Chapter 2

Historical and Political Context for Regulation of Research

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In the context of the current extensive and often generous support for scientific and engineering research in the United States, it is easy to forget that, although scientists have always exercised a variety of restraints on their own work, the present governmentally imposed, legally enforceable constraints on research topics, procedures, and communication are relatively new. Most of the current regulatory schemes were developed alongside the post-World War II arrangements for Federal financing of research and were influenced by the political attitudes and assumptions governing those arrangements and how they were instituted.

Before World War II, many scientists considered Federal research grants to private universities—where most basic research was conducted—to be improper if not unconstitutional.[1] In the 1930s, for example, the leaders of the National Academy of Sciences "objected on principle to letting private universities accept government funds."[2] In part, this attitude had to do with the scientists' fears of losing autonomy. Some university research was supported by the professors themselves. They were not required to account to the government for their time or for minor expenditures; "They simply did what research their other duties and their pocketbooks allowed them to do."[3] But objections were also linked to concern that government funding might provide the opportunity for restraints on research, as had happened during wartime. During World War I, for example, scientists had accepted military restrictions on their communications; they were subject to censorship and were, in some cases, persuaded to delay publication until the end of the war.[4] The American Chemical Society had even opposed President Wilson's order transferring gas warfare research from Bureau of Mines control to War Department control, not out of anti-war fervor but because it "feared the numbing effect of the . . . 'red tape' of War Department methods upon the spirit of originality, daring and speed in following new trails, so essential to the successful prosecution of research."[5] The chemists predicted a "national disaster" if the "fast machine" of gas research was slowed. Such attitudes of arms-length cooperation with government were prevalent in the scientific community during the first part of the century.

Before the 1940s, industry supported a substantial proportion of the Nation's research and development (R&D) effort; the Federal Government played a relatively minor part. Scientists in the 1930s felt confident in asserting that "most of our great advances in the past have been through private initiative," including both industry and private foundations.[6] Even as late as 1940, the Federal Government paid only for about 19 percent of the Nation's $345 million expenditures for scientific research and development.[7]

Since 1940, these funding patterns have changed dramatically and, along with them, the regulatory environment for U.S. research in science and

[1] Don K. Price, "Endless Frontier or Bureaucratic Morass?" *The Limits of Scientific inquiry,* Gerald Holton and Robert S, Morison (eds.) (New York: W.W. Norton & Co., 1979), pp. 75-92.

[2] Ibid. In 1945, Frank B. Jewett, President of the National Academy of Sciences and also of Bell Labs, opposed the creation of the National Science Foundation on these grounds. In letters to Vannevar Bush, Jewett stated that private initiative should furnish the means for fundamental research:

> Every direct or indirect subvention by Government is not only coupled inevitably with bureaucratic types of control, but likewise with political control and with the urge to create pressure groups seeking to advance special interests

Merton J. England, A *Patron for Pure Science* (Washington, DC: National Science Foundation, 1982), p. 35,

[3] James Penick, Jr., et al. (eds.), *Politics of American Science, 1930 to the Present* (Cambridge, MA: The MIT Press, 1972), p. 7.

[4] A. Hunter Dupree, *Science in the Federal Government (Cambridge, MA: Harvard University Press, 1957)*; also see Harold C. Relyea, "Increased National Security Controls on Scientific Communication," *Government Information Quarterly*, vol. 1, No. 2, 1984, pp. 187-188.

[5] David Rhees, American Philosophical Society, personal communication, 1985,

[6] Robert H. Kargon (ed.), *The Maturing of American Science* (Washington, DC: American Association for the Advancement of Science, 1974).

[7] John R. Steelman, *Science and Public Policy*, vol. 1 (New York: Arno Press, reprinted from 1947), p. 11.

engineering. As the Federal Government has assumed an ever larger share of all U.S. research funding, the institutional responsibility for nourishing the research system has begun to shift. In 1960, the government was funding about 57 percent of all basic and applied research in the United States; industry, 37 percent; universities, 3 percent. By 1985, the government's share was nearly 50 percent; industry's, over 41 percent; and universities', 6 percent. The responsibility for basic research also appears to be shifting to the Federal Government (from 60 percent in 1960 to almost 67 percent in 1985) while the responsibility for applied research has shifted to industry (from 40 percent in 1960 to nearly 55 percent in 1985). (See table 2-l.) Who funds and sponsors research can have considerable impact on the locus for regulation and on the type of regulatory mechanism chosen. The shifts of funding source in the last 5 to 10 years, therefore, may be one explanation for the signs of strain described in this report, as industry becomes subjected to regulations originally intended for basic research conducted in a university setting (e.g., recombinant DNA regulation), and universities are asked to comply with regulations originally intended for industry.

