's Defense of His Tenure

During his tenure as science advisor, Press often defended his performance by noting that working quietly within the inner precincts was consistent with the Carter administration's operating style, and that any attempt to go beyond that style would endanger the newly established science advisory system. In a short article published near the end of his term, he noted that the abolition of PCST had come under particular criticism:

> *Conditions for operating a PCST or PSAC are different today [than during the Eisenhower or Kennedy administrations] when one takes into account the Freedom of Information Act's requirement for open meetings, and the vast agenda beyond national security concerns for the Science Adviser. However, the lack of these formal groups has not deterred the President, nor*

[5]Ibid.

[6]News and Comment, *Science* (June 17, 1977), 1300.

[7]Congressional Research Service, *op. cit.*

[8]This agreement was the first between agencies of the two governments. However, the Committee on Scholarly Communication with the Peoples Republic of China, a consortium consisting of the National Academy of Sciences, the Social Science Research Council, and the American Council of Learned Societies, had existed since 1965 and, despite the ensuing Cultural Revolution, succeeded in sending an occasional delegation of U.S. scientists for short visits to China during the Mao Zedong era.

OSTP, from calling on the country's most knowledgeable people in all fields of science and engineering for broad or specific advice. [9]

Press often displayed irritation bordering on contempt at the frequent calls to testify before congressional committees. Later, he referred to congressional oversight as "an albatross around the neck of the science adviser," in that it stood in the way of a fully confidential relationship with the president.[10] He advocated a return to the Eisenhower practice of having the science advisor provide confidential advice to the president without accountability to Congress or coordination with the federal research system.[11]

The general impression at the end of the Carter administration was that the hoped-for revitalization of national science policy had not materialized. OSTP failed to gain sufficient institutional standing to weather an easy transition into the Reagan administration, and congressional committees, convinced that they could not share responsibility for science policy with the White House, lost interest in comprehensive science policy and focused on parochial issues.

12.4 University-Industry Research Cooperation

During the latter half of the 1970s, science policy began including the interests and participation of American industry. As foreign countries rebuilt their war-damaged industrial infrastructures, American companies significantly increased their R&D expenditures; by 1979, federal and industrial R&D expenditures were equal, although industrial investment was much more weighted toward development and applied research.

Private industry also began not only to support but also to participate directly in university research. By 1975, industrial support for research in universities constituted 3.3 percent of total investment, with the federal government accounting for 67.2 percent. Perhaps more important were federal initiatives to foster research cooperation between universities and industry. Although by law the NSF cannot provide research support to profit-making organizations, it could and did begin supporting universities in research collaborations with industry. In 1978, NSF initiated a pilot program to encourage such cooperation, initially called the Applied Science and Research Applications Program. Although the program was terminated at the insistence of the National Science Board, support for university-industry cooperation continued under other programs.

The NSF also began adding engineering research to its portfolio, creating both a Directorate of Engineering and Applied Science and a Directorate of Engineering.

The Bayh-Dole Act of 1980 provided considerable incentive for industrial firms and universities to enter into cooperative research agreements.[12] The act granted rights to federally funded research results to the organization that conducted the research, allowing private firms to negotiate potentially profitable rights agreements with their university partners.

12.5 The President Needs [Scientific] Help!

Early in 1980, the quarterly journal *Technology in Society* published a special issue on "Science Advice to the President."[13] Edited by William T. Golden, the volume featured essays by all but two presidential science advisors from the Truman through the Carter administrations, and included reflections on the presidential advisory system from fifteen other veteran observers, including former President Ford. According to Golden, the objective of the volume was to explore "how to be most effective in encouraging the President, every President, to seek, consider, evaluate, and utilize such wise and spirited advice." That Golden, his editors,

[9] Frank Press, "Advising Presidents on Science and Technology," in William T. Golden, ed., *Science Advice to the President* (New York: Pergamon Press, 1980), 8.

[10] Press in Golden, 1988, *op. cit.*

[11] National Science Board, *Science and Engineering Indicators 2006. Volume 2.* (Arlington, VA: National Science Foundation, 2006 (NSB 06-01A)), Chapter 4

[12] Council on Governmental Relations, *The Bayh-Dole Act: A Guide to the Law and Implementing Regulations* (Washington, DC: Council on Governmental Relations, 1999).

[13] Later in 1980, this edition of the journal was published as a free-standing book. See Golden, *op. cit.*

and his contributors chose to address these essays to "the President, every President" during an election year highlights their dissatisfaction with the presidential advisory system under Carter.

Golden explicitly called for the restoration of PSAC: "The 'argument of the work [the collection of articles],' in Winston Churchill's phrase, is that the office of Science Adviser to the President should be retained and that, before or promptly after the 1980 Presidential election, a President's Science Advisory Committee should be reestablished, with privacy if exemption can be won but without it if it cannot."[14]

Many contributors praised Frank Press, the incumbent science advisor, for his effectiveness in dealing with the president and his inner circle. That Press himself contributed a Foreword suggests that he did not regard the volume as an attack on himself or Carter.

As already noted, Press did concede, however, that President Carter's decision "in reorganizing the science advisory apparatus. . .not to make use of a formal outside group such as the President's Committee on Science and Technology (PCST) had come under some criticism." The thrust of the implied criticism by Golden's contributors was that the administration had not adequately involved the scientific community in policy formulation. Edward David, Jr., Richard Nixon's last science advisor, made that point explicitly. While conceding that the science advisor's principal constituent had to be the president rather than the Congress, the scientific community, or the amorphous general public, former Nixon science advisor Edward David, Jr., emphasized, "If, indeed, there are elements missing from the current White House science advice performance, it is the function of providing paths to the future based upon new technological possibilities and basic relationships in the research and development process. It is indeed unrealistic to expect this kind of performance from the White House or OSTP staffs themselves. . . Indeed, the missing element appears to be the broad and deep contributions by dedicated members of the scientific communities... In past times, this effort was supplied by the President's Science Advisory Committee and its panels."[15]

If Golden and his contributors hoped to reverse Carter's course, they were destined for disappointment. Ronald Reagan, who regarded the science advisory system as an even lower priority than had Carter, viewed it as nothing more than a special interest lobby.

In June 1981, Reagan nominated George A. (Jay) Keyworth II as his science advisor and OSTP director. Keyworth had been a weapons physicist at the Los Alamos National Laboratory throughout his career and was virtually unknown outside of the defense science community, and his nomination did little to allay academic anxiety regarding the Reagan administration's interest in science. Nor did the fact that he had been suggested to the president by the hawkish Edward Teller, whom many establishment scientists had still not forgiven for his role in the Oppenheimer affair. However, by December 1985, when he resigned both positions, Keyworth had won over a good many skeptics.

[14] William T. Golden, "Contours of Wisdom: Presidential Science Advice in an Age of Flux," in Golden, *op. cit.*, 5.
[15] Edward E. David, Jr., "Current State of White House Science Advising," in Golden, *op. cit.*, 57.

Figure 12.2: President Ronald Reagan and George (Jay) Keyworth in the Oval Office. Courtesy of the Ronald Reagan Presidential Library.

Recognizing the problem, Keyworth made special efforts to establish good working relations with both the university-based scientific community and the federal R&D line agencies. In consultation with the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academies of Sciences and Engineering and the Institute of Medicine, Keyworth arranged a series of annual research briefings in areas COSEPUP identified; and on the advice of the National Academy of Engineering, he strongly endorsed the Presidential Young Investigator awards, prestigious post-doctoral appointments intended to encourage outstanding PhDs in science, and particularly engineering, to pursue academic research careers.

However, in his first appearance before a large scientific audience (the April 1981 annual American Association for the Advancement of Science's Science and Technology Policy Colloquium in Washington, DC), he made it clear that he intended to be a White House team player rather than an emissary from the scientific community, and that he had no intention of recommending the restoration of PSAC.[16]

Much of the initial anxiety about Reagan's support for the broad-based national research system abated with the submission of his proposed budget to Congress in January 1982. As anticipated, substantial increases in defense-related R&D were proposed, along with sharp cuts in non-defense applied research and development, on the grounds that the latter should be left to the private sector. But the budget did propose substantial increases for basic research support, much to the relief of university-based scientists, and these increases continued over the next three years.

In April 1984, Keyworth emphasized the administration's commitment to basic research, noting with

[16]Barbara J. Culliton, "Keyworth Gives First Speech," *Science* (July 7, 1981), 183-84.

approval the elimination of costly energy demonstration projects that were better left to the private sector.[17] Although such programs had been cut back significantly during the Carter administration, they disappeared almost completely under Reagan. Keyworth noted that total federal R&D obligations had increased from $35 billion in fiscal year 1981 to $53.1 billion in fiscal year 1985, with most of the increase in defense R&D, which grew from $16.5 billion in fiscal year 1981 to $34.2 billion in fiscal year 1985. Total federal obligations for basic research increased from $5.1 billion in fiscal year 1981 to $7.9 billion in fiscal year 1985.

Keyworth's claim that the Reagan administration and Congress were generous to science was echoed by the external community, as evidenced by a July 3, 1987, *Science* article entitled, "Science Budgets Fare Well in House Action."[18] This trend for basic research persisted until politically unacceptable federal deficits forced the administration and Congress to reexamine their priorities, beginning with the president's proposed fiscal year 1988 budget.[19]

Support for the social sciences in Reagan's first budge request, however, was drastically reduced, and NSF's science education budget almost entirely eliminated. In response, the National Science Board, as NSF's policy-making and governing body, invoked a rarely used provision of the National Science Foundation Act of 1950 by convening a special commission to examine the broad science education issue. This commission lent support to subsequent congressional restoration of science education through creation of NSF's Directorate for Education and Human Resources. All 435 members of the House of Representatives, after all, had schoolteachers in their districts, many of whom had profited from programs the Reagan administration was proposing to cut. Congress voted to restore funding for science education to NSF, and the administration had no choice but to comply. From then on, science education would be an integral component of U.S. science policy.

12.6 Engineering Research Centers

The relatively modest university-industry cooperative research programs initiated by NSF in 1978 proved to be so well received that in 1984, the agency initiated its Engineering Research Centers program, which provided substantial support to a small number of universities or university consortia to undertake large, long-term research programs in cooperation with industry. In 1986, NSF expanded the centers concept again, creating a parallel Science and Technology Centers program.

The academic community was initially unhappy with these programs, contending that NSF ought to confine its support to small groups of academic investigators for whom the costs of the new programs would seriously reduce available funding. But NSF Director Erich Bloch argued persuasively that science had changed drastically since *Science—the Endless Frontier* was released in 1945. Many contemporary science and engineering problems, he argued, could be addressed only by large, interdisciplinary groups with guaranteed long-term support. Further, it could no longer be assumed that industry would automatically pick up and develop the results of university basic research. Industry needed direct involvement with large, complex, university-based research programs that would, in turn, sensitize university researchers and students to industry's needs. He also urged professional science and engineering societies to set their priorities for large-scale programs rather than having NSF and other science-related agencies set them by default.[20]

12.7 Science and Foreign Relations in the Reagan Years

During the early 1980s, competition with Japan intensified. American companies accused Japanese manufacturers and the Japanese government of unfair trade practices in microelectronics, tools, and automobiles,

[17] G.A. Keyworth, Jr., "Four Years of Reagan Science Policy: Notable Shift in Priorities," *Science* (April 6, 1984), 9-13. Two of these demonstration projects were international collaborative efforts, one involving Germany, the other Japan. Their elimination provided seeming evidence for the well-worn charge that the United States was an unreliable foreign partner.

[18] "News and Comment," *Science* 237 (July 3, 1987), 21.

[19] Irwin Goodwin, "Physicists Dismayed by NSF's Many Cuts in Congress's Hard-Times 1988 Budget," *Physics Today* (March 1988), 41-44.

[20] Irwin Goodwin, "Erich Bloch: on Changing Times and Angry Scientists at NSF," *Physics Today* (August 1988), 47-52.

among other areas, and trade negotiations between the two countries grew increasingly acrimonious. When the U.S.-Japan umbrella agreement on scientific cooperation came due for renewal in 1986, officials in the Office of the Trade Negotiator, the Commerce Department, and OSTP insisted that more stringent conditions be added, on the grounds that cooperative research in science and engineering could provide Japan with proprietary information that would undercut American competitiveness. They also pressed for greater access for American scientists to Japanese research facilities.[21]

The renegotiated umbrella agreement, completed in 1988, created a Joint Committee on Access, a postdoctoral fellowship program for American scientists in Japan, and a summer institute program in Japan, to begin in 1990, for American graduate students. The program came to be so highly regarded that by 2009 there would be six more participating countries: Korea, Taiwan, China, Australia, New Zealand, and Singapore.

12.8 Decline of OSTP

Senior Carter administration OSTP officials had hoped to institutionalize the office as a non-political entity that would maintain continuity from administration to administration, as did OMB. Their model was the Office of Science and Technology through the Kennedy, Johnson, and Nixon years. But the incoming Reagan administration had little interest in a presidential science advisory system, and by the time Keyworth assumed the OSTP directorship in July 1981, it was staffed almost entirely by junior level officers, several serving as little more than caretakers. Within two years, even the junior Carter-era appointees had departed, reinforcing the impression that politics and ideological purity had become important criteria for staff selection. Staff allotments, begun under Carter, were further cut under Reagan, and the office failed to deliver requested reports to key congressional committees, who responded by further cutting the OSTP budget.[22]. This led to more failure to produce reports and additional staff reductions. As a result, OSTP came to rely heavily on temporary detailees from other federal agencies. By 1987, the General Accounting Office (GAO) was reporting, "OSTP does not, in practice, have the authority or responsibility in the budget process that was intended in Public Law 94-282 [the OSTP Act of 1976]."[23] As a consequence, "we have not seen any evidence under the current administration that the Director of OSTP has enough influence with agency heads to reconcile conflicting views on cross-agency issues... This would require [also] strong presidential support." Thus, "OSTP studies and reports on issues and opportunities in specific topical areas but generally does not address the crosscutting issues among the fields of science and engineering."

Important issues in this largely policy-for-science category included: the level and distribution of support required to maintain the national research system; how to deal with the physical erosion of university research facilities; establishing criteria for selecting among competing, large-scale scientific "megaprojects"; and providing appropriate incentives for students to pursue postgraduate study in science and engineering.

12.9 White House Science Council

Sensitive to criticisms that the OSTP during the Carter years had been too inward-looking, Keyworth established a White House Science Council (WHSC) in 1982, with members drawn from universities, industry, and government laboratories. The stated purpose was to assist the science advisor in examining issues affecting federal science agencies and to conduct studies of programmatic and policy problems cutting across agency lines.

Unlike the defunct PSAC or the aborted PCST, Keyworth's council was responsible to the science advisor rather than the president, had access to the president only through the science advisor, and had no explicit authority to set its own agenda. Thus it failed to provide the direct, independent channel of communication

[21] One OSTP official also insisted that Japanese engineers cease and desist from publishing in their own language on the grounds that that constituted a trade barrier. (Engineers, unlike academic scientists, frequently publish in national rather than international journals when their work deals with specific local problems.)

[22] D. Allan Bromley, *The President's Scientists* (New Haven: Yale University Press, 1994), xx.

[23] Congressional Research Service, *op. cit.*

between the president and the scientific community that Golden advocated, although it did provide a channel for external advice to reach OSTP.

Several WHSC reports, including *Research in Very High Performance Computing* (November 1985) and the *Report of the White House Science Council Panel on the Health of U.S. Colleges and Universities* (February 1986), made strong pleas for stronger cross-agency coordination. But while a few specific recommendations of these reports were reflected in subsequent budgets, their implicit, collective plea for more serious attention to fundamental national research system issues went unheard. By 1987, bipartisan congressional resolve to control a politically unacceptable federal budget deficit killed any chances that budgetary support for the national research system would grow at all.[24]

12.10 Status of the Science Policy Act

It is hard to fault the Reagan administration for failing to resolve problems that had beset American science policy for more than forty years. But the administration was sharply (and fairly) criticized for failing to recognize that a strategic reorientation in science policy might have provided it tools for addressing serious national problems, including economic problems. Other nations, particularly in East Asia, were implementing successful, coherent industrial science policies that posed a serious challenge to the global economic position of the United States. A close reading of the Science Policy Act's legislative history could have offered a framework for such a reoriented policy. But by 1981, even Congress seemed to have abandoned any serious attempt either to convince the executive branch to adopt a broad, strategic approach to science policy, as intended by the 1976 act, or to coerce it to do so by means of its oversight authority or its control of the federal budget.