Table 2-1 .—Funding of Research and Development by Source in 1960 and 1985

	1960	1985
Basic research:		
Federal Government.	60.00/0	66.60/0
Industry	28.5	18.7
Universities/colleges	6.0	10.0
Applied research:		
Federal Government.	56.0	39.7
Industry	40.0	54.6
Universities/colleges	2.0	3.6
Basic and applied research:		
Federal Government.	57.0	49.5
Industry	37.0	41.4
Universities/colleges	3.0	6.0
Development:		
Federal Government.	68.0	45.2
Industry	31.6	54.3
Universities/colleges	—	—
Research and development:		
Federal Government.	64.6	46.7
Industry	33.4	50.0
Universities/colleges	1.0	2.0

SOURCE: Division of Science Resources Studies, National Science Foundation, 1985

Prior to the postwar infusion of Federal funds, government aid to science in the universities had also been managed with a philosophy of "loose control''—sponsors of unclassified research left the researchers more or less free to conduct their research as they believed scientifically appropriate and free to disseminate their results, subject to minor supervision and general accountability. The scientists perceived any threat to their autonomy as a questioning of their authority and expertise, During World War II, of course, that autonomy had been curtailed, but after the wartime security restrictions were lifted, government control of research tended to return to the prewar management model, expressing a basic political trust in the productiveness and reliability of scientists. George Pimentel, Professor of Chemistry at the University of California at Berkeley, characterizes that post-1945 philosophy as one of "fund creative people, but don't tell them what to do."[8] Especially over the last 40 years, however, the climate of unassailable autonomy has evolved into the current climate of strong economic support coupled with attentive direction. Researchers now operate in a mixed environment of incentives and restrictions,[9] which often replace scientists' own professional judgments about what subjects to work on and how to proceed.

A quite different shift in emphasis has also occurred in where the research is performed and therefore in who actually does the research. In 1940, 70 percent of government-funded basic research took place in government facilities. By 1944, only 30 percent was performed in government facilities; 50 percent was performed by private firms; and 20 percent in universities.[10] After the war, the pattern of funding again changed, but the distribution among performers remained similar. Industrial spending for R&D began to increase. By 1982, industry was carrying out even more of the Nation's research (72 percent); universities, 9 percent; Federally Funded Research and

[8]U. S. Congress, House Committee on Science and Technology, Science Policy Task Force, Hearing, Feb. 28, 1985.

[9]Thane Gustafson, "Survey of the Structure and Policies of the U.S. Federal Government for the Support of Fundamental Scientific Research, " *Systems for Stimulating the Development of Basic Research* Washington, DC: National Academy of Sciences, 1978), p. I-82.

[10]David Noble, *The Forces of Production* (New York: Alfred A. Knopf, Inc., 1984).

Development Centers, 3 percent; nonprofit institutions, 3 percent; and government labs, 13 percent. " The impact of this shift was to extend government control of research—through grant and contract provisions—into the private sector.

Finally, the discovery during World War II–and in the subsequent U.S. nuclear program—that basic research could have considerable value for maintaining the Nation's military security led to a fourth change in how science was funded and organized. Increased Department of Defense spending led to an increased proportion of research either totally classified—and hence performed away from traditional research networks—or else having the potential for classification (or similar control) because of its potential military applications. The course of the last **40** years has also seen significant shifts in the proportion of basic research sustained by the defense agencies and, as a consequence, shifts in the climate of more or less classification of new areas of basic research.

[11] William C. Boesman, Science Policy Research Division, "U.S. Civilian and Defense Research and Development Funding, " Report No. 83-183, Congressional Research Service, Aug. 29, 1983.

CHANGING POLITICAL CONCERNS*

Before World War II, national politics had only minimal influence on the research agenda for science and engineering. Because the Federal Government funded very little university research, for example, it did not have the administrative mechanisms for exerting influence. Only in a few selected fields, such as agriculture, did the agenda respond to political influence. 12 Moreover, even if scientists wanted society to benefit from their activities, the traditions of science offered no patterns to guide them and few mechanisms through which to provide advice to society. Scientists who were distrustful of government argued that financial dependence on government might damage the "autonomy of their intellectual activities" in unpredictable ways.[13]

This independence was put aside temporarily during World War II, when thousands of scientists and engineers worked, either as military or civilian personnel, in such government research projects as the Committee on Medical Research (part of the Office of Scientific Research and Development (OSRD)) and the Manhattan Project. Most were required to shift to a different line of research. They conducted their inquiries under government control and with government funding. Although new and different, this relationship with government proved to be successful for both parties.