Finally, in 1984, Congressman Don Fuqua (D-FL), Chairman of the House Committee on Science and Technology, announced formation of an eighteen-member bipartisan task force to conduct a two-year review of critical national science policy issues. At first, the task force review was billed as the first comprehensive study of national science policy since the 1945 Bush report (evidently forgetting the extensive congressional hearings that had preceded the Science Policy Act). But its agenda was limited primarily to policy-for-science issues and focused heavily on problems of concern primarily to universities. By the time Fuqua retired in 1986, his task force had produced twenty-four volumes of hearing transcripts and thirteen commissioned background volumes. While these provide valuable source material for historians and students of the congressional process, they had little discernible impact on executive or congressional science policy.

Part of the problem in Congress was due to fractured jurisdiction. The House Science and Technology Committee lacked oversight authority over several agencies whose activities and expenditures comprised a major share of the federal R&D enterprise. Oversight authority for the Departments of Defense and Agriculture and the National Institutes of Health were the jurisdiction of other, more powerful committees that seldom viewed the R&D programs of the respective agencies as part of a potentially comprehensive national package. Other agencies, such as the Departments of Commerce and State, which indirectly affected federal science policy, were under the jurisdiction of still other committees. Fragmentation of R&D oversight authority in the Senate was even worse; in 1981 and for several years following, he Senate failed even to consider an authorization bill for the National Science Foundation because of a jurisdictional dispute between the Committee on Commerce, Science, and Transportation and the Committee on Labor and Human Resources.

These jurisdictional problems worsened in the early 1980s, when organizational reforms intended to limit the power of House committee chairs led to a proliferation of subcommittees. By one count, there were five hundred such subcommittees in both houses by 1988—nearly one for each member of Congress. This absurd state of affairs considerably worsened the legislative tendency to view science policy in terms of traditional special-interest politics, giving rise to a practice that came to be known as "academic pork barreling."[25] Some

[24] The Graham-Rudman-Hollins Balanced Budget Act of 1985 required that the federal budget be balanced by 1991. However, when 1991 approached, Congress repealed this legislation.

[25] Irwin Goodwin, "Universities Reach Into Pork Barrel With Help From Friends in Congress," *Physics Today* (April 1989), 43-45.

universities, frustrated in their attempts to obtain research funding through conventional agency channels, hired professional lobbyists to take their case directly to the floor of the House or Senate. The lobbyists would persuade a home-district legislator to move an amendment for the university's desired facility to the appropriations bill for an R&D agency, thus bypassing both agency and congressional committee review. Condemnation of the practice by the National Science Board, the National Academy of Sciences, and the National Association of Research Universities was derided as an attempt by the "haves" to deny the "have-nots" their fair share of federal funding.

Meanwhile, as the size of the federal deficit increased, the budget became a source of almost continuous controversy between the White House and Congress. Congress repeatedly failed to enact several of the thirteen appropriations bills required to keep the government operating, relying instead on eleventh-hour continuing resolutions, followed by hastily patched-together appropriations measures to do so. The situation became more politically charged after 1984, when the Gramm-Rudman-Hollings Act mandated automatic across-the-board reductions in agency appropriations if the total contained in the thirteen appropriations bills exceeded prescribed limits.

The patchwork character of the thirteen appropriations committees militated against a coherent federal R&D budget even under relatively favorable circumstances, and these circumstances were far from favorable. At the end of 1987, the stock market collapsed, leading Reagan and leaders of Congress to send a positive message to the financial markets in the form of a drastically slashed federal budget. Significant items in the administration's proposed budgets for R&D agencies, including NSF funding that would have provided enhanced support both for traditional, disciplinary-based research projects and innovative interdisciplinary science and technology centers, were reduced or eliminated entirely.[26]

12.11 Restoration of PSAC?

During the waning days of the Reagan administration, several scientific elders grew more openly critical of the absence of a coherent federal science policy. Most of their criticism focused on the presidential science advisory system. On May 17, 1986, *The New York Times* published a guest editorial by physics Nobel laureates Hans Bethe and John Bardeen, who lamented the "remarkably haphazard" character of the science advice reaching the president. On April 27, 1987, Jerome Wiesner, former science advisor to President Kennedy, delivered a blistering address at Washington, DC's Cosmos Club, attributing a number of national maladies, including the "disintegration" of the U.S. space program and the decline of U.S. economic competitiveness, to the absence of an effective science advisory system.

In January 1988, William T. Golden produced a second anthology, entitled *Science and Technology Advice to the President, the Congress, and the Judiciary.*[27] It consisted of eighty-five short articles from a wide spectrum of contributors, including a handful of former science advisers—most notably Jerome Wiesner and George Keyworth. Of those essays, fewer than twenty dealt with the congress or the judiciary, reflecting a continuing preoccupation with the presidential advisory system. Most essays (including Keyworth's) were openly critical of the science advisory system, with a few (including Wiesner's update of his Cosmos Club address) bordering on hostility.[28] A sizable majority advocated reinstitution of a PSAC-like system, and a few suggested that the science advisor be elevated to the rank of cabinet member without portfolio. Keyworth's essay resurrected the option of a cabinet-level official presiding over a full-fledged Department of Science.

A few contributors were skeptical about any single institutional innovation resulting in a more consistent, coherent science policy. They believed that PSAC had been effective in its heyday largely because it devoted most of its attention to defense issues, which required a relatively narrow range of disciplinary expertise. Since the range and complexity of issues had proliferated, so had the breadth of expertise a resurrected PSAC would have to include. Could such a large, heterogeneous science advisory committee be functional?

[26] Irwin Goodwin, *Physics Today* (March 1988), *op. cit.*
[27] Golden, *op. cit.*
[28] Jerome Wiesner, "The Rise and Fall of the President's Science Advisory Committee," in Golden, ibid., 372-384.

Furthermore, two successive presidents with different agendas and distinct operating styles had ignored the requirements of the Science Policy Act of 1976, which had been designed to give science advisors and the EoP office they headed extensive planning, coordination, and oversight authority, with or without a standing presidential science advisory committee. Either president could have established such a committee without a congressional mandate.

These contributors also pointed out that as the 1988 presidential election approached, neither presidential candidate was making science policy a part of his campaign. It seemed clear, in the words of Don K. Price, Director of the Kennedy School of Government at Harvard and a former protégé of Louis Brownlow, that: "Scientists have not yet conquered the basic difficulties in the American political system which have turned on the problem of integrating and adding a greater degree of responsibility to the uses made of public money... [We lack] a system of tying together the influence of science as attached to the presidency with the influence of the president in strengthening a conviction of the importance of politics and public service and the need to pull things together in the public interest. This is something that science ought to do a lot more about and hasn't yet really learned how to do."[29]

[29]Don K. Price, "Money and Influence: The Links of Science to Public Policy," in Gerald Holton and William A. Blanpied, eds., *Science and its Publics: The Changing Relationship* (Boston: Reidel Publishing Company, 1976), 97-113.

Chapter 13

The Bush-41 Years: 1989-93[1]

Unlike other countries, we have not developed coherent national science policies. Indeed, the very idea is abhorrent to many. Our free enterprise laissez-faire system has served us well during periods of expansion and growth, but in retrenchment the development of more formal science and technology policies seems essential if we are to preserve the best aspects of our system.

—D. Allan Bromley, 1982

I will upgrade the President's science advisor to Assistant to the President and make him an active member of the Economic Policy Council and our national security planning processes. And I will create a President's Council of Science and Technology Advisors, composed of leading scientists, engineers and distinguished executives from the private sector.

—George H.W. Bush, October 1988

During the 1988 presidential campaign, Vice President George H.W. Bush had a science adviser: D. Allan Bromley, Professor of Physics at Yale and a charter member of the White House Science Council.[2] Upon his election, Bush nominated Bromley as Assistant to the President for Science and Technology and director of the OSTP.[3] The Senate unanimously confirmed him in the latter position on August 4; confirmation was not required for the former.

Bromley brought a significant roster of accomplishments along with him. Soon after arriving as associate professor of physics at Yale in 1960, he managed to obtain federal funding for a state of the art tandem Van de Graff particle accelerator, with construction of the facility itself funded by the university. While at Yale, he made many advances in nuclear physics, and was awarded the National Medal of Science in 1988. He was also elected to the National Academy of Sciences and the American Academy of Arts and Sciences.

13.1 Reviving the Substance of the OSTP Act of 1976

During the Carter and Reagan administrations, Congress had expressed increasing frustration with the failure of either president to implement significant features of the OSTP Act.

[1]This content is available online at <http://cnx.org/content/m34591/1.2/>.

[2]Jeffrey Mervis, "Science and the Next President," *The Scientist* (June 27, 1988).

[3]Bromley was the first science advisor to hold the title Assistant to the President for Science and Technology. Both of Clinton's successive science advisors had that title, as does the science advisor to President Barack Obama.

Figure 13.1: President George H. W. Bush and D. Allan Bromley in the Oval Office, May 1991. Courtesy AIP Emilio Segre Visual Archives, Physics Today Collection.

For example, although the Ford administration had created the Act's mandated President's Council on Science and Technology, the Carter administration never convened the PCST, nor did it ever fulfill its promise to conduct the congressionally mandated two-year survey of the federal government's science and technology programs. By the end of the Reagan administration, the attitude of Congress towards OSTP ranged from indifference to open hostility.[4] Bush's pre-election pledge to reestablish a body comparable to the President's Science Advisory Committee, created by Eisenhower and abolished by Nixon, seems to have reflected Bromley's views about the inadequacy of the WHSC. Bromley clearly enjoyed his membership on the WHSC, but he believed that its membership was hampered in the formulation and implementation of a national science policy by its lack of direct access to the president. During his first discussions with Bush about joining the new administration, Bromley insisted on three conditions, which the president accepted:

1. That he [Bromley] would have access to him [the president] whenever he needed it.
2. That once he [Bromley] and the president had agreed on some action involving science and technology, that I would have his full support to make it happen.
3. That the president would, for the first time, nominate all four of the OSTP Associate Directors provided for in PL 94-282. [5]

The third of these conditions underlined Bromley's largely unarticulated promise to recognize aspects of the OSTP Act that his three predecessors had ignored. That Act had provided for four OSTP Associate

[4]Bromley, *op. cit.*, 39.
[5]Ibid, 17.

Directors, who had to be confirmed by the Senate. As science advisor to Carter, Frank Press had appointed only assistant directors who did not require confirmation. His two successors under Reagan followed his precedent.

Bromley seems to have had no problem with asking the president to nominate associate directors who would also be comfortable with congressional testimony. His first selections for those positions were J. Thomas Ratchford, Associate Director of AAAS and formerly a senior staff member on the House Science and Technology Committee, nominated as Associate Director for Policy and International Affairs; and James Wyngaarden, Director of the National Institutes of Health, nominated as Associate Director of Life Sciences.

Figure 13.2: President Bush speaking at the National Academy of Sciences, May 1991. Left to right: D. Allan Bromley, Frank Press, President of NAS, Bush, and Senator Lamar Alexander (R-TN). Courtesy AIP Emilio Segre Visual Archives, Bromley Collection.

Bromley accompanied Ratchford and Wyngaarden to Capitol Hill to introduce them to the Senate Commerce, Science, Space and Technology Committee for what was expected to be their *pro forma* confirmation hearings. The confirmation portions of those hearings were, in fact, *pro forma*, but Bromley himself was subjected to a fifty-five–minute grilling by committee chair Albert Gore (D-TN) about the administration's weak to non-existent activities on environmental issues, particularly global climate change. Bromley's principle defense was that more research was required before a scientific consensus could be reached on the detailed nature of global change and the economic consequences of mitigation. According to one report, "The gentlemanly, silver-haired Bromley stood up to the Senators throughout the ordeal. But at times, he sounded foolish and even uninformed as he dutifully attempted to defend the administration's weak environmental performance against vintage congressional bombast."[6]

Two of the four associate directors resigned midway through the Bush administration. From early 1991 on, Donald A. Henderson, Dean of the School of Public Health at Johns Hopkins University, served as Associate Director for Life Sciences. Eugene Wong replaced Phillips as Associate Director for Industrial Technology. Karl A. Erb, a former Yale colleague of Bromley's who had served as Assistant Director of OSTP for Physical Sciences and Engineering since 1990, then replaced Wong as Associate Director for Physical Sciences and Engineering under the OSTP.

13.2 Bridge Building

During the months between his nomination and Senate confirmation, the science press reported on its first impressions of Bromley. In a July interview, he informed a reporter for *Science* that he intended to make more vigorous use of science and technology as tools for international diplomacy. Among the issues he expected to be asked to address at his forthcoming confirmation hearings, Bromley cited:

- International competitiveness
- The environment
- The meaning of reduced East-West military tensions for defense R&D
- Conflicts of interest
- High technology
- The "infamous" infrastructure.[7]

By his own count, Bromley testified more than forty-two times before various congressional committees during his years in Washington.[8] His first meetings brought about more cordial future relations between OSTP and the key members and committees on which OSTP and the federal government's principal science and technology agencies depended for support.

Bromley also discovered that attitudes toward the federal government among leaders of industry were at best neutral, and more often adversarial,[9] so he organized meetings between leaders of key American companies and senior White House staff members, including John Sununu, the president's chief of staff. (Unfortunately, these meetings generally resulted in demands for White House action on industry's behalf rather than, as Sununu requested, the development of long-range, strategic plans that could help them adapt to future economic realities.

[6]"A Bad Day on Capitol Hill for Dr. D. Allan Bromley," *Science & Government Report* XIX, No. 17 (Nov. 1, 1989), 1-5.
[7]Barbara J. Culliton, "Science Adviser Gets First Formal Look," *Science*, 245 (July 21, 1989), 247- 48.
[8]Bromley, *op. cit.*, 34.
[9]Ibid., 53.

Figure 13.3: Left to right: James Wyngaarden, D. Allan Bromley, and J. Thomas (Tom) Ratchford. Wyngaarden and Ratchford were, respectively, OSTP Associate Directors for Science and for Policy and International Affairs. Courtesy AIP Emilio Segre Visual Archives, Bromley Collection.

Bromley also rebuilt productive relations with the U.S. science and engineering communities. He arranged to have Bush address the annual NAS meeting; Bush was the first president to do so since Kennedy.[10]

Probably the most effective of Bromley's bridge-building activities involved the high-level, inner White House staff. As Assistant to the President for Science and Technology, he was the first presidential science advisor to participate in the president's early morning White House senior staff meetings, although he was not a cabinet member. He was thus in a favorable position to establish good working relations with senior administration officials.

No doubt the most important of these officials was OMB Director Richard Darman. By establishing reasonable though never close working relations with the "prickly" Darman, Bromley got OSTP and OMB staff working together on the science and technology components of the president's fiscal year 1991 budget submission.

In October 1989, only two months after his confirmation, a reporter for *Science* wrote about Bromley's determination to revitalize the presidential science advisory system, starting with OSTP.[11] "The President has really bent over backwards to be supportive," Bromley stressed. Asked about his policy priorities, he put education at the top, noting that "in a great many cases, pre-college education has been literally perpetrating a fraud on the younger generation." The global environment also ranked high on Bromley's list of priorities,

[10]Ibid., 52-53.

[11]Barbara Culliton, "A Conversation with D. Allan Bromley," *Science* 246 (October 13, 1989), 203-04.

although he certainly could not have foreseen the grilling he would receive from Senator Gore on that topic two weeks later.

13.3 Revitalizing OSTP

When he arrived in Washington, Bromley discovered that the OSTP staff had only eleven members and a $1.5 million budget, down from fifty members and $4 million during the Carter years.[12] Bromley moved quickly to recruit competent new OSTP staff. By the time he departed Washington in January 1993, the OSTP budget was $6.25 million and its staff numbered sixty-five. Bromley managed this turnaround in part because of the cordial relations he established with key members of Congress. Additionally, since he had abided by the substance of the Science Policy Act by recruiting four associate directors subject to confirmation by the Senate, prospective OSTP staff members at lower levels felt assured that they could make a difference. These staff members served as liaison to the principal federal research agencies, to other organizations within the Executive Office of the President—particularly the OMB—supported the activities of the newly constituted PCAST, and helped upgrade the status of the FCCSET, whose revitalization Bromley considered one of his principal achievements.

13.4 Federal R&D Budgets

Bush's budget requests for science- and technology- related agencies signaled from the outset that he was convinced of their importance to the nation. In a statement accompanying his first budget request for fiscal year 1990, which he delivered personally before a Joint Session of Congress, he laid out the following proposals:

- Keeping on track to double the budget of the National Science Foundation by 1993;
- Making permanent the tax credit for R&D;
- Creating a new task force on competitiveness, to be chaired by the Vice President;
- Funding for NASA and a strong space program: "We must have a manned space station; a vigorous, safe space shuttle program, and more commercial development in space";
- A new attitude about the environment: "We must protect the air we breathe. I will send to you shortly legislation for a new, more effective Clean Air Act."[13]

The president's proposed budget for fiscal year 1991 was the first whose science and technology components had been crafted in large measure by Bromley. For the first time in more than a decade, the budget included a far larger increase for civilian as opposed to military R&D. But, as *Science* noted, "big science" was the big winner in these proposals. The bulk of the proposed budget was to support six big science projects:

1. The Strategic Defense Initiative;
2. The Space Station;
3. The Moon/Mars initiative;
4. The Superconducting Super Collider;
5. The National Aerospace Plane;
6. The Human Genome Project.[14]

The inability of the federal budget simultaneously to support so many big science projects and the desirability of seeking international support for the civilian-oriented projects were soon to become major themes during Bromley's tenure.

The fiscal year 1991 budget proposed a major increase for research on global climate change. The proposed budget for global change research exceeded $1 billion, with NASA's Earth Observation System satellites as

[12] Bromley, *op. cit.*, 40-41.
[13] "Text: 'A Realistic Plan for Tackling' Deficit," *Los Angels Times* (Feb. 10, 1989), 20.
[14] Colin Norman, "Bush Budget Highlights," *Science* 247 (Feb. 2, 1990), 517-19.

its centerpiece. However, for the first time, the Bromley-crafted R&D budget presented a cross-cutting proposal, with six agencies in addition to NASA receiving substantial support for global change-related research. Budget cross-cuts were to become a notable aspect of Bromley's revitalization of FCCSET.

Working with Richard Darman, Bromley tried to fashion a series of coherent federal R&D budgets that would visibly manifest a coherent federal science policy. However, the congressional budget process, in which various different committees deal with budget requests from different R&D agencies, tends to frustrate attempts at coherence. Bromley lamented this "balkanization" of Congress.[15] More than once, he and Darman suggested that joint hearings on the R&D budget be held before several House and, later, Senate appropriations committees. This request was granted only once: for hearings on administration proposals for mathematics and science education.[16]

13.5 PCAST

Early during his administration, Bush asked Bromley to draw up a list of nominees for a new body that would be called the President's Council of Advisors on Science and Technology (PCAST), to distinguish it from the long-defunct PSAC.[17] PCAST consisted of twelve members who did not require Senate confirmation. The members included six representatives from universities, four from industry, one from a nonprofit organization, and one from the Smithsonian Institution.[18] There were engineers, two physicists, two chemists, two biologists, one ecologist, one physician, one mathematician, one geologist, and one economist. Only two were women.

Most PCAST reports were meant for the president and his senior advisors and were therefore not made public. However, in December 1992, Bush agreed to make public all PCAST reports completed during that year. These included:

- *Achieving the Promise of the Biosciences Revolution: the Role of the Federal Government*;
- *High Performance Computing and Communications Report*;
- *LEARNING to meet the Science and Technology Challenge*;
- *Megaprojects in the Sciences*;
- *Science, Technology, and National Security and the American Standard of Living*; and
- *Renewing the Promise: Research-Intensive Universities and the Nation.* [19]

Bromley later regretted that a draft PCAST report on world population had never been forwarded to the president because of political contentiousness on the issue.

13.6 FCCSET

Bromley recognized that FCCSET needed to become an effective tool of governance if his goal of revitalizing the entire presidential science advisory system was to be realized.[20] Accordingly, he insisted that the heads of the relevant federal organizations attend FCCSET meetings in person. In reasonably short order, the membership agreed upon a set of cross-agency initiatives for FCCSET to explore in depth:

- Global Change;
- High Performance Computers and Communications;
- Advanced Materials Science and Processing;
- Biotechnology;
- Mathematics and Science Education;

[15] Bromley, *op. cit.*, 84, 87.
[16] *Advancing Innovation*, *op. cit.*, 38.
[17] Ibid., 91-92.
[18] Ibid., 261-62.
[19] Ibid., 97-98.
[20] Bromley, *op. cit.*, 61-62.

- Advanced Manufacturing.

FCCSET subcommittees were formed to explore these initiatives, several of which—starting with global change research in fiscal year 1991—resulted in cross-agency budget initiatives.

During a September 2000 panel discussion after he had returned to Yale, despite some skepticism, Bromley maintained that FCCSET had functioned effectively during his tenure. The one federal organization that had failed to take its FCCSET responsibilities seriously, according to Bromley, was the Department of State, quite probably because State lacked any significant budget for science and technology and therefore had no stake in any of the cross-agency budget proposals that FCCSET and its subcommittees initiated. The State Department's failure to recognize what Bromley believed was the vital importance of science as a tool for international diplomacy may also have reflected a reluctance of other FCCSET members to follow his lead.[21]

13.7 Technology Policy

Bromley was by no means the first to note that the "T" in both the Office of Science and Technology and the Office of Science and Technology Policy was often a distant second to the "S." In an effort at improvement, OSTP issued a statement in September 1990 that noted the building blocks of a new national technology policy:

- a quality workforce that is educated, trained, and flexible in adapting to technological and competitive change;
- a financial environment that is conducive to longer-term investment in technology;
- the translation of technology into timely, cost-competitive, high- quality manufactured products;
- an efficient technological infrastructure, especially in the transfer of information;
- a legal and regulatory environment that provides stability for innovation and does not contain unnecessary barriers to private investments in R&D and domestic production.[22]

Despite intense criticism and opposition from some in the White House, Bromley received considerable support from key members of Congress. In 1991 Senator Jeff Bingaman (D-NM), chairman of the Armed Services Appropriations Subcommittee, directed OSTP to establish a Critical Technologies Panel "drawn equally from the private sector and from within the federal government, that was charged with examining the critical technologies that had been prepared by the Department of Commerce, the Department of Defense, and various private organizations."[23]

The list of critical technologies identified by the panel were materials, manufacturing, information and communications, biotechnology and life sciences, aeronautics, energy and environment.[24]

In 1992, Senator Bingaman introduced legislation creating a Critical Technologies Institute, providing resources and staffing that would "make possible the long-range strategic planning for implementing the critical technologies in the industrial sector."

13.8 Science and International Relations

Like most senior physicists, Bromley had occasion to participate in frequent international conferences. As a measure of his standing with the international physics community, he served as president of the International Union of Pure and Applied Physics (IUPAP) from 1984 through 1987.

Well aware of the importance of international scientific initiatives, Bromley helped create the Organisation for Economic Co- operation and Development (OECD) Megascience Forum (now known as the Global Science Forum). Every three to five years the OECD's Committee on Science and Technology Policy (CSTP), which

[21] *Advancing Innovation*, *op. cit.*, 42.
[22] Bromley, *op. cit.*, 128.
[23] Ibid., 131.
[24] Ibid., 265-66.

normally meets twice a year, holds a meeting at the ministerial level, bringing together the ministers of science from the twenty-four countries that were OECD members in 1992. Bromley proposed creation of the Megascience Forum, where leading scientists could convene to discuss large-scale scientific programs whose costs exceeded or at least strained the budget of any single nation.[25] Bromley had hoped that the Forum would lead to international cost-sharing of expensive programs and facilities. While this hope never materialized, the Forum did provide a unique and useful venue for assessing the status of research in a number of big science fields, for developing probable scenarios for the future, and for coordinating national and regional activities.

13.9 National Innovation Systems

Bromley's recollections of his Bush administration years contain not one mention of the word "innovation."[26] Well before the end of the Clinton administration, however, "innovation" would become a buzzword. During the 1980s, a handful of scholars had begun to investigate ways in which innovation originated, grew, and ultimately succeeded or failed. In 1993, the economists Richard R. Nelson and Nathan Rosenberg published their influential *National Innovation Systems: A Comparative Analysis*, which argued that university and industrial research, and the federal agencies that supported university research, were not the only institutions required for successful international competitiveness.[27] Nor was a robust scientific research system a necessary or adequate foundation for competitiveness. What was required, they argued, was a national innovation policy.

No single event in the Bush administration led to this scholarly interest in national innovation systems. Rather, it had been increasingly clear since the late 1970s that the so-called linear model expounded in *Science—the Endless Frontier* was inadequate. That model assumed something like a conveyer belt, from which the results of basic research were picked up and used by applied researchers who passed them on for engineering development of a useful process or product. However, while the Bush report may have tacitly assumed that such products would easily be commercialized or used for military purposes, it was clear that this did not happen automatically. Rather, there were other, heretofore neglected factors that had to be involved: e.g., the necessary capital to proceed from a pilot model to full-scale production, as well as marketing expenses. In short, research and development were insufficient. What was required was a broader innovation system that encompassed research and development, and more besides.

Although no single event in the first Bush administration triggered these academic studies, these innovation studies had a notable impact on the formulation of science policy beginning in the early days of the succeeding Clinton administration.

In addition to rejecting the implicit Bush linear model, Nelson and Rosenberg noted that a problem originating in industrial research often stimulated new basic research programs in universities. Moreover, they asserted, advances in commercial and military technology very often relied not on breakthroughs in research but rather on incremental gains. Since the days of the Wright Brothers, for example, advances in the aircraft industry often were based on incremental improvements gained through trial and error.

The study of innovation systems explores such questions as: How does technical advance proceed? What are the key processes? Who are the key actors? How does technical innovation translate into economic growth? Among the indispensable institutions in the United States are research universities, industrial research laboratories, and the principal federal agencies that conduct and support R&D. Beyond that, links between industrial research laboratories and company operating units are essential; this is why Bell Labs, IBM, and Xerox all broke up their autonomous research labs in the 1980s and melded them with their operating units. Similarly, scholars came to recognize that tax and regulatory authorities played as vital a role in innovation systems as did direct federal R&D support.

[25]Ibid., 211.

[26]Bromley, *op. cit.*

[27]Richard R. Nelson and Nathan Rosenberg, eds., *National Innovation Systems: A Comparative Analysis* (Oxford: Oxford University Press, 1993).

In addition to universities, industry and government, capital to move a promising idea to a stage where industry can afford the applied research and development required for commercialization is vital. To this end, the National Science Foundation created programs in the early 1990s for small businesses, providing funds for aspiring entrepreneurs to conduct "proof of concept" research that might lead large companies either to fund further research or to acquire the entrepreneurial firm.

Along the same lines, venture capital firms were identified as an important component of national innovation systems. Such firms support new companies during their early stages of development and provide vital financial and management experience. Almost unique to the United States, venture capital firms' existence may be closely linked to the almost unique concept of risk in this country. An individual who fails in one business may raise the necessary funds to start another—business failure is not seen as moral failure in the United States.

Mowery and Rosenberg also identified the U.S. research university system as an essential element in the national innovation system.[28] The American research university system is, by several measures, by far the best in the world. They also pointed to data demonstrating that small and medium-sized enterprises (SMEs) in the United States develop more potentially innovative ideas than larger firms. They suggested that SMEs would continue to play a significant role in the U.S. national innovation system.[29]

13.10 Council on Competitiveness

The Council on Competitiveness (CoC) was created in 1986 during a time when the United States appeared to be lagging behind other nations—particularly Japan—in its ability to compete in a number of key industries. It consists of major company CEOs, labor leaders, university presidents, and the heads of the principal science and technology agencies of the federal government.

Even as the national innovation concept broadened the way research and development was conceived, so meetings of the Council on Competitiveness were considerably broader than conventional professional science society meetings, such as those of the American Association for the Advancement of Science and the American Physical Society. That is, CoC meetings involved other actors in the innovation process in addition to scientists and engineers.

Although established during the first Bush administration, the CoC did not become a recognized organization until well into the Clinton administration, during which it held three notable conferences. The first was held on February 24, 1997, at the University of California, San Diego, and was billed as "California and the Future of American Innovation."[30] California Governor Pete Wilson participated, as did John Gibbons, the first of Clinton's two science advisors, NSF Director Neal Lane (later Clinton's second science advisor), Congressman George Brown (D-CA), Steven Schiff (R-NM), and the heads of several universities and corporations.[31] The two subsequent conferences took place in Atlanta on March 3 and in Indianapolis on April 1-2.

[28]David C. Mowery and Nathan Rosenberg, "The U.S. National Innovation System," from Richard R. Nelson and Nathan Rosenberg, eds., *National Innovation Systems: A Comparative Analysis* (Oxford: Oxford University Press, 1993), 29- 52.

[29]In their article in the Nelson-Rosenberg collection, Hiroyuki Odagiri and Akira Goto (*op. cit.*) ignore university-industry research cooperation as important to Japan's national innovation system, citing the importance of universities only as a source of skilled manpower. Yet beginning in 1996, the Japanese government embarked on a series of five-year Science and Technology Basic Plans which, among other things, took measures to encourage university-industry research cooperation. In 2004, universities became autonomous organizations, largely unregulated by the government's Ministry of Education—*Monbukogausho*, or MEXT—and permitted to compete on the basis of their own competitive niches.

[30]Jon Cohen, "U.S. Science Policy: All Start Group Prescribes Partnerships for R&D Woes," *Science* (March 7, 1997), 1410-11.

[31]Ibid.

Chapter 14

The Clinton Years: 1993-2001[1]

Maybe we are working on an outmoded paradigm about who we are and what are world really is. It was once that we had a simple and clear vision of who we are—leader of the free world, saving the world from the darkness of communism. Now we see anachronisms in terms of world security. Is there a new way for us to lead? Should it involve, say, provisions of goods and services without environmental damage? Should that be the new world focus for us?

—John H. Gibbons, 1989

In spite of the pitfalls and the perils, our nation has always believed that what scientists do would always transform our world for the better in the end. Benjamin Franklin, the father of our scientific revolution, once wrote: "The progress of human knowledge will be so rapid and discoveries made of which we at present have no conception. I begin to be almost sorry I was born so soon since I cannot have the happiness of knowing what will be known in years hence."

—William J. Clinton, February 12, 1998

The world has changed in 60 years. In part due to advances in technology—computing and the Internet—it has become smaller and, in the words of Tom Friedman, "flatter." In a world where large multinational corporations can take their manufacturing, service divisions, even R&D facilities to whichever parts of the world can offer skilled workers at a good price, traditional arguments about the value of having the best universities and research facilities—and providing the necessary federal funding for them—become more complex. (TIS, p. 259)

—Neal Lane, 2008

14.1 Clinton at the AAAS

On February 12, 1998, President Bill Clinton addressed the one hundred fiftieth anniversary meeting of the AAAS in Philadelphia.[2] Although Clinton had faced a Republican majority in both houses of Congress since January 1995, the political atmosphere was far from toxic. Following the collapse of the Berlin Wall in 1989 and the dissolution of the Soviet Union two years later, and with the attack on the Twin Towers and the Pentagon more than three years in the future, the United States basked in its status as the world's sole superpower.

Clinton extolled the virtues of science and technology and the benefits they conferred on the nation. He compared the current state of scientific knowledge and its visible fruits with that at the time Truman had addressed the AAAS's centennial meeting fifty years before, and speculated on what still-unknown wonders his successor as president would use to illustrate the promise of science at the bicentennial meeting of the AAAS in 2048.