As the war was ending, the scientists who had been administering the Federal research effort began to discuss how the science-government relationship might be sustained and structured after the war, The incentives were many. Not only had World War 11 fostered the creation of a formal administrative relationship between government and science but the results of scientific projects such as radar and penicillin had also demonstrated the power and potential of government-funded, government-directed science. By and large, the community of scientists and friends of science agreed on the need for a government agency to channel funding for basic research. They disagreed, however, about the institutional structure of such an organization and about who would exercise (and to what extent) political control over the research agenda .14

There were two well-defined perspectives on how the postwar relationship should be structured. The most prominent spokesman for a model of loose Federal control was Vannevar Bush, a Massachusetts Institute of Technology engineer who was Director of the wartime Office of Scientific Research and Development, President of the Carnegie Institution of Washington, and

*This section benefits from work done at OTA by George Hoberg, Massachusetts Institute of Technology, in August 1984.

[12] André Mayer and Jean Mayer, "Agriculture: The Island Empire, " *Daedalus*, vol. *103*, summer 1974, pp. 83-96,

[13] Lewis E, Auerbach, "Scientists in the New Deal, " *Minerva*, vol. 3, summer 1965, pp. 457-482.

[14] Noble, op. cit., p. 192.

a principal science advisor to President Roosevelt. Actively opposed to the Bush position was Senator Harley Kilgore, (D-WV), who was supported by such scientists as Harold C. Urey, Edward U. Condon, and Harlow Shapley. A group within the executive branch, led by Presidential Assistant John R. Steelman, also opposed the Bush position and participated in the postwar debate on how the National Science Foundation would be structured.

Bush's perspective on control of research was most clearly articulated in the 1945 report Science —The Endless *Frontier.* Written at President Roosevelt's request, the "Bush report" outlined a plan for organizing science after the war. Bush wanted to create a secure funding base for American scientific research while protecting science's traditional independence in matters of agenda, procedure, and communication. Because there had been such clear separation between science and government before the war (and because the circumstances that had brought them together during the war were clearly unusual), the Bush report had to construct a basic argument for support. It found the justification in a classic American metaphor: "Basic United States policy" had traditionally been to advance all types of frontiers, thus the Federal Government must take on new funding responsibilities to assure adequate cultivation of those "areas of science in which the public interest is acute" but where private sources may not supply sufficient resources.[15] "Scientific progress is essential, " the Bush report stated, to wage war on disease, to assure the future of American industry, and to prevent future military conflicts.[16]

In its plan for how such responsibilities would be fulfilled, the Bush report provides a measure for subsequent change in the regulation and control of research. The report proposed five principles to guide the government's new role in science: 1) Whatever the extent of support may be, there must be stability of funds over a period of years so that scientists may undertake long-range research programs. 2) The agency to administer such funds should be composed of citizens selected only on the basis of their interest in and capacity to promote the work of the agency. They should be persons who understand the peculiarities of scientific research and education, but need not be scientists. 3) The agency should promote research through contracts or grants to organizations outside the Federal Government, but should not operate any laboratories of its own. 4) Control of policy, personnel, and the method and scope of supported research should be left to the research institutions themselves. 5) And finally, the agency should be responsible to the President in that policies and procedures would be guided by the executive branch. The advocated policy was that "scientists should have control over how these funds were distributed, to ensure that the best science was supported as it had been by OSRD during the war."[17] Bush was not, however, "asking for free access to the Treasury; funds expended in this way would represent only a small proportion of those spent on research and development through the mission agencies of the Executive Branch . . . ."[18]

Although the report acknowledged the necessity of wartime security restrictions, it advocated that, when the war was over, scientists should once again enjoy freedom of inquiry. Controls should also be lifted on scientific information—especially that related to medicine—of potential use to civilian institutions.[19] Bush believed that removing the wartime controls would help to recover "that healthy competitive scientific spirit so necessary for expansion of the frontiers of scientific knowledge. "[20] Scientific progress, the report continued, results from "the free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown. "[21] And open publication of the research would be to the benefit of the Nation.

[15] Vannevar Bush, *Science—The Endless Frontier,* a report to the President on a Program for Postwar Scientific Research (Washington, DC: National Science Foundation, 1980 (reprinted from Office of Scientific Research and Development, 1945)), p. 12.

[16] Ibid., p. 5,

[17] Alex Roland, testimony before the U.S. Congress, House Committee on Science and Technology, Science Policy Task Force, Mar. 7, 1985.

[18] Ibid.

[19] Bush, op. cit. , p. 28.

[20] Ibid., p. 12.