[1]This content is available online at <http://cnx.org/content/m34592/1.2/>.

[2]William J. Clinton, "Address to the 150th AAAS Annual Meeting (1998)," in Albert Teich, ed., *Science and Technology Policy Yearbook, 1999* (Washington, DC: American Association for the Advancement of Science, 1999).

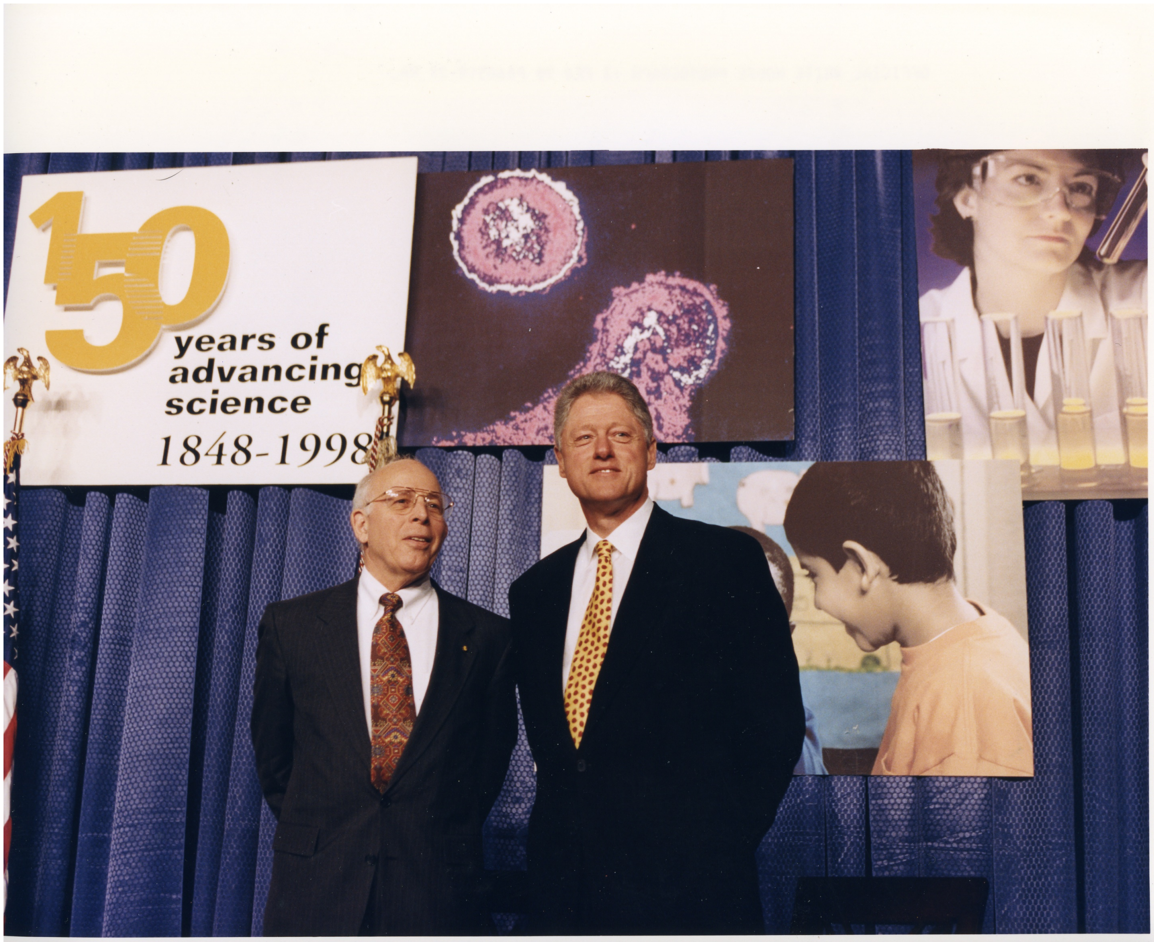

Figure 14.1: Following his address to the AAAS on February 13, 1998, President Clinton announced the resignation of John (Jack) Gibbons, his first science advisor. Courtesy of the William J. Clinton Presidential Library.

Toward the end of his speech, the president announced the resignation of John Gibbons, who had served as his science advisor from the beginning of his administration. He then announced his intention to nominate National Science Foundation director Neal Lane as his successor, and Rita Colwell, Professor of Biology at the University of Maryland, as the first female director of NSF.

Figure 14.2: Clinton then announced his intention to nominate Neal Lane as Gibbon's successor. On the right: Jane Lubchenco, President of the AAAS. Courtesy of the William J. Clinton Presidential Library.

Gibbons and Lane convinced the president to appoint outstanding members to PCAST, which produced reports that often caught the president's attention. It apparently was Gibbons who convinced Clinton to upgrade FCCSET to the status of the National Science and Technology Council (NSTC).

14.2 NSTC

President Clinton established the NSTC as a cabinet-level council by Executive Order on November 23, 1993. In addition to the heads of the principal science- and technology-related agencies who had been members of FCCSET, NSTC's membership included the Secretaries of State, Defense, Interior, Agriculture, Commerce, Labor, Transportation, Energy, and Education; the directors of the Office of Management and Budget; the Central Intelligence Agency and the Arms Control and Disarmament Agency; and the Assistants to the President for National Security Affairs, Economic Policy, and Domestic Policy.

Most of the NSTC's work was carried out by the following nine standing committees (each chaired by a senior federal agency official and co-chaired by an associate director nominated by the president and confirmed by the Senate):

- Committee on Health, Safety, and Food
- Committee on Fundamental Science
- Committee on Computing, Information, and Communications

- Committee on Environment and Natural Resources
- Committee on Technological Innovation
- Committee on Education and Training
- Committee on Transportation
- Committee on National Security
- Committee on International Science, Engineering, and Technology.

Both of Clinton's science advisors made use of NSTC to help determine R&D budget priorities and identify cross-agency initiatives that could be packaged as coherent budget requests to the Congress.

14.3 John H. Gibbons

In 1989, Gibbons, then director of the Office of Technology Assessment (OTA), had posited that, "Maybe we are working on an outmoded paradigm about who we are and what our world really is. It was once that we had a simple and clear vision of who we are—leader of the free world, saving the world from the darkness of communism. Now we see anachronisms in terms of world security. Is there a new way for us to lead? Should it involve, say, provisions of goods and services without environmental damage? Should that be the new world focus for us?"[3]

Gibbons must have been at least somewhat aware that the new paradigm he called for would soon be articulated as a national system of innovation by Nelson, Rosenberg and their contributors. In any event, the scientific community applauded Clinton's selection of him as science advisor.[4] A physicist who had been on the faculty at the University of Tennessee and subsequently a senior member of the staff at the Oak Ridge National Laboratory, he had served as Director of the Office of Technology Assessment (OTA) since 1979, and was widely recognized for having made it function as it was meant to when it was established during the 1960s.[5]

Clinton and Vice President Al Gore were determined to integrate technology more closely with the economy. On February 23, 1993, they issued a technology-policy statement that barely mentioned universities and did not refer to science at all. The immediate reaction of the scientific community, which had become accustomed to hearing a succession of presidents proclaim the importance of basic research and the imperative for federal support, was one of chagrin, even outrage, with several scientists claiming that the Clinton administration was anti-science.

Clinton and Gore seem to have gotten the message. At Gibbons's request, the National Academy of Sciences convened a Forum on Science in the National Interest in January 1994, proclaiming that it was "a milestone in shaping this Administration's goals and strategies for science." The results of the forum were published in August under the authorship of Clinton and Gore.[6]

In November 1995, the White House issued a follow-up to its February 1993 policy statement, again paying due respect to science.[7]

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[3] Wil Lepkowski, *C&EN News* (April 3, 1989), 12.

[4] Gibbons has published a collection of his writings divided into a book with two parts: the first from 1990, when he was still a senior staff member at the Oak Ridge National Laboratory, to 1992 when he was nominate as Clinton's science advisor. The second part deals with the years 1992-1996, while still serving as science advisor pending nomination and confirmation of his successor. John H. Gibbons, *This Gifted Age: Science and Technology at the Millennium* (New York: Springer Verlag, 1997).

[5] The prime mover in the creation of OTA was Congressman Emilio Q. Daddario (D-CT), chair of the Science Committee of the House Committee on Science and Technology. After being defeated in his attempt to be elected Governor of Connecticut, Daddario became the first Director of OTA. However, he was judged as being too attuned to the wishes of his former congressional colleagues to prove effective in that position. His successor, Russell Train, was criticized for taking inordinate amounts of time to complete reports requested by the bipartisan, bicameral committee with oversight responsibilities for OTA. Gibbons struck the right balance between being attuned to balancing requests from the oversight committee for studies on the probable downstream effects of technologies, and maintaining the independence of OTA, as well as balancing the need for thorough investigation of a given topic with the issuance of reports in a timely manner.

[6] President William J. Clinton and Vice President Albert Gore, Jr., *Science in the National Interest* (Washington, DC: Executive Office of the President, Office of Science and Technology Policy, August 1994).

[7] President William J. Clinton and Vice President Albert Gore, Jr., *Technology and Economic Growth: Producing Real Results for the American People* (Washington, DC: the White House, November 8, 1995).

The administration's February 1993 *faux pax* notwithstanding, Clinton was moving decisively to manage the federal science and technology enterprise. On August 17, 1993, Gibbons and OMB director Leon Panetta issued a five-page memorandum to the heads of each cabinet department and independent agency ordering agencies to cease categorizing R&D in terms of basic research, applied research, and development in their annual budget requests, and to list priorities and describe how their requests were consistent with administration goals and the broader public good. According to the memorandum, "while these categories have some utility, they provide little information about their relevance to society.... Does the overall S&T budget reflect the kinds of priorities that it is meant to support, mainly the president's overarching national goals?"[8]

Another innovation was particularly problematic for agencies providing primary federal support for R&D and basic research. *Reinventing Government*, a study headed by Gore, resulted in a 1993 Act of Congress—the Government Performance and Results Act (GPRA)—which required organizations to work with OMB on a five-year performance plan that would then be submitted to the Congress along with the president's budget request.[9] Each plan was to be accompanied by a set of metrics that would help assess an agency's progress in meeting its performance goals; annual reports based on these metrics were to be submitted to OMB and the Congress, beginning with the fiscal year 1999 budget. Although it was fairly straightforward for agencies charged with producing such tangible products as improved airport safety systems and better services to constituency groups to define quantitative metrics, agencies such as NSF and NIH, whose primary missions are to support basic research, were faced with a more difficult challenge. How, from year to year, were they to quantify the results of research they supported in non-government organizations if the tangible results of such research rarely if ever were visible in fewer than five or even ten years? (These agencies did, however, develop five-year plans and performance metrics to the satisfaction of both OMB and their congressional appropriations committees.[10])

Two years into the Clinton administration, OSTP was receiving a "mixed midterm report."[11] George Brown, (D-CA), ranking minority member of the House of Representatives Science Committee, declared, "They're just not producing. And a lot of what they are doing is disconnected from reality." Brown and Senator Barbara Mikulski (D-MD) complained that OSTP lacked sufficient influence in important decisions regarding science. They also pointed out that *Science in the National Interest* foresaw a goal of devoting 3 percent of the nation's gross domestic product to research and development, but that the Clinton administration had announced its intention of requiring 3 percent across-the-board reductions in budget requests by the federal bureaus, with no exemptions for the National Institutes of Health and the National Science Foundation, the principal supporters of basic research.

14.4 Neal Lane

On February 2, 1998, Clinton unveiled his fiscal year 1999 budget request before a joint session of the Congress.[12] Thanks to a booming economy, the federal deficit had vanished and the administration could propose more generous budgets. Most of Clinton's proposed R&D budget was packaged into a $31 billion Twenty-first Century Research Fund for America. Overall, it would rise by 6 percent, to $36.4 billion, "the largest commitment to civilian research in the history of the United States," according to Gore. All agencies were slated to benefit, with the exception of NASA. NIH's budget would increase by 8.4 percent, to $14.8 billion, and NSF's by 10 percent, to nearly $3.8 billion. This commitment was reiterated in a weeklong series of speeches by the president and vice president. For the first time, research on climate change was specifically included in a budget request.

[8] Jeffery Mervis, "Clinton Moves to Manage Science," *Science* (September 24, 1993), 1668-1669.

[9] Neal Lane, "U.S. Science and Technology: An Uncoordinated System Which Seems to Work," *Technology in Society* 30 (August-November 2008), 251.

[10] Results of these annual evaluation reports for all federal organizations can be found at http://www.omb.gov/ (<http://www.omb.gov/>). Five-year performance plans as well as results of annual evaluation reports can be found on the websites of many agencies, e.g., http://www.nsf.gov (<http://www.nsf.gov>).

[11] Andrew Lawler, "OSTP: a Mixed Midterm Report," *Science* (April 14, 1995), 192-94.

[12] Andrew Lawler, "The 1999 Budget: Science Catches Clinton's Eye," *Science* (February 6, 1998), 794-97.

At the time he presented his proposed budget, Clinton was still seeking a successor to Gibbons. Various individuals close to the White House advocated an industrial scientist as Gibbons' successor.[13] One reason for Clinton's protracted search was that he was over a year into his second term as president when Gibbons announced his intention to resign. Many qualified scientists who might have been tempted by the position no doubt decided that they could make little impact on national science policy under a lame duck president. By the time Clinton announced his intention to nominate Lane in February 1998, there were slightly less than three years remaining in his term. Presidents are unlikely to announce broad, innovative programs at such late stages in their administrations. So Clinton, reportedly in close cooperation with Gore, sought a qualified individual who would keep a low profile and hold a steady course.

Neal Lane was a perfect choice in that respect. Genial and low-key, he had been NSF Director since October 1993 and soon gained a reputation for being a good listener and a conciliator. At the time of his appointment, the Republican majority in Congress, particularly the House of Representatives, was becoming increasingly vocal in its opposition to Clinton. Early during his tenure at NSF, Lane made several trips to the Hill to speak with key members of congressional committees, convincing them that support for R&D—particularly basic research—should be a non-contentious issue exempt from the increasing rancor Republicans directed at Clinton.

Lane appears to have managed the federal science and technology system well. According to *Science*, the president's proposed FY2001 budget, transmitted to the Congress early in February 2000, included a 7 percent ($2.8 billion) increase for programs accounting for the bulk of government spending on civilian science and technology, providing "a windfall to researchers exploring everything from the sun to atomic-level machines on Earth," and representing "a strong commitment to academic research. It [the proposed budget] also challenges Congress to ease up on [Contract with America-mandated] spending limits in favor of boosting science."[14]

At the April 2000 AAAS Science and Technology Policy Forum, Lane publicly set what *Science* referred to as "some uncharacteristically specific science policy goals." Among them: doubling federal spending on civilian research to 1 percent of GDP in ten years; a doubling of corporate investment in university-based research; and a 10 percent per year increase in science-related degrees awarded to minorities and women.[15]

Lane also spoke often about the importance of scientists going outside their laboratories to become civic scientists as well, involving the non-scientific public in supporting the American science and technology system by making plain its social and economic benefits.[16]

14.5 FCCSET/NSTC

Under the guidance of Gibbons and Lane, FCCSET, elevated and expanded as the National Science and Technology Council (NCST) in 1994, continued to function at reasonably effective levels. Among the studies and reports of FCCSET/NSTC and its working subcommittees, three either resulted in cross-agency budget initiatives or consisted of reports on those initiatives: global change research (1994, 1996, 1997, 1998, and 2000); nanotechnology (1999 and 2000), and high performance computing and communication (1991, 1993, 1994, 1995, and 1996).[17]

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[13] Andrew Lawler, "Wanted: the Ideal Science Adviser," *Science* (December 12, 1997), 1872-73.

[14] Andrew Lawler, "Clinton Seeks 'Major Lift' in U.S. Research Programs," *Science* (January 28, 2000), 558-59.

[15] "Science Scope," *Science* (April 21, 2000), 413.