[21] Ibid,

One of the committees that assisted Bush, the Committee on Science and the Public Welfare, * gave strong support to the idea that traditional models of university research be preserved. University research must not be "distorted" by the government's encouragement to examine short-range problems at the expense of more fundamental problems, for ". . . the freedom of the scientist may be decreased by the introduction of some degree of commercial control. "[22] Society must guard science against too much control by industry as well as by government. That committee urged the new agency "to devise ways and means of allocating funds in large measure *without determining what particular problems are to be worked on and who is to carry them out.* " "Variety" and "decentralization" foster novelty, they wrote.[23]

The Medical Advisory Committee voiced similar concerns. If Federal aid was "misdirected, " it could do "serious harm" to the development of medical science. Therefore, the new agency's direction and policies should be administered by people "who are experienced in research and who understand the problems of the investigator. "[24] The government should encourage "individual initiative and freedom of research. " Control that is too close (or, in the Committee's words, "regimentation") could lead to "mediocre work" and "disastrous impairment . . . of research itself. "[25]

Industry-based research, if it was to flourish after the war, also required some special arrangements. Patent laws designed to "stimulate new inventions" would "make it possible for new industries to be built around new jobs and new processes" and would help small industries, the Bush committees asserted. Although they were concerned about the domination of markets by big industry, the committees did not support government ownership of patents;[26] patent policy was to be left to the discretion of the new science agency's governing board .27

These and many other of the Bush report's recommendations were subsequently incorporated in legislation (which Bush helped to draft) introduced by Senator Warren Magnuson (D-WA) in 1945.

The Bush report did not, however, represent a consensus in either the scientific or political communities. During the war, Senator Harley Kilgore held a series of hearings on post-war planning for science, before a subcommittee of the Senate Committee on Military Affairs. And in 1945, he introduced a bill which expressed his ideas for a national science foundation. He favored a director who was appointed by and much more politically responsible to the President than had been advocated in the Bush report. Moreover, Kilgore's position was that "organizations receiving funds should be free to conduct their research and development work in a manner which they think most productive, subject only to a routine supervision and review by the foundation. "[28]

Soon after the publication of *Science— The Endless Frontier*, President Truman's Scientific Research Board, objecting to what they considered to be an "underlying anti-democratic sentiment" in the Bush report, issued their own report. The White House study, directed by John R. Steelman, placed the basic questions of science policy in a political context: "Public policy cannot be shaped in a vacuum and recommendations for a national policy on science must necessarily reflect many considerations but remotely connected with the laboratory. "[29]

The "Steelman report" was just as effusive as the Bush report in its praise of the social benefits emanating from scientific advance and in the tone of its underlying rationale for support of science: "It is difficult to think of any other national activity which more directly benefits all the people or which makes a larger contribution to the national welfare and security. "[30] But, despite agreement on the need for a significant Federal role in fund-

*Chairman of the Committee was Isaiah Bowman, President of the Johns Hopkins University.

[22] Bush, op. cit , p. 91

[23] Ibid., p 94

[24] Ibid., p. 02

[25] Ibid p 03

[26] Daniel Kevles, *The Physicists* (New York: Alfred A. Knopf, Inc , 1978), pp. 342-344,

[27] Merton J. England, *A Patron for Pure Science* (Washington, DC: National Science Foundation, 1982), p. 14

[28] Penick, et al., op. cit., vol 1, p. 6

[29] Steelman, op cit., vol. 1, p. 6.

[30] Ibid., vol 1, p, 26.

ing basic science and in training scientific personnel, the reports differed on the organization of funding and on the control of the research process. The Steelman report did not object to funding research in government laboratories; it recommended maintaining the extant distribution of funds among universities, industry, and government labs[31] and it recommended that the new agency's director be appointed by and responsible to the President.

The Steelman report also concluded that government security regulations should not be applied widely but instead should be applied "only when strictly necessary and then limited to specific instruments, machines or processes. They should not attempt to cover basic principles or fundamental knowledge. "[32] In the conclusion to Volume I, "A Program for the Nation, " the report states:[33]

> . . . it is sometimes argued that . . . the world is in its present state because the physical sciences have developed too rapidly and have unleashed forces too strong for us to control. It has even been suggested that a moratorium should be called in science, while we catch our breaths.
>
> This is a doctrine of weaklings and of men of little faith in the ultimate capacity of our people. There can never be too much knowledge, though it can be discovered at uneven rates in various fields. The cure is not to slow down the runner who is ahead—but to extend a helping hand to those who are behind.

The differences between the Bush and Steelman reports represented more than the usual political disagreements about the administration of a new agency. They reflected fundamentally different conceptions of the relationship between government and science. The political perspective represented by the Kilgore hearings and the Steelman report regarded science as a special interest. Although large-scale government support for science was a new phenomenon, science was not considered to be sufficiently different from other policy areas to warrant any special political relationships.[34] The characteristics of science were not believed to "justify a departure from our traditions of democratic government or from tested principles of administrative organization, "[35] including the principles of close accountability and avoidance of the concentration of power.

The conservative view represented by the Bush report regarded government intervention as a potential threat to scientific liberty,[36] an attitude viewed by some as reflecting a lack of faith in the competence of government administrators. But the Bush report supporters were also convinced that science was distinct from other types of government programs, that it must be free from political control, and that, to be successful, scientists should be able to direct their own affairs. Non-scientists might administer the foundation but it would be the scientists who, through advisory groups and a system of review by scientific peers, would decide how research should be conducted and would influence the research agenda, This demand to have "support without control, " according to one commentator, amounted to "bestowing upon science a unique and privileged place in the public process—in sum, for science governed by scientists, and paid for by the publie. "[37]

On July 22, 1947, Congress passed legislation (S.526, National Science Foundation Act of 1947, 80th Congress, 1st session) to establish a National Science Foundation (NSF), This legislation contained no patent provisions, no authority for support for the social sciences, no mechanisms for geographical distribution, and a large degree of autonomy from Presidential control .38 The governing structure was the most important point of argument, however. When President Harry Truman vetoed this first NSF legislation, he objected primarily to the bill's provisions for lack of political control. In his veto message, Truman stated:[39]

> . . . this bill contains provisions which represent such a marked departure from sound principles

[31] Ibid., vol. 1, p. 27.
[32] Ibid., vol. 3 p. 37.
[33] Ibid., vol. 1, p. 68.
[34] Noble, op. cit., p. 15

[35] Steelman, op. cit., vol. 1, p, 31.
[36] England, op. cit., pp. 35-36,
[37] Daniel S. Greenberg, *The Politics of Pure Science (New* York: New American Library, 1967), p. 107, There was precedent for this arrangement in the National Advisory Committee on Aeronautics (NACA), of which Bush was chairman in 1939. See James Killian, *Sputnik, Scientists and Eisenhower* (Cambridge, MA: The MIT Press 1977).
[38] England, op. cit., pp. 78-80.
[39] *Congressional Record*, vol. 93 (Washington, DC: U.S. Government Printing office, Nov. 17, 1947), p. 10568.

> for the administration of public affairs that I cannot give it my approval. It would, in effect, vest the determination of vital national policies, the expenditure of large public funds, and the administration of important governmental functions in a group of individuals who would be essentially private citizens. The proposed National Science Foundation would be divorced from control by the people to an extent that implies a distinct lack of faith in democratic processes.

Three years later, after extended debate and political maneuvering, another bill was passed by Congress (National Science Foundation Act, May 10, 1950, 64 Stat. 149) and signed by President Truman. This bill represented a compromise between the opposing political groups, but probably reflected the preferences of a substantial portion of the scientific community. The director of the NSF would be appointed by the President, and the bill included a mandate for evaluating and coordinating all Federal research efforts. It also provided that these responsibilities be shared with a part-time National Science Board, organized along the lines suggested by Bush. The bill did not change patent granting procedures.

The Foundation's first director, Alan Waterman, was previously the chief scientist at the Office of Naval Research (ONR). He considered any "centralized evaluation of Federal research impossible and inappropriate. "[40] His experience at ONR undoubtedly influenced the shape he gave to the new foundation, for that agency had maintained an unusual contract research program, especially in basic research. Established by an Act of Congress in 1946, ONR was to "provide scientific liaison with the War Department and with that novel and highly effective civilian organization, the Office of Scientific Research and Development. "[41] The philosophy that guided ONR was best understood in its view of the basic researcher as one "motivated by curiosity and interest in science rather than applicability, " and the administrator as influenced by the agency's "practical mission. " The key was to keep these perspectives separate: "In this way selected mission-related basic research may be supported. . . without controlling or disturbing the aim of the investigator or the course of the research. "[42] The ONR contracting system extended the traditional military R&D contracting with industry to research establishments, particularly academic institutions, thereby enabling the government to utilize the most skilled scientists and engineers available to do weapons research.

After several years of debate between the Budget Bureau, NSF, and other agencies over NSF's role in Federal science policy, on March 19, **1954,** President Eisenhower issued Executive Order 10521 that established the new agency's role.[43] NSF's role in policy development and evaluation was to be "cooperative rather than . . . regulatory. " NSF was not made the principal Federal sponsor of basic research; instead, the order sanctioned a pluralistic system of Federal support. It encouraged other agencies to sponsor basic research that was "closely related to their missions. "[44]

The Order declared that one of the purposes for NSF's establishment had been to develop and encourage pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences. From time to time, NSF would recommend to the President Federal policies that would strengthen the national scientific effort and it would furnish guidance toward defining the responsibilities of the Federal Government in the conduct and support of scientific research. The Foundation, in concert with each Federal agency concerned, would review the scientific research programs and activities of the Federal Government in order to formulate methods for strengthening the administration of such programs and activities by the responsible agencies; it would study areas of basic research where gaps or undesirable overlapping of support may exist; and it would make recommendations to the heads of agencies concerning the support given to basic research.