[16] Lane, *op. cit.*, 260.

[17] Texts of all FCCSET/NSTC reports from 1991 through January 2001 can be accessed at http://www.ostp.gov/cs/documents_reports/nstc_reports_archive (<http://www.ostp.gov/cs/documents_reports/nstc_reports_archive>).

Figure 14.3: President Clinton signing the executive order creating the National Science and Technology Council. Behind Clinton, left to right, Gibbons and Vice President Al Gore. Courtesy of the William J. Clinton Presidential Library

The high performance computing and communication topic enjoyed special status. In 1991, during the first Bush administration, Congress authorized the creation of The President's Information Technology Advisory Committee (PITAC), whose scope was expanded under the Next Generation Internet Act of 1998.[18] "Comprising leading IT experts from industry and academia, the Committee helps guide the Administration's efforts to accelerate the development of information technologies vital for American prosperity in the 21st century."[19]

At Clinton's request, Congress authorized the National Nanotechnology Initiative (NII) as one of the major fiscal year 2001 research initiatives.

14.6 PCAST

Gibbons and Lane built on the precedent set by D. Allan Bromley in the first Bush administration by appointing and making good use of the President's Council of Advisors on Science and Technology (PCAST). This list of reports and less formal letters enumerates the range and scope of the issues they considered:

[18] http://www.nitrd.gov/pitac/index.html (<http://www.nitrd.gov/pitac/index.html>).
[19] http://www.nitrd.gov/about/about_nco.aspx (<http://www.nitrd.gov/about/about_nco.aspx>).

- The U.S. Program of Fusion Energy Research and Development Report (July 1995)[20]
- Science and Technology Principles (September 1995)
- Report to the President on Academic Health Centers (November 1995)
- Principles on the U.S. Government's Investment Role in Technology (June 1996)
- Report on Research Universities (June 1996)
- Report on Preventing Deadly Conflict (November 1996)
- Second-Term Science and Technology Initiatives (December 1996)
- Report on Sustainable Development (January 1997)
- Report to the President on the Use of Technology to Strengthen K-12 Education in the United States (March 1997)
- PCAST Letter on Cloning (March 1997)
- Report to the President on Federal Energy Research and Development for the Challenges of the 21st Century (November 1997)
- PCAST Letter on International Energy Research and Development (May 1998)
- PCAST Letter on Educational Research (June 1998)
- Teaming with Life: Investing in Science to Understand and Use America's Living Capital (June 1998)
- PCAST Letter on the FY2000 Budget (November 1998)
- PCAST Letter on Critical Infrastructure Protection (December 1998)
- Powerful Partnerships: the Federal Role in International Cooperation on Energy Innovation (August 1999)
- PCAST Review of the NSB [National Science Board] Report on Environment
- Science and Engineering for the 21st Century (December 1999)
- PCAST Letter to the President regarding FY2001 Budget Priorities (December 1999)
- PCAST Letter to the President endorsing a National Nanotechnology Initiative (December 1999)
- Wellspring of Prosperity—Science and Technology in the US Economy—Spring 2000 (June 2000)
- Letter from PCAST to the President (January 2001)
- Letter from PCAST to Neal Lane (January 2001)
- Biodiversity: Connecting with the Tapestry of Life (January 2001).

14.7 Science and International Relations

In its final (January 2001) letter to President Clinton, PCAST expressed thanks for his support and pointed to what it regarded as some of its most significant accomplishments. Among these, it singled out increasing the use of American strengths in science and technology as instruments of the nation's international diplomacy. Lane spoke and wrote frequently about the importance of science and technology in international relations, particularly with important emerging economies such as China's and India's.[21] By the time PCAST addressed this final letter to Clinton, science and technology had become far more visible and accepted tools of American foreign policy. During Clinton's first term, the interest of the State Department in science had declined even further than during the H.W. Bush Administration. Recognizing Vice President Gore's interest in environmental matters, State replaced many of the science counselors posted in U.S. embassies with Environment Counselors. During the 1980s, there were twenty-two science counselors posted at embassies; by the end of 1997, only ten remained.

In a November 27, 1998, op-ed piece in *Science*, J. Thomas Ratchford, who had served as Associate Director for Policy and International Affairs under Bromley, virtually washed his hands of the State Department:

> *Elegant organizational constructs and unfunded legislative mandates for the Department of State cannot work. The commonsense approach is to give the federal research and development (R&D) agencies the policy direction and resources to do for State much of what it has not been able*

[20] Texts of all these reports can be accessed from http://www.ostp.gov./cs/pcast/documents_reports/archive (<http://www.ostp.gov./cs/pcast/documents_reports/archive>).
[21] Lane, *op. cit.*

to do for itself. Only this will catalyze the necessary two-way interchange between science and engineering on the one hand and foreign-policy development on the other.[22]

At the time, a special committee of the National Academy of Sciences was already considering recommendations to strengthen the links between science and technology and U.S. diplomacy. Apparently, the increasingly vocal outrage among experts about the virtual elimination of science and technology from American foreign policy had caught the attention of Secretary of State Madeline Albright. In April 1998, she asked NAS to prepare a report on specific means through which the links between science and technology and international diplomacy could be restored and strengthened.[23] The NAS panel, chaired by Robert Frosch, a research fellow at Harvard University, stated bluntly: "Ironically, as the world becomes more technologically interdependent, the trend at the State Department has been to downplay science and technical expertise." He advised Albright "to articulate and implement a policy that calls for greater attention to [science] dimensions of foreign policy throughout the department."[24]

The panel recommended that the number of science counselors posted in U.S. embassies be increased to at least twenty-five, and that the Secretary of State should appoint a Science Advisor. Gibbons agreed to come out of retirement to serve as interim Science Adviser to the Secretary of State until Norman Neureiter, a retired industrial chemist who had served as science counselor in several Eastern European capitals earlier in his career, assumed the post in November 2003.

Even though Albright (and, to a lesser extent, her successors) sought to follow the NAS panel's recommendation, the uses of science and technology made by the State Department as tools of international diplomacy remain problematic. Although the number of science counselors has increased, they were rechristened as Counselors for Science, Technology, Environment, and Health, thus increasing their responsibilities without providing them with the requisite additional staff to cope with them. Additionally, most of these counselors are ill-equipped by virtue of their backgrounds to serve effectively. While most countries appoint science counselors to their foreign embassies by detailing individuals from R&D ministries, the State Department selects career diplomats, few of whom have any scientific training. A principal qualification for appointment seems to have been experience serving in a U.S. diplomatic mission in the given country. The appointees' lack of a professional science or technology background tends to impede their effectiveness.

14.8 Assessment

Near the end of Clinton's term, an article in *Science* concluded that his administration deserved relatively high marks with respect to science policy.[25] "Such praise, Washington policy watchers say, illustrates how the science community has warmed to what many originally perceived to be at best his ambivalence about science policy." Clinton was credited for significant increases in budgets for the federal government's principal science and technology agencies and for beating back attempts by the Republican majority in Congress to weaken his R&D budgets.

[22] J. Thomas Ratchford, "Science and Government: Put Science and Technology Back into Foreign Policy," *Science* (November 27, 1988), 1650-51.

[23] David Malakoff, "Diplomacy: Gibbons Joins Effort to Boost Science at State," *Science* (October 15, 1999), 391-92.

[24] Ibid.

[25] David Malakoff, "Science Policy: Clinton's Science Legacy: Ending on a High Note," *Science* (December 22, 2000), 2234-36.

Figure 14.4: President Clinton tries out the White House website designed by OSTP staff. Courtesy of the William J. Clinton Presidential Library.

However, not all science policy experts gave the Clinton administration high marks. A September 2000 meeting convened by the AAAS and the Center for the Study of the Presidency gave high marks to Gibbons and Lane, but faulted Clinton for not using PCAST as effectively as he might have, and was skeptical about whether the roles of science and technology in international affairs had really been strengthened under him.

These criticisms, however, were relatively mild. Had the same participants in that September 2000 meeting been reassembled eight years later, their criticisms of the second Bush presidency (2001-09) would likely have been considerably harsher.

Chapter 15

The Bush-43 Years: 2001-09[1]

Our economy is growing in large part because America has the most ambitious, educated and innovative people in the world—men and women who take risks, try out new ideas, and have the skills and courage to turn their dreams into new technologies and new businesses. To stay competitive in the global economy, we must continue to lead the world in human talent and creativity.

—George W. Bush, August 2007

On May 1, 2001, MIT President Charles Vest convened a meeting of eight former science advisors.[2] According to *Science*, "The former advisers ticked off several recent actions by the new president that they feel could have benefited from input from a science adviser. They include the decision to abandon the process spelled out in the Kyoto Treaty to limit greenhouse gases, reduce spending on energy R&D, reverse water-quality standards, and move ahead with a new missile defense system. Decisions on the use of stem cells in research and oil drilling in the Arctic loom on the horizon, they added."[3] That several of these decisions were viewed negatively by many leaders of the scientific community no doubt contributed to the reluctance of several potential candidates to consider serving as George W. Bush's science advisor.

Three months after his inauguration, Bush announced that he would nominate Floyd Kvamme, a former computer industry executive and at the time of his nomination a venture capitalist, to lead PCAST.[4] Allan Bromley referred to the timing of the PCAST head's nomination (coming prior to that of a science advisor) as "a little peculiar."

A month later, Bush nominated Brookhaven National Laboratory director John H. Marburger III as his science advisor and director of the OSTP.[5] That Marburger would have less influence on or access to the president was made clear when was not also nominated as Assistant to the President for Science and Technology, meaning that he would be excluded from cabinet meetings. His offices, traditionally next door to the White House in the Old Executive Office Building, were also moved across Pennsylvania Avenue.

[1] This content is available online at <http://cnx.org/content/m34593/1.1/>.
[2] Andrew Lawler, "Former Advisers Fret Over OSTP Vacancy," *Science* (May 11, 2001), 1041-43.
[3] Ibid.
[4] David Malakoff, "Bush Appointment: Venture Capitalist to Lead Science Panel," *Science* (April 6, 2001), 28-29.
[5] Andrew Lawler, "White House: President's Science Adviser Ready to Put Science in Its Place," *Science* (June 29, 2001), 2408-09.

Figure 15.1: Presidential Science Advisor John Marburger III, speaking at the fortieth anniversary of the American Institute of Physics Niels Bohr Library. Courtesy AIP Emilio Segre Visual Archives.

Immediately following his Senate confirmation, Marburger replaced the traditional four associate directors of OSTP with two deputy directors: one for technology and one for science. Portfolios formerly held by associate directors, including environmental matters and national security, would henceforth be folded into either science or technology. "The changes have unsettled some members of the science and technology community," wrote Andrew Lawler. "Eliminating the national security position 'is a big blow' to forging links to the powerful National Security Council, says one former OSTP official. 'The need to incorporate science in the burgeoning war on terrorism suggest that Marburger's moving in the wrong direction,' says Al Teich, head of science and policy at the American Association for the Advancement of Science. Dropping the environmental job, Teich adds, is a 'surprising move given the importance of global warming and related issues."' [6]

15.1 Unsettling Developments

In January 2004, the Union of Concerned Scientists listed more than twenty incidents in which it claimed that the Bush administration had politicized science, including stacking advisory panels with ideological allies, doctoring reports that didn't support its policies, and muzzling government scientists.[7] In February, sixty prominent scientists signed an accompanying statement accusing the administration of ignoring or distorting

[6] Andrew Lawler, "U.S. Science Policy: Marburger Shakes Up White House Office," *Science* (November 2, 2001), 973-74.
[7] David Malakoff, "Science Politics: White House Rebutes Charges It Has Politicized Science," *Science* (April 9, 2004), 184-85.

technical findings inconsistent with its political views. The White House fought back, with Marburger's office issuing a twenty-page rebuttal.[8]

The charges persisted. In September, David Baltimore, a Nobel Laureate and President of the California Institute of Technology, wrote:

> *[A]s we approach the election, it is important to examine the most critical issues at the interface of science and politics in the determination of public policy. And on several of these issues, a new pattern of behavior by the administration is becoming clear. The sequence is as follows: A government position is taken on a matter of scientific importance; policy directions are announced and scientific justifications for those policies are offered; strong objections from scientists follow; the scientific rationale is then abandoned or changed, but the policies based on that science remain, stuck in the same place.*[9]

Immediately following Bush's narrow reelection, the Federation of American Scientists presented a paper making the case for an effective presidential science advisory system and urging Bush to move decisively in that direction.[10] The paper also reviewed the status of science advice throughout the executive branch, with a focus on the National Science Board—by law, the governing body of the National Science Foundation—arguing that such advisory bodies, while important, were no substitute for a strong presidential system. It also urged the administration to take greater advantage of the capabilities of the U.S. National Academies[11] to provide well-reasoned scientific advice. Finally, it recommended that the Congress recognize the need for such advice and strengthen those bodies that provide it.

15.2 Innovate America

Innovate America, a report of the National Innovation Initiative of the Council on Competitiveness, was made public in September 2004. Release of the report was followed by an Innovation Summit held in Washington on December 15, 2004.[12] The Initiative defined innovation as "the intersection of invention and insight, leading to the creation of social and economic value." It grouped its recommendations under three headings:

1. Talent
    - Build a national innovation education strategy for a diverse, innovative and technically trained workforce
    - Catalyze the next generation of American innovators
    - Empower workers to succeed in the global economy
2. Investment

- Revitalize frontier and multidisciplinary research
- Energize the entrepreneurial economy
- Reinforce risk-taking and long-term investment
- Infrastructure

- Create national consensus for innovation growth strategies
- Create a 21st century intellectual property regime

[8] Ibid.

[9] David Baltimore, "Science and the Bush Administration," *Science* (September 24, 2004), 1873-74.

[10] Federation of American Scientists, *Flying Blind: The Rise, Fall, and Possible Resurrection of Science Policy Advice in the United States* (Cambridge, MA: Federation of American Scientists, December 2004).

[11] National Academies refers collectively to the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

[12] Council on Competitiveness, *Innovate America: National Innovation Initiative Summit and Report* (Washington, DC: Council on Competitiveness, 2005).

- Strengthen America's manufacturing capacity
- Build 21^{st} century innovation infrastructures—the health care test bed.

The report characterized its recommendations in the form of the following imperatives:

- Educate next generation innovators
- Deepen science and engineering skills
- Explore knowledge intersections
- Equip workers for change
- Support collaborative creativity
- Energize entrepreneurship
- Reward long-term strategy
- Build world-class infrastructure
- Invest in frontier research
- Attract global talent
- Create high-wage jobs

The December 15 summit sought to mobilize key players in the American national innovation system to lobby the administration, Congress, and their own constituencies in academia and private industry to help implement the report's recommendations. Participants included Deborah Wince-Smith, president of the council; F. Duane Ackerman, chair of the council and chairman and CEO, BellSouth Corporation; G. Wayne Clough, co-chair of the National Innovation Initiative, currently secretary of the Smithsonian Institution and then President of the Georgia Institute of Technology, and Samuel H. Palmisano, co-chair of the National Innovation Initiative and chairman and CEO of the IBM Corporation.

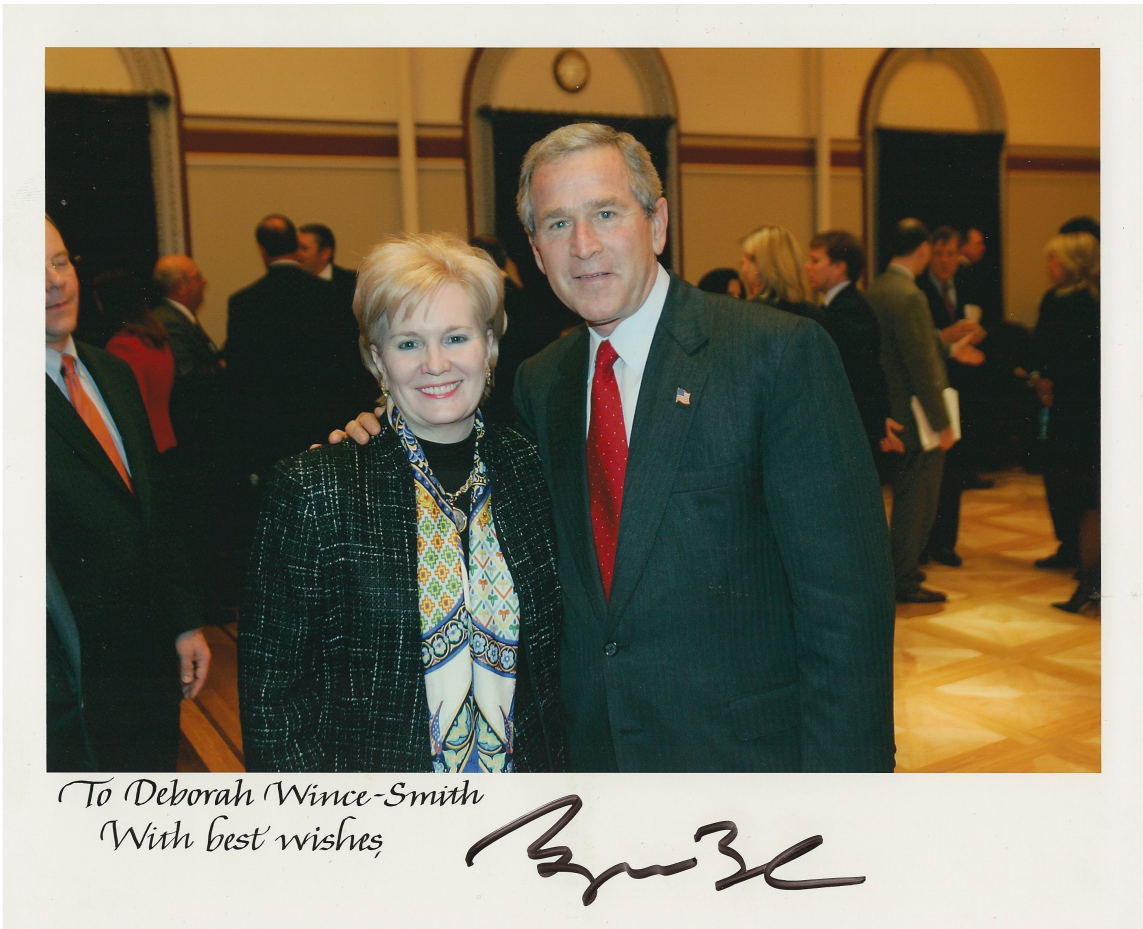

Figure 15.2: President George W. Bush with Deborah Wince-Smith, President of the Council on Competitiveness, December 15, 2004, on the occasion of the Council's Innovate America! Summit. Courtesy of Deborah Wince-Smith.

15.3 Rising Above the Gathering Storm

In the fall of 2005, the U.S. National Academies released the report of a panel chaired by Norman R. Augustine,[13] retired chairman and CEO of the Lockeed Martin Corporation, entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*[14] On October 20, immediately following the release of the report, Augustine, P. Roy Vagelos, retired chairman and CEO of Merck & Company, Inc., and William Wulf, president of the National Academy of Engineering, described the report and its recommendations in testimony before the U.S. House of Representatives Committee on Science. Augustine noted, "It is the unanimous view of our committee that America today faces a serious and

[13]Both Augustine and Charles Vest, President of MIT, had been appointed to PCAST during the Clinton administration and retained their positions during the Bush administration. That Augustine and, to a somewhat lesser extent, Vest, as administration "insiders," publicly criticized the policies of the Bush administration is reminiscent of the controversy during the Nixon administration when PSAC members, particularly Richard Garwin, openly criticized administration positions.

[14]Committee on Prospering in the Global Economy of the 21^{st} Century, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academies Press, 2005).

intensifying challenge with regard to its future competitiveness and standard of living. Further, we appear to be on a losing path. We are here today hoping both to elevate the nation's awareness of this developing situation and to propose constructive solutions."

Examples he gave of foreign competition included the following:

- U.S. companies each morning receive software that was written in India overnight in time to be tested in the U.S. and returned to India for further production that same evening.
- Drawings for American architectural firms are produced in Brazil.
- U.S. firms' call centers are based in India—where employees are now being taught to speak with a Midwestern accent.
- U.S. hospitals have X-ray and CAT scans read by radiologists in Australia and India.

Augustine and his colleagues emphasized that the United States could compete in the global marketplace in the realm of "knowledge capital." Encouraging the development of ideas and accelerating their conversion into products and processes would require additional federal investment in research and development, and stronger partnerships between the federal government, state and local governments, academia, and private industry—including venture capital companies. Augustine's committee viewed the issue of competitiveness not simply in terms of science policy, but in terms of the U.S. National Innovation System. This was made abundantly clear in the four sets of recommendations in their report:

- "Ten Thousand Teachers, Ten Million Minds"—which addresses America's K-12 education system.
- "Sowing the Seeds"—which addresses America's research base.
- "Brightest and Best"—which addresses higher education.
- "Incentives for Innovation"—in which we address the innovation environment itself.

15.4 American Competitiveness Initiative

Evidently, Bush was listening. In his 2006 State of the Union message, he announced that he would ask Congress to enact an American Competitiveness Initiative. On August 7, 2007, he signed into law the America Competes Act of 2007. During his first term, Bush had not been receptive to pleas for increased R&D support. But in his press conference following the signing of the America Competes Act into law, Bush noted that in his previous State of the Union speech he had asked Congress to "expand America's investments in basic research, so we can support our nation's most creative minds as they explore new frontiers in nanotechnology or supercomputing or alternative energy sources. I asked Congress to strengthen math and science education so our children have the skills they need to compete for the jobs of the future. I asked Congress to make permanent the research and development tax credit, so we can encourage bolder private-sector initiatives in technology."

Congress, however, did not appropriate funds to support Bush's objectives. Although the administration continued to pursue its American Competitiveness Initiative in subsequent budget requests, appropriations enacted by the Congress fell short of meeting such objectives as doubling the budget of the NSF. On the other hand, appropriations for the NSF, the National Institute of Standards and Technology, and the DoE's Science Office did increase substantially over previous years.[15]

15.5 PCAST

When Bush announced his twenty-two candidates for PCAST membership in December 2001, the list included only one working scientist, with more than half coming from industry and many having served under Bush's father.[16] According to Marburger, the "dearth of scientific expertise is deliberate.... The goal is to get advice from leadership in higher education and industry and not necessarily at the scientific level."

[15] During the Reagan Administration, the mandate of the National Bureau of Standards (NBS) was expanded and rechristened as the National Institute of Standards and Technology (NIST).

[16] "Sciencescope," *Science* (December 21, 2001), 2455.

During the Bush administration, PCAST issued considerably fewer public reports than its Clinton administration predecessor. These reports were:

- Maximizing the Contribution of Science and Technology within the Department of Homeland Security
- Assessing U.S. R&D Investment
- Building Out Broadband
- Technology Transfer
- The S&T of Combating Terrorism
- IT Manufacturing and Competitiveness
- Science and Engineering Capabilities
- S&T Collaboration: Ideas for Enhancing European-American Cooperation
- Federal State Cooperation: Improving the Likelihood of Success
- The National Nanotechnology Initiative at Five Years: Assessment and Recommendations of the National Nanotechnology Advisory Panel
- The Energy Imperative: Technology and the Role of Emerging Companies
- Federal Networking and Information Technology R&D (NITRD) Program Review
- The National Nanotechnology Initiative: Second Assessment and Recommendations of the National Nanotechnology Advisory Panel.[17]

15.6 NSTC

The National Science and Technology Council continued to meet regularly with the same federal organizations as it had during the Clinton administration, and continued the practice of ignoring Allan Bromley's wish that only principals attend. Most of the NTSC's business was conducted by standing committees consisting of lower-level member agency staff.[18] The nine committees under Clinton were reduced to four under Bush: Environment and Natural Resources, Homeland and National Security, Science, and Technology.

15.7 Science and International Relations

With the exception of a nuclear treaty with India allowing that country to buy civilian nuclear technology from the U.S. and other countries, the Bush administration made scant use of science as an instrument of foreign policy. This appears now to have been part of a general, if unstated, Bush administration policy of downplaying the importance of science in government.

15.8 Assessment

Although Bush did try to increase the budgets of the National Science Foundation, the National Institute of Standards and Technology, and the Department of Energy, few of his requests survived the congressional appropriations process. And outside of these budget initiatives, his administration has been criticized for muzzling administration scientists who opposed administration ideology, and for doctoring official reports. Although specialists have long recognized that science can and should be only one factor that policymakers consider in coming to a decision, the Bush administration was probably the first in American history to distort rather than simply to marginalize science as an instrument of governance. Bush himself, for example, while not openly advocating creationism, did suggest the legitimacy of teaching intelligent design along with evolution in high school biology classes. He forbade the use of federal funds to harvest embryonic stem cells beyond the lines available when he announced his decision. Perhaps most famously, he persistently ignored mounting evidence for human contributions to global warming, and worldwide calls for action to reduce carbon emissions.

[17] http://www.ostp.gov/cs/pcast/documents_reports (<http://www.ostp.gov/cs/pcast/documents_reports>).
[18] http://www.ostp.gov/cs/nstc (<http://www.ostp.gov/cs/nstc>).

Regardless of some R&D budget increases, the Bush administration's attitudes toward science during its eight years would most likely be regarded as among the darkest in recent memory. Chris Mooney has argued that Bush's adversarial stance towards science is nothing particularly new, since right-wing Republican attacks on science go back as far as the New Deal, and intensified during the Nixon and Reagan administrations.[19] Even so, it appears that Bush was the most eager presidential recruit for the far right's "war on science."

[19] Chris Mooney, *The Republican War on Science* (New York: Basic Books, 2005).

Chapter 16

The First Obama Months[1]

At such a difficult moment, there are those who say we cannot afford to invest in science, that support for research is somehow a luxury at moments defined by necessities. I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before.

—Barack Obama, April 27, 2009[2]

16.1 Recommendations for the Next President

In June 2008, reenacting what had become an election year ritual, a small group convened by the Woodrow Wilson Center for Scholars in Washington, DC, and released a report containing recommendations for the next president.[3] Entitled *OSTP 2.0: Critical Upgrade*, it likened the presidential science advisory system to a software package needing refinement and enhanced utility.

The report is based on interviews with over seventy people, including all living former science advisors except for H. Guyford Stever, science advisor to Presidents Nixon and Ford.[4] The key issues it identified for the next presidential science advisor included:

1. Environmental and energy challenges, such as global climate change;
2. Enhancing U.S. global leadership in innovation;
3. Responding to national security challenges;
4. Assuring that the United States has access to the best and brightest science and technology talent in adequate numbers through improved science and technology education at all levels;
5. Improving health and health care delivery on a foundation of world-class biomedical research, prudent and efficient safety review of new drugs and devices, and the application of information technology;
6. Assessing the future of the U.S. space program, including science, earth observation systems, and the balance between human and non-human exploration as well as the benefits for defense and environmental policy;
7. Finding means of ensuring public understanding of scientific issues and advances as well as technological opportunities.

Predictably, the report called for early selection of a presidential science advisor, preferably between the election and the inauguration.[5] It recommended that the science advisor be restored to the quasi-cabinet-level position of Assistant to the President for Science and Technology, as had been the case during the Bush

[1]This content is available online at <http://cnx.org/content/m34594/1.2/>.
[2]Address at National Academy of Sciences, April 27, 2009.
[3]http://wilsoncenter.org/contact (<http://www.wilsoncenter.org/contact>).
[4]One of the principal authors of the report had worked with Stever, who was too ill to be interviewed, and also reviewed written materials concerning the issues raised.
[5]Although not referenced by the report, this has occurred only once: when President-elect Clinton had announced his

père and Clinton administrations. It also called for restoration of the four presidentially-appointed OSTP associate directors authorized by the OSTP Act of 1976, re-invigoration and more effect use of PCAST and the NSTC, and presidential attendance at PCAST meetings.

16.2 Science in the Presidential Campaign

During the 2008 primary campaigns, the science community seemed intent on reversing trends established during the outgoing Bush administration. The *ScienceDebate2008* initiative invited all presidential candidates to publicly debate federal involvement in key science and technology issues. "The National Academy of Sciences, the National Academy of Engineering, the National Institute of Medicine, the American Association for the Advancement of Science, the Council on Competitiveness, dozens of Nobel laureates and presidents of major universities, former presidential science advisors, and thousands of distinguished scientists, engineers, and concerned citizens joined in the effort [to promote such a debate]."[6] The community undoubtedly was driven to act in part by the spectacle during one Republican primary debate of seeing nearly all the participants raise their hands when asked if they believed in creationism or intelligent design.

Although neither presidential candidate addressed science and technology directly in any public appearance, both did speak extensively about science- and technology-related issues, including alternative, renewable energy resources, the effects of anthropogenic global climate change, and embryonic stem cell research. Neither candidate publicly addressed the level of federal support for R&D until the September 2008 financial crisis obliged them to declare that budgets during their first year in office would be tight,[7] but that federal R&D budgets would not be cut significantly.

Obama sought a great deal of advice on science, most notably from Nobel laureate Harold Varmus, president of the memorial Sloan-Kettering Cancer Center and former director of the National Institutes of Health. Varmus reputedly drafted Obama's answers to an October 2007 Research!America questionnaire in which Obama wrote that he "supports increasing funding at the NIH, the Centers for Disease Control and Prevention, and 'expanding and accelerating research using stem cell lines."'[8]

On December 20—earlier than any of his predecessors—Obama announced the selection of his science advisor, to be designated Assistant to the President for Science and Technology: John Holdren, director of the Science, Technology and Public Policy Program at Harvard's Kennedy School of Government and the Woods Hole Institute.

intention of nominating John Gibbons as director of OSTP during the week after Christmas 1992, when he also announced the names of his intended cabinet.

[6]Sheril R. Kirshenbaum, et. al., "Science and Government: Science and the Candidates," *Science* (April 11, 2008), 182-85.

[7]At the February 2008 annual meeting of the AAAS, a panel discussed the views of the would-be candidates on science and technology-related issues. Senator Hillary Clinton stated during one of the debates among the Democratic candidates that she would, if elected, upgrade the presidential science advisory system.

[8]Bob Grant, "The Future of U.S. Science Policy," *The Scientist* 22 (issue 9), 30-33.

Figure 16.1: Future Presidential Science Advisor John Holdren at a January 2008 Energy Roundtable on Capitol Hill. Left to right: Michael Tamor, Phil Schewe, Holdren, Congressman Steve Israel (D-NY), Rosina Bierbaum, and Fred Dylla. Courtesy AIP Emilio Segre Visual Archives.

Obama subsequently announced that Varmus and MIT Biology professor Eric Lander would be co-chairs of PCAST, and in a February 27, 2009, address to the National Academy of Sciences, he announced his selection of the eighteen PCAST members.

Early on, Obama would also nominate Steven Chu, a Nobel Laureate in Physics and Director of the Lawrence Berkeley National Laboratory, as Secretary of Energy; Jane Lubchenco, a marine biologist from the University of Oregon, as director of NOAA; and NIH Human Genome Project Director Francis Collins as director of the National Institutes of Health. Chu and Lubchenco were the first scientists ever to occupy those positions.

On several occasions, Obama stressed his support for scientific research and education. Most noteworthy, in a November 27, 2009, address to the National Academy of Sciences, he promised to increase the R&D/GDP ratio to 3 percent by the end of his administration.[9]

[9]In 2007, the U.S. R&D/GDP ratio was 2.67 percent, a decrease from its most recent high of 2.81 percent, in 2003. Since industry contributes almost 70 percent of national R&D expenditures as opposed to slightly less than 30 percent for the federal government, a substantial increase in the R&D/GDP ratio would require a substantial increase in industrial as well as federal expenditures.

Figure 16.2: President Barack Obama addressing the National Academy of Sciences, February 27, 2009. Courtesy of the National Academy of Sciences.