[40]Kevles, op. cit., p. 360; England, op. cit., p. 149.

[41]Alan T. Waterman, "Pioneering in Federal Support of Basic Research, " *Research in the Service of National Purpose: Proceedings of the Office of Naval Research Vicennial Convocation,* F. Joachim Weyl (cd.) (Washington, DC: Office of Naval Research, 1966), p. 3,

[42]Warren weaver, quoted in Weyl, op. cit., p. 5

[43]England, op. cit., ch. 10.

[44]1 bid., ch. 15.

Sharp divisions over the political control of research were not unique to the debate on the National Science Foundation. In the late 1940s and 1950s, intense debate preceded the creation of both the Atomic Energy Commission (AEC) and the National Aeronautics and Space Administration (NASA), debates that also focused on patent policies, communication restrictions, and mechanisms for political control of each agency.

The legislation creating the Atomic Energy Commission–the Atomic Energy Act of 1946 [Public Law 585] –gave the Federal Government "an absolute monopoly over all aspects of atomic energy research, development, and production, " including provisions to control the dissemination of data related to atomic weapons and the production, or use of fissionable material .45 This tight Federal structure essentially removed control of even peacetime atomic energy research, or research directed at civilian power applications, from the scientific community that had developed the research field in the first place. Moreover, it created a situation in which all atomic weapons or atomic energy information was "born classified." As political analyst Harold Relyea and others have pointed out, these provisions meant that no special governmental effort was necessary to bring such information under the statute's "umbrella of secrecy."[46] The Act also prohibited the issuance of patents for inventions useful in the production or utilization of fissionable material. Although these patent provisions were relaxed somewhat in the subsequent Atomic Energy Act of 1954 and although that revision also authorized the controlled involvement of private industry in nonmilitary atomic technologies, many of the most stringent controls on research initiated by the original Act—including those on who may do such research or have access to technical information for such research—remained in force.

The initial legislation in 1958 to create the National Aeronautics and Space Administration contained language that would have created a much looser policy on patents for that agency. But draft bills in both the House and the Senate, which modeled their patent provisions on the Atomic Energy Act, would have enabled the government to maintain ownership of patents generated by NASA-funded research. The final legislation gave patent ownership to the government, but also gave the administrator of NASA the authority to waive title. Similar discussions and debates over the political control of research or of research products took place during the development of other Federal agencies and programs.

Another critical outcome of the postwar support of science was the burgeoning of the National Institutes of Health (NIH), which before the war had been a small "oldline" Federal health research organization. The Public Health Service had been created in **1912** to increase biomedical research directly related to large public health problems. At the end of the 1920s, an effort to establish NIH promoted a stronger Federal role in the encouragement of research, and in 1930, the Ransdall Act expanded and redesigned the Hygenic Laboratory of the Public Health Service into NIH. Public and congressional desire to find a cure for cancer resulted in the creation of the National Cancer Institute in 1937.

During World War II, advances in biomedical research had helped to demonstrate dramatically the effects of Federal funding of biomedical research. This success reinforced intensive lobbying during the 1950s, by public interest groups and a number of powerful individuals, for aggressive NIH-funded research focused on specific health problems, Congress often responded to this pressure by identifying and funding research areas that had broad public appeal, but that were scientifically misunderstood. The director during this period, James V. Shannon, was able to moderate, however, between the call for targeted research and the need for basic medical research; he persuaded Congress that funding of both basic and applied research was essential to reach the goals of diagnosing and curing disease.

Reflecting on the sweep of events during the formation of the current bureaucratic arrangements for science, Don K. Price has observed that the scientists engaged in constructing these arrangements adopted a three-part tactic to avoid, in particular, the constraints in choice of topic which had characterized pre-war agricultural research .47

[45] Harold C. Relyea, "Information, Secrecy, and Atomic Energy, " New *York University Review of Law and Social Change,* vol. 10, No. 2, 1980-1981.

[46] 1 bid., p. 269.

[47] Price, op. cit., p. 77.

First, they sought to combine research with university teaching. They regarded such an arrangement as "the best way of strengthening basic research in the one setting most free of commercial self-interest or political pressure—the university, "[48] thereby obtaining a stable base from which to defend science's independence against "popular passions or economic self-interest. " Second, they focused on the mechanism of the project grant, because it "offered a tactic to avoid detailed congressional control of funds" and also allowed Federal support to universities "without adopting a general program of aid to higher education. "[49] And third, the pattern of organization proposed by the scientists gave them a political authority not dependent on popular votes .50 In many cases, they gained this control through a growing system "of policy planning by part-time advisers under government grants and contracts. " But as Price notes carefully, the authority gained by the scientists was not the type defensible as a Constitutional right; rather, it was a delegated authority. "[I]t depended on the continued confidence among elected politicians in the assumption on which the tacit bargain was founded—that basic research would lead automatically to fruitful developments. "[51]

[48]Ibid , p. 78
[49]Ibid.