A substantial increase in R&D investment, he emphasized, would contribute to the development of less expensive solar cells, learning software that could provide superior computer tutorials, and alternative, clean energy sources. "Energy," he said, "is this generation's great project." He suggested that the United States commit itself to reduce carbon pollution by 50 percent by 2050. To this end, he announced the creation of the Advanced Research Project Agency for Energy—or ARPA-E, analogous to DARPA—in the Department of Energy.[10]

16.3 Early Policy Actions

During his campaign, Obama had noted that bans on government funding for embryonic stem cell research harmed American competitiveness, as it impeded research into potential treatments for Parkinson's, diabetes and Alzheimer's. In March 2009, he ended a Bush-imposed eight-year ban on embryonic stem cell research utilizing cell lines created after August 9, 2001. He promised "strict oversight" of stem cell research and asked the National Institutes of Health to develop new guidelines. The president also instructed the White House Office of Science and Technology Policy to "develop a strategy for restoring scientific integrity" to government decision-making—a step designed to base science on "facts, not ideology."

Of course, the president's nomination of outstanding scientists to serve in his administration constituted a significant early policy action, as Neal Lane wrote approvingly in a *Science* editorial.[11] Lane pointed out

[10] A transcript of Obama's remarks at the National Academy of Sciences is available from that organization.
[11] Neal Lane, "Helping the President," *Science* (April 10, 2009), 147.

that multiple senior advisers now had access to the president, and that his science advisor was only one among many to bring issues to his attention. Thus, the advisor had to cultivate close working relations with key senior White House officials, including the directors of OMB, the National Economic and Domestic Policy Advisors, and the National Security Council.

Figure 16.3: Left to right: White House Economic Advisor Lawrence Summers, Jane Lubchenco, and Steven Chu at the National Academy, February 27, 2009. Courtesy of the National Academy of Sciences.

16.4 The American Recovery and Reinvestment Act

On February 17, 2009, Obama signed into law the American Recovery and Reinvestment Act (commonly known as the stimulus package). The approximately $800 billion package contained more than $30 billion for science and technology, with investments in clean energy, education, basic research, health care, broadband communications, infrastructure, and medical discoveries. Specific R&D increases included:

- National Science Foundation: $3 billion, including $2.5 billion for research and related activities, $400 million for major research equipment and facilities, and $100 million for improving instruction in science, math and engineering.
- National Institutes of Health: $10 billion, including $1.3 billion for the National Center for Research Resources ($1 billion of this for competitive awards, construction and renovation of extramural research facilities); $8.2 billion to the Office of the Director ($7.4 billion for Institutes and Centers and Common Fund); and $500 million for repair and improvement of NIH buildings and facilities.

- Department of Energy: $0.4 billion, including $16.8 million for energy efficiency, renewable energy sources and batteries, and $1.6 million for science programs.
- ARPA-E: $400 million for high-risk, high-payoff research into energy sources and energy efficiency.
- NASA: $1 billion, including $400 million for science, $150 million for aeronautics, and $400 million for exploration.
- National Institute of Standards and Technology: $600 million, including $220 million for research, competitive grants fellowships and equipment, and $360 million for maintenance and construction of NIST facilities.
- U.S. Geological Survey: $140 million for surveys, investigations and research.
- Department of Defense: $300 million for research, testing and evaluation.

16.5 Energy Initiatives

The development of clean, alternative, sustainable energy sources was accorded an early high priority by the Obama administration. To this end, solicitation for ARPA-E's first round of funding awards was made in April 2009; the following October, Secretary of Energy Steven Chu announced the first thirty-seven awards. The lead researchers were in seventeen states, 43 percent of the awardees were small businesses, 35 percent were educational institutions, and 19 percent were large corporations.[12] That December, Chu announced a second round of awards in three categories: Innovative Materials and Processes for Advanced Carbon Capture Technologies; Batteries for Electrical Energy Storage in Transportation; and Electrofuels.[13] Chu also announced a new ARPA-E fellowship program to enable qualified scientists and engineers to spend up to two years working in relevant federal agencies.

This program of funds is unique in at least two ways. The program resulted from the United States being in the worst depression since the 1930s; and the package was generous to several key science and technology-related agencies, the funding designed to foster both energy independence and green technologies. Although it is impossible to say what previous administrations would have done had they encountered the serious economic problems that Obama faced even before he became president, no administration since that of the first President Bush has focused so much attention on science and technology; and no administration in history has earmarked funds for such energy innovation.

In summary, these early actions taken by Obama and his senior advisors demonstrate not only the seriousness with which high-priority national issues are taken, but the conviction that investments in science and technology can help resolve them.

16.6 Budgets

While overall R&D spending in Obama's fiscal year 2010 budget was up only 0.3 percent from 2009, there were some substantial targeted increases. The NSF budget was increased 9.5 percent, to $5.3 billion, the NIST was up 15.8 percent, to $637 million, and the DOE was up 3.3 percent, to $4.5 billion. Despite these and other proposed increases, however, the federal R&D budget as measured in constant 2009 dollars has remained essentially flat since 2004.

[12] *American Institute of Physics Bulletin of Science Policy News* (November 9, 2009).
[13] Ibid., December 10, 2009.

Fig. 14-1
OSTP

continued investments in R&D, technology, and STEM education.

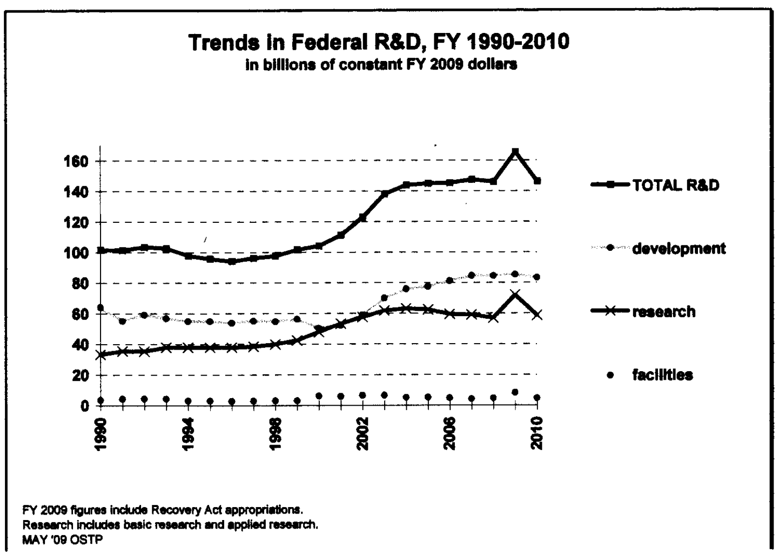

Figure 16.4

Congress had barely begun work on the fiscal year 2010 budget before John Holdren and OMB Director Peter Orszag sent a memorandum to the heads of all federal science and technology agencies instructing them to redirect resources "to science and technology activities that address four practical challenges" in areas such as economic recovery and growth, reducing energy imports and mitigating climate change, improving health while reducing health costs, and national security. OMB and OSTP were interested in increasing research productivity, improving STEM (science, technology, engineering, and mathematics) education, vital infrastructure, and "enhancing our capabilities in space."[14]

Writing in *Science*,[15] Holdren editorialized that he "saw the top S&T priorities in terms of four practical challenges":

- bringing science and technology more fully to bear on driving economic recovery;
- driving the energy-technology innovation needed to reduce energy imports and climate-change risks;

[14] *American Institute of Physics Bulletin of Science Policy News*, *op. cit.* (August 1, 2009).
[15] John P. Holdren, "Science in the White House," *Science* (May 1, 2009), 567.

- applying advances in biomedical science and information technology together to help Americans live longer, healthier lives with reduced health care costs; and
- ensuring that we have the defense, homeland security, and national intelligence technologies required to protect our troops, citizens, and national interests.

16.7 A Strategy for Innovation

In September 2009, the National Economic Council and the Office of Science and Technology Policy issued *A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs.* The paper outlined the Obama administration's approach to rebuilding "a new foundation for durable, sustainable economic growth":

> *Restoring American leadership in fundamental research" is a key factor in promoting economic growth and quality jobs. The Administration's strategy is presented as a three-tiered pyramid, the base of which is labeled* ***"Invest in the Building Blocks of American Innovation."*** *Within this tier, in addition to fundamental research, are education and the creation of a world-class workforce, physical infrastructure, and the development of an advanced information technology ecosystem. The pyramid's second tier,* ***"Promote Competitive Markets that Spur Productive Entrepreneurship,"*** *consists of export promotion, opening capital markets, encouragement of entrepreneurship, and improving public sector and community innovation. The third tier, "****Catalyze Breakthroughs for National Priorities,"*** *includes clean energy, advanced vehicle technologies, health care technology, and an interesting range of grand challenges.*[16]

The document expresses concern that the American economy has relied too heavily on unsustainable, bubble-driven growth in the technology, housing, and financial sectors, resulting in "a short-term focus [that] has neglected essential fundamental investments" in education, physical and technological infrastructure, and health care. "Furthermore," the report continues, "we have compounded the problem by ignoring essential investments in high technology research that will drive future growth. Over the last four decades, Federal funding for the physical, mathematical, and engineering sciences has declined by half as a percent of GDP (from 0.25 percent to 0.13 percent) while other countries have substantially increased their research budgets." The report also highlighted the administration's approach to R&D funding:

> *The recent crisis illustrates that the free market itself does not promote the long-term benefit of society, and that certain fundamental investments and regulations are necessary to promote the social good. This is particularly true in the case of investments for research and development, where knowledge spillovers and other externalities ensure that the private sector will under-invest—especially in the most basic of research. . . .*
>
> *The true choice in innovation is not between government and no government, but about the right type of government involvement in support of innovation. A modern, practical approach recognizes both the need for fundamental support and the hazards of overzealous government intervention. The government should make sure individuals and businesses have the tools and support to take risks and innovate, but should not dictate what risks they take.*
>
> *We propose to strike a balance by investing in the building blocks that only the government can provide, setting an open and competitive environment for businesses and individuals to experiment and grow, and by providing extra catalysts to jumpstart innovation in sectors of national importance. In this way, we will harness the inherent ingenuity of the American people and a dynamic private sector to generate innovations that help ensure the next expansion is more solid, broad-based, and beneficial than previous ones.*

[16] *American Institute of Physics Bulletin*, *op. cit.* (Oct. 13, 2009).

16.8 Space Policy: The Augustine Committee Review

In 2004, the Bush administration approved a plan for NASA to build a base on the moon by 2020 at latest, to be used as a platform for launching humans to Mars.[17] Although considerable skepticism was voiced at that time and since, the first phases of the plan were at least sufficiently concrete to permit a reasonable estimate of its cost. For that reason, many in Congress oppose major deviations from the plan. The plan also envisions retiring the Space Shuttle in 2010 in favor of a new launcher called Constellation, which would be used for constructing the proposed moon base.

During the spring of 2009, President Obama appointed a Committee to Review U.S. Human Space Flight Plans, chaired by Norman Augustine, retired CEO of the Lockheed Martin Corporation. A summary of the resulting Augustine committee report was released early in September, in time for hearings before the House Science and Technology Committee on September 15-16. The complete 115-page report was released on October 22.

The committee report made no recommendations, but suggested several options that NASA should consider.[18] These included:

- That the administration's fiscal year 2010 budget request be increased by $3 million, with comparable increases in future years if human space exploration were to continue "in any meaningful way."
- The committee determined that shuttle flights will likely "stretch into the second quarter of 2011," beyond the vehicle's scheduled retirement in 2010. The committee also predicted it "will be at least seven years" before a replacement will provide a U.S. human launch capability.
- The committee found that the return on investment of International Space Station (ISS) to both the United States and the international partners would be significantly enhanced by an extension of ISS life from 2015 to 2020. "It seems unwise to de-orbit the Station after 25 years of assembly and only five years of operational life. Not to extend its operation would significantly impair U.S. ability to develop and lead future international spaceflight partnerships."
- The schedule has slipped for the development of the Constellation program's two launch vehicles, an astronaut capsule and lunar lander. The committee suggested that "a lighter capsule may reduce operational costs," but cautions that a redesign would lead to additional delays and a "significant increase in cost."
- The committee also stated that "it is an appropriate time to consider turning this transport service over to the commercial sector. This approach is not without technical and programmatic risks, but it creates the possibility of lower operating costs for the system and potentially accelerates the availability of U.S. access to low-Earth orbit by about a year, to 2016."

One significant option suggested by the Augustine committee review appeared on the first page of its summary: "Space exploration has become a global enterprise." Noting that the total of other nations' funding for space programs is comparable to that of NASA, the committee recommended that the United States consider partnering with other nations "to chart a path for human expansion into the solar system."

The committee suggested that the ultimate goal of landing humans on Mars was not likely for fifteen to twenty years. However, "there is great merit in having some interim milestones along the way to Mars [such as landing on one or more asteroids] where you can point to significant scientific and technological accomplishments."[19]

Obama accepted the principal points in this report, including cancellation of the Constellation program. His fiscal year 2011 budget request canceled Constellation funding; as an alternative, it encouraged the development of private-sector capabilities to carry astronauts into low-earth orbit vehicles and eventually back to the moon. In an April 2010 address to the staff of NASA headquarters in Texas, he sympathized with those who were concerned about their jobs. However, he emphasized that the advent of greater involvement of the private sector in space would create additional, more promising jobs in the long term.

[17] Andrew Lawler, "Obama Facing Tough Decision on Whether to Keep Aiming for the Moon," *Science* (Sept. 25, 2009), 1616-07.

[18] *American Institute of Physics Bulletin*, *op. cit.* (Sept. 11, 2009).

[19] Lawler, *op. cit.*

16.9 Obama Administration Priority Issues

The president's emphasis on developing alternative energy sources to reduce dependence on foreign oil and to reduce dangerous greenhouse gas emissions has met with some success. His initiatives had both the federal government and several states subsidizing two of the best-known forms of sustainable energy sources: solar and wind power. Although alternative energy sources have a promising future, there was also general agreement in the administration and elsewhere that they will not replace more conventional sources for many years. Early in the spring of 2010, the administration signaled its understanding of the problem when it issued a statement specifying a mix of technologies required for the nation's energy future. As might have been anticipated, the development of alternative energy sources were assigned high priorities. So was a revival of nuclear fission. Surprisingly, the list also included a lifting of the moratorium on offshore drilling, reflecting the reality that many years would be required to reduce reliance on petroleum significantly.

Unfortunately, in mid-April the oil rig Deepwater Horizon, operated by British Petroleum in the Gulf of Mexico, exploded and sank, leading to the most disastrous oil spill in U.S. history. The Obama administration was criticized for failing to sufficiently oversee offshore drilling. It was also criticized for not recognizing the seriousness of the problem at first. By early June, after many futile efforts, BP managed to place a dome over the leak and partially reduce its flow. Two relief wells were being drilled, but these would not be effective until August. At any rate, the administration announced a moratorium on future drilling.

16.10 NCST/PCAST

PCAST has stressed the need for improvement in STEM education, particularly at the precollege levels. This emphasis is consistent with the scientific community's decision to rise to the president's challenge with a nationwide Educate to Innovate campaign,[20] which is supported by several professional science and engineering societies, including the American Institute of Physics, the American Physical Society, the American Chemical Society, and the International Institute of Electrical and Electronics Engineers. The objective is to draw attention to STEM subjects, boost student interest in these fields and see thousands of volunteer scientists enter classrooms and work with educators. The highlight of the campaign was a National Lab Day during the first week of May 2010, which brought volunteer scientists and engineers to schools to demonstrate STEM concepts, donate or repair lab equipment, arrange or host field trips, and develop and oversee hands-on learning supplements.

At its May 21, 2010, meeting, Science Advisor Holdren characterized the current PCAST as "the most active and productive PCAST in history."[21] At that same meeting, PCAST announced that it was working on a report on influenza vaccinology, and had briefed the president on its progress during March.

16.11 Assessment

Whether Obama's commitment to science policy as demonstrated by his fiscal year 2010 budget request and his obvious understanding of essential science programs would translate into effective use of the presidential science advisory system at his disposal was still an open question in the summer of 2010. Many in the scientific community welcomed Obama's election and, as expected, his administration has been more friendly to scientific and engineering research and education than was his predecessor's, and his policies on such hot-button issues as stem cell research and global climate change are science-friendly rather than ideologically driven. With the exceptions of President Ford and the first President Bush, presidents have rarely come into office with an understanding or appreciation of the science policy tools at their disposal. At this writing, the Obama administration, less than two years old, seems poised—electoral politics permitting—to amply justify the expectations of those in the scientific community who welcomed his election.

[20]Ibid., No. 140 (November 24, 2009).

[21]*FYI: The AIP Bulletin of Science Policy News* (June 2, 2010).

However, these supporters recognize that the president will continue to wrestle for some time with the effects of the economic downturn he inherited. Even some of these supporters are becoming skeptical about whether his much-vaunted economic stimulus package will bring about the full economic recovery that would allow for greater progress in his science-policy initiatives.

Chapter 17

Afterword[1]

The premise of this book holds that the concept of a national science policy derives from three goals: that science be an effective tool for governance; that science serve the public good; and that science help provide national defense. The first was stated definitively by the Delano Committee in its 1938 report, *Relation of the Federal Government to Research*; the second by *Science—the Endless Frontier* and the public and congressional debates in the aftermath of World War II; and the third by considerably less-than-public debates and planning.

Governance, science, technology, and national defense have all grown significantly more complex since World War II. Although the New Deal significantly expanded the scope of issues in which the federal government could claim a legitimate stake, the scope of issues has further expanded since then. Additionally, debates about how and when the federal government should participate in scientific work have become more contentious.

How then, with an endless pattern of reversals, a rigorously inconsistent application of political philosophy to science policy, can science be used as an effective tool for governance as first suggested by *Relation of the Federal Government to Research*?

Although most scientists believe that science is—or at least should be—free from politics, this is not the case with science *policy*. Science policy has, from Roosevelt's time on, been enmeshed in domestic politics. Yet it is an oversimplification to suggest that science policy has progressed better under liberal presidential administrations than under conservative ones. It is true that science policy flourished during the Civil War era, when southern conservatives were sitting in the Confederate Congress in Richmond. Likewise, the progressive Roosevelt administration did far more than its conservative predecessor, the Hoover administration. A similar progressive reversal of conservative policies is under way as this book is going to press, with the Obama administration reversing Bush administration policies shutting down stem cell research and work on global climate change.

Still, effective science policy hasn't necessarily equated with liberal politics. Dwight Eisenhower created and made effective use of the presidential science advisory system. Gerald Ford worked closely with the scientific community and both houses of Congress to enact the National Science and Technology Policy, Organization and Priorities Act of 1976 (PL 94-282), the most far-reaching piece of science legislation in American history. The politically liberal Carter administration ignored the features of this legislation deemed most important by Congress. It was a Republican—the first President Bush—who first took seriously both the substance and the spirit of the act. In appointing D. Allan Bromley as his Assistant for Science and Technology, Bush selected and supported a scientist who was arguably the most effective science advisor since the position was created in 1957.

There is no question, however, that science policy changes—sometimes even reverses—with the political environment. A given presidential administration might conceivably formulate a coherent national science policy, but elements subject to congressional approval might be watered down or eliminated; and the next

[1] This content is available online at <http://cnx.org/content/m34595/1.1/>.

administration, particularly if from the opposite party, tends more often than not to undo the work of its predecessor.

Still, although science policy has moved along in fits and starts since the Constitutional Convention and particularly since the New Deal, it has, in general, progressed. For the past forty years, there more often than not has been bipartisan agreement on the core idea that the federal government should support research in universities and nurture the next generation of scientists and engineers. This book has tried to demonstrate that although there have been numerous set-backs, the body politic has shown remarkable adaptability in making effective use of science in the service of governance. This is not to say that it will ever be possible in our democracy to formulate and implement a coherent, long-term science policy; but it is to say that science will be used to increasingly good effect in addressing the nation's significant challenges.

In the opinion of this author, the quest for a coherent national science policy (not to be confused with a rigid policy that takes no account of changing national and international circumstances) is worth pursuing, even though it may persistently prove elusive. "Research," as Franklin Roosevelt wrote in 1937, "is one of the Nation's very greatest resources and the role of the Federal Government in supporting and stimulating it needs to be reexamined." That reexamination will—and should—remain a feature of American politics as long as there are changes in presidential administrations.

Chapter 18

Appendix A: Chronology[1]

18.1 1743

American Philosophical Society founded

18.2 1790

American Academy of Arts and Sciences founded

18.3 1803-05

Lewis and Clark Expedition

18.4 1846

Smithsonian Institution founded

18.5 1848

American Association for the Advancement of Science founded

18.6 1862

Passage of Morrill Act, establishing land-grant colleges

Department of Agriculture established by Congress

18.7 1863

National Academy of Sciences chartered

[1] This content is available online at <http://cnx.org/content/m34596/1.1/>.

18.8 1876

Johns Hopkins University founded

18.9 1878

Coast and Geodetic Survey established

U.S. Geological Survey established

18.10 1884-86

Allison Commission hearings

18.11 1890

Weather Bureau established

18.12 1902

National Bureau of Standards created

18.13 1912

Public Health Service created

18.14 1915

National Advisory Committee on Aeronautics established

18.15 1916

Emphasis on scientific facilities in State of the Union message

National Research Council established by executive order on a temporary basis

18.16 1918

National Research Council established on a permanent basis

18.17 1921

Bureau of the Budget established within Treasury Department

18.18 1923

Social Science Research Council created

Hygienic Laboratory within Public Health Service renamed National Institute of Health

18.19 1933

Science Advisory Board (Compton Board) established

18.20 1935

National Resources Committee established
Science Advisory Board expires

18.21 1937

President's Committee on Administrative Management report released

18.22 1938

Relation of Federal Government to Research, vol. 1 of *Research: a National Resource* released

18.23 1939

Executive Office of the President (EoP) created
Bureau of the Budget moved from Treasury Department to EoP

18.24 1940

National Defense Research Committee established

18.25 1941

Office of Scientific Research and Development established

18.26 1945

Science—the Endless Frontier transmitted to President Truman

18.27 1946

Council of Economic Advisors created within EoP
Atomic Energy Commission created
Office of Naval Research created on permanent basis
President's Scientific Research Board (Steelman Board) created

18.28 1947

Unification of Armed Forces with creation of Department of Defense

National Security Council created within EoP

Secretary of State Marshall announces plan for reconstruction of Europe

A Program for the Nation, vol. 1 of the Steelman Board's *Science and Public Policy*, transmitted to President Truman

18.29 1948

National Institute of Health renamed National Institutes of Health

18.30 1949

Federal Council for Science and Technology established

18.31 1950

National Science Foundation created

18.32 1951

Science Advisory Committee to Office of Defense Mobilization created

18.33 1957

Soviet Union places *Sputnik* into orbit

President's Science Advisory Committee established

18.34 1957

International Geophysical Year begins

18.35 1958

National Defense Education Act signed into law

Defense Advanced Project Agency created within DoD

18.36 1961

Arms Control and Disarmament Agency created

18.37 1962

Office of Science and Technology created within EoP

18.38 1963

Nuclear Test Ban treaty ratified by Congress

18.39 1970

Bureau of the Budget renamed Office of Management and Budget

Environmental Protection Agency created

18.40 1972

Office of Technology Assessment created

18.41 1973

Abolition of presidential science advisory system made public

First Asilomar conference

18.42 1975

Energy Research and Development Agency created, absorbing Atomic Energy Commission

Second Asilomar conference

18.43 1976

National Science and Technology Policy, Organization and Priorities Act (PL 94-282) signed into law, establishing: President's Council on Science and Technology; Office of Science and Technology Policy; Federal Coordinating Committee for Science, Engineering and Technology (renamed Federal Council for Science and Technology)

18.44 1977

Department of Energy created

18.45 1980

Bayh Dole Act passed by Congress

18.46 1982

White House Science Council created

18.47 1983

Strategic Defense Initiative proposed

18.48 1990

President's Council of Advisors on Science and Technology created

18.49 1991

President's Information Advisory Committee established

18.50 1992

Critical Technologies Institute created

18.51 1993

Government Performance and Results Act passed by Congress

18.52 1994

National Science and Technology Council created, absorbing and expanding membership of Federal Coordinating Committee for Science, Engineering and Technology

18.53 2001

National Nanotechnology Initiative approved by Congress

18.54 2007

America Competes Act passed by Congress

18.55 2009

American Recovery and Reinvention Act passed by Congress

Chapter 19

Appendix B: Abbreviations and Websites[1]

NB: Websites are given only for organizations that still exist.

19.1 A

AAAS: American Association for the Advancement of Science, www.aaas.org[2]
ACS: American Chemical Society, www.acs.org[3]
AIP: American Institute of Physics, www.aip.org[4]
APS: American Philosophical Society, www.amphilsoc.org[5]
APS: American Physical Society, www.aps.org[6]

19.2 B

BoB: Bureau of the Budget
Bush Report: *Science-the Endless Frontier*, accessible at www.nsf.gov/about/history/vbush1945.jsp[7]

19.3 C

CIA: Central Intelligence Agency, www.cia.gov[8]
CEA: Council of Economic Advisers, www.whitehouse.gov/eop/cea/[9]
CoC: Council on Competitiveness, www.compete.org[10]

[1] This content is available online at <http://cnx.org/content/m34597/1.1/>.
[2] http://cnx.org/content/m34597/latest/www.aaas.org
[3] http://cnx.org/content/m34597/latest/www.acs.org
[4] http://cnx.org/content/m34597/latest/www.aip.org
[5] http://cnx.org/content/m34597/latest/www.amphilsoc.org
[6] http://cnx.org/content/m34597/latest/www.aps.org
[7] http://www.nsf.gov/about/
[8] http://cnx.org/content/m34597/latest/www.cia.gov
[9] http://cnx.org/content/m34597/latest/www.whitehouse.gov/eop/cea/
[10] http://cnx.org/content/m34597/latest/www.compete.org

19.4 D

DARPA: Defense Advanced Research Projects Agency, www.darpa.mil[11]
DoC: Department of Commerce, www.commerce.gov[12]
DoD: Department of Defense, www.defense.gov[13]
DoE: Department of Energy, www.energy.gov[14]
DHS: Department of Homeland Security, www.dhs.gov[15]

19.5 E

ERDA: Energy Research and Development Administration
EPA: Environmental Protection Agency, www.epa.gov[16]
EoP: Executive Office of the President, www.usa.gov/Agencies/Federal/Executive/EOP.shtml[17]

19.6 F

FCST: Federal Council for Science and Technology
FCCSET: Federal Coordinating Committee for Science, Engineering and Technology

19.7 G

GAO, Government Accountability Office, www.gao.gov[18]
GPRA: Government Performance and Results Act www.whitehouse.gov/omb/mgmt-gpra_gplaw2m/[19]

19.8 I

IDA: Institute for Defense Analysis, www.ida.org[20]
IOM: Institute of Medicine: www.iom.edu[21]
ISETAP: Intergovernmental Science, Engineering, and Technology Advisory Panel
IBM: International Business Machines, www.ibm.com[22]
ICSU: International Council of Science, www.icsu.org[23]
IGY: International Geophysical Year

19.9 M

MIT: Massachusetts Institute of Technology, www.mit.edu[24]

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[11] http://cnx.org/content/m34597/latest/www.darpa.mil
[12] http://cnx.org/content/m34597/latest/www.commerce.gov
[13] http://cnx.org/content/m34597/latest/www.defense.gov
[14] http://cnx.org/content/m34597/latest/www.energy.gov
[15] http://cnx.org/content/m34597/latest/www.dhs.gov
[16] http://cnx.org/content/m34597/latest/www.epa.gov
[17] http://www.usa.gov/Agencies/Federal/Executive/EOP.shtml
[18] http://cnx.org/content/m34597/latest/www.gao.gov
[19] http://www.whitehouse.gov/omb/mgmt-gpra_gplaw2m/
[20] http://cnx.org/content/m34597/latest/www.ida.org
[21] http://cnx.org/content/m34597/latest/www.iom.edu
[22] http://cnx.org/content/m34597/latest/www.ibm.com
[23] http://cnx.org/content/m34597/latest/www.icsu.org
[24] http://cnx.org/content/m34597/latest/www.mit.edu

19.10 N

NAE: National Academy of Engineering, www.nae.edu[25]
NAS: National Academy of Sciences, www.nas.edu[26]
NACA: National Advisory Committee for Aeronautics
NASA: National Aeronautics and Space Administration, www.nasa.gov[27]
NOAA: National Oceanic and Atmospheric Administration, www.noaa.gov[28]
NBS: National Bureau of Standards
NIH: National Institutes of Health, www.nih.gov[29]
NIST: National Institute of Standards and Technology, www.nist.gov[30]
NNI: National Nanotechnology Initiative, www.nano.gov[31]
NRC: National Research Council, www.nationalacademies.org/nrc[32]
NDRC: National Defense Research Committee
NSB: National Science Board, www.nsf.gov[33]
NSF: National Science Foundation, www.nas.gov[34]
NSTC: National Science and Technology Council, www.ostp.gov/cs/nstc[35]
NSC: National Security Council www.whitehouse.gov/administration/eop/nsc/[36]

19.11 O

OMB: Office of Management and Budget: www.whitehouse.gov/omb[37]
ONR: Office of Naval Research, www.onr.navy/mil[38]
OSRD, Office of Scientific Research and Development
OST: Office of Science and Technology
OSTP: Office of Science and Technology Policy, www.ostp.gov[39]
OTA: Office of Technology Assessment

19.12 P

PCST: President's Committee on Science and Technology
PCAST: President's Council of Advisors on Science and Technology, www.ostp.gov/pcast[40]
PITAC President's Information Technology Advisory Committee, www.cra.org/Policy/pitac.html[41]
PSAC: President's Science Advisory Committee
Rad Lab: Radiation Laboratory
RANN: Research Applied to National Needs
RDB: Research and Development Board

[25] http://cnx.org/content/m34597/latest/www.nae.edu
[26] http://cnx.org/content/m34597/latest/www.nas.edu
[27] http://cnx.org/content/m34597/latest/www.nasa.gov
[28] http://cnx.org/content/m34597/latest/www.noaa.gov
[29] http://cnx.org/content/m34597/latest/www.nih.gov
[30] http://cnx.org/content/m34597/latest/www.nist.gov
[31] http://cnx.org/content/m34597/latest/www.nano.gov
[32] http://cnx.org/content/m34597/latest/www.nationalacademies.org/nrc
[33] http://www.nsf.gov/
[34] http://cnx.org/content/m34597/latest/www.nas.gov
[35] http://cnx.org/content/m34597/latest/www.ostp.gov/cs/nstc
[36] http://cnx.org/content/m34597/latest/www.whitehouse.gov/administration/eop/nsc/
[37] http://cnx.org/content/m34597/latest/www.whitehouse.gov/omb
[38] http://cnx.org/content/m34597/latest/www.onr.navy/mil
[39] http://cnx.org/content/m34597/latest/www.ostp.gov
[40] http://cnx.org/content/m34597/latest/www.ostp.gov/pcast
[41] http://cnx.org/content/m34597/latest/www.cra.org/Policy/pitac.html

19.13 S

SAC /ODM: Scientific Advisory Committee to the Office of Defense Mobilization
SSRC: Social Science Research Council, www.ssrc.org[42]
SDI: Strategic Defense Initiative
SSC: Superconducting Super Collider
SST: Supersonic Transport
State, Department of State, www.state.gov[43]
STEM, Science, Technology, Engineering, and Mathematics Education

19.14 U

USAID: US Agency for International Development, www.usaid.gov[44]
USDA: Department of Agriculture, www.usda.gov[45]
USGS: US Geological Survey, www.usgs.gov[46]

19.15 W

WHSC: White House Science Council

[42] http://cnx.org/content/m34597/latest/www.ssrc.org
[43] http://cnx.org/content/m34597/latest/www.state.gov
[44] http://cnx.org/content/m34597/latest/www.usaid.gov
[45] http://cnx.org/content/m34597/latest/www.usda.gov
[46] http://cnx.org/content/m34597/latest/www.usgs.gov

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