[50]Ibid.
[51]Ibid., p. 80.

THE 1960s: PUBLIC CRITICISM OF SCIENCE

In the 1960s, questioning of several of these basic assumptions began to shape a new political receptivity to science. More and more questions were raised about the negative effects of scientific knowledge, including both its informative value and its use as technology. News reports of calloused abuse of human subjects in scientific experimentation led to political calls for increased social accountability. Vigorous criticism of science came from a number of quarters: intellectual and theological questioning of the philosophical foundations of science; the linking of science with war (which came out of the protest against the Vietnam war and nuclear escalation); concerns about science's "technological side effects" on the environment; and ethical questions about research procedures. As a 1971 Organisation for Economic Co-Operation and Development report, *Science, Growth, and Society,* observed, "Scientific research itself became associated in the minds of many with war, and with environmental and social deterioration resulting from the large-scale application of technology."[52]

It is important to recognize, however, that theological or political efforts to control or regulate research are neither unique to the United States nor new. In 1927, for example, an English cleric suggested that "every physical and chemical laboratory be closed for about ten years to enable society at large to assimilate the staggering amounts of new scientific knowledge. " Although he reportedly spoke partly in jest, the shock of such a suggestion produced considerable reaction in the United States as well and the Bishop's remark became the stimulus for debate over the "primacy of ends over means" and the moral depth of science.[53] In the 1930s, many scientists expressed their apprehension about "anti-intellectuals who wish to impose ideological or theological constraints on research, "[54] and humanists and theologians voiced their concern that science was like an engine out of control. Many of these same concerns cropped up again in the 1960s in several widely-circulated intellectual criticisms of the scientific establishment and social values, such as Herbert Marcuse's *One-Dimensional Man* (1964).

An early example of the 1960s questioning was the controversy that arose over Project Camelot ,[55]

[52]*Science, Growth and Society* (Paris, France: Organisation for Economic Co-Operation and Development, 1971).

[53]Carroll Pursell, " 'A Savage Struck by Lightning': The Idea of A Research Moratorium, 1927 -37," *Lex et Scientia*, vol. 10, October-December 1974, pp. 146-158.
[54]Price, Op. cit., p. 76.
[55]For more extensive discussion of Project *Camelot, see Technical information for Congress*, report to the U.S. Congress, House Committee on Science and Technology, Subcommittee on Science, Research, and Technology, July 1979, pp. 145-179. Also see Irving L. Horowitz, "The Life and Death of Project Camelot, " *Transaction*, November-December 1965, pp. 4-10.

In his 1961 message on the defense budget, President John F. Kennedy, motivated by the first Cuban crisis and growing instability in some developing countries, had proposed to increase the U.S. capability in dealing with "guerilla forces, insurrections, and subversion," by strengthening military resources of anthropological, cultural, and other social science data in relevant geographic regions. The result of this proposal was Project Camelot, a Department of Defense (DOD) project in applied research in the social sciences. The project would have attempted to study the political, economic, and social preconditions of instability and potential Communist usurption of power in several developing countries. Political reaction to the project, however, was strong and significantly negative. Congress opposed DOD intrusion into foreign policy and the military takeover of foreign policy research, and feared the potential damage in foreign relations with Latin American countries. Social scientists were concerned about military sponsorship of social science research and, more generally, about the relationship between the Federal Government and the social science community in the utilization of social science research and data in serving national purposes. As a result of the controversy, Project Camelot was eventually suspended.

Later in the decade, as the universities became the institutional arena for protest against the Vietnam War, some of that activity was directed against university involvement in scientific research supported by the Department of Defense. Boycotts and petitions were spearheaded by Scientists and Engineers for Social and Political Action, later renamed Science for the People. One of its founders, Charles Schwartz, described the animating beliefs of this group as a reaction to the "specific corruption of science": "Science as a whole is being abused by the powerful political, industrial and military interests, and we are all losers."[56] This political movement was strengthened when scientists at over **30** schools, following the lead of scientists at Harvard University and Massachusetts Institute of Technology, held a work stoppage for one day on March 4, 1969, interrupting their research to protest the war and the use of science for military purposes.[57] At some institutions, the result of such activities was that classified weapons research was transferred to laboratories that were off-campus and separately administered.

Concerns about military domination of academic science were not confined to campus activists and scientists. Senator William J. Fulbright proclaimed in a 1967 Senate speech:[58]

> The universities might have formed an effective counterweight to the military-industrial complex by strengthening their emphasis on traditional values of our democracy, but many of our leading universities have instead joined the monolith, adding greatly to its power and influence.

Acting on these concerns, Congress passed an amendment in August 1969 to the Defense Authorization Bill of 1970 which included language prohibiting DOD from funding basic research not directly related to a specific military function or operation. Called the "Mansfield Amendment" after Senator Mike Mansfield (D-MT), who was a cosponsor and one of its most outspoken defenders, Section 203 of Public Law 91-121 sought to realign the funding patterns for basic science:[59]

> The intent of the provision is clear. It is a mandate to reduce the research community's dependence on the Defense Department when it appears that the investigation under consideration could be sponsored more reasonably by a civilian agency. After all, the National Science Foundation was created by Congress back in 1950 specifically to channel federal funds into basic research.

Mansfield proclaimed that the amendment was "neither anti-military nor anti-research"; rather, its intention was to reinforce the role of the NSF as the "primary source" of basic research funds, because the role of DOD in sponsoring basic research was "intended to be incidental rather than predominant."[60]

[56] Penick, et al., op. cit., p. 430.

[57] Jonathan Allen (cd.), *March 4: Scientists, Students, and Society* (Cambridge, MA: The MIT Press, 1970).

[58] David Dickson, *The New Politics of Science* (New York: pantheon, 1984).

[59] U. S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, "National Science Policy," Hearings on H. Con. Res. 666, U.S. House of Representatives, 91st Cong., 2d sess., 1970.

[60] Penick, et al., Op. cit., pp. 344-346. Also see Rodney W. Nichols, "Mission-Oriented R& D," Science, vol. 172, Apr. 2, 1971, pp. 29-37.

The direct and immediate effect of the Mansfield Amendment was not very great. It was legally in effect for only 1 year and was not renewed. Only 220 of the 6,600 research projects that were reviewed were affected by the amendment, involving a total of $8.8 million, or only 4 percent of Defense funds for academic research. In the following year, the amendment's language was changed from "direct and apparent relationship" to military needs, to "in the opinion of the Secretary of the Defense, a potential relationship."[61] Nevertheless, the Mansfield Amendment did signify a change in policy toward the support of basic science, and in the words of former Presidential science advisor, Edward E, David, Jr., "its influence has continued to be felt throughout the Department of Defense . . . [and] it has drastically reduced the willingness of many other Federal agencies to fund basic scientific work that cannot be clearly related to their current missions."[62] The amendment appears to have created a climate of greater caution and uncertainty in making research grants, not only in DOD but in other agencies.

By the 1960s, the Federal agencies were also playing an active role in shaping the Nation's environmental future, often without any clear statement of national environmental policy. The U.S. Bureau of Reclamation, the U.S. Corps of Engineers, the U. S. Department of Agriculture, the Federal Highway Administration, and similar agencies had been reshaping the landscape.[63] Their actions, however, were not always benign; some appeared to result in inadvertent, unanticipated degradation of the environment or destruction of plant or animal species, or chemical contamination of waterways. Although some of the environmental degradation may have actually been due more to deployment and expansion in the scale of old technologies, or due to actions taken to accomplish political goals, the negative effects were often blamed on science and technology.

A legislative result of this concern was the passage of the National Environmental Policy Act of 1969 (NEPA), which focused on the Federal Government's role in shaping and protecting the environment. The legislation gave a message that there was a need to anticipate environmental impact and to do some of that through research. Lynton Caldwell has observed that: "The task set for its authors was to redirect national policy toward the environment, " but "the method was procedural reform, " including the instigation of research.[64] In attempting to make Federal agencies accountable for "actions that significantly affected the quality of the human environment,"[65] NEPA requires Federal agencies to prepare environmental impact assessments for all major actions significantly affecting the environment[66] and it creates administrative requirements that agencies either cite research knowledge as evidence for decisions or, as necessary, commission and conduct research of their own. NEPA, Title 1, Section 102 mandates agencies to "utilize a systematic, interdisciplinary approach which will insure [sic] the integrated use of the natural and social sciences and environmental design arts in planning and decisionmaking."[67] One of the responsibilities of the Council on Environmental Quality created by NEPA was "to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality."[68] The Council on Environmental Quality later specified in new regulations that "if scientific uncertainty exists but can be cured by further research, the agency must do or commission the research."[69] In recent years, the courts have taken a more active role in requiring the agencies to fulfill this mandate.

The increased environmental regulation of industry—as well as other social legislation—had a number of unplanned effects on the scientific research system. * In the late 1960s and early

[61]Dickson, op. cit., p. 122.

[62]Edward E, David, Jr., "The Federal Support of Mathematics, " *Scientific American, vol.* 2.52, May 1985, p. 45.

[63]Lynton K, Caldwell, *Science and the National Environmental Policy Act; Redirecting Policy Through Procedural Reform* (University, AL: The University of Alabama Press, 1982), p. 8.

[64]Ibid., p. 9,

[65]Ibid.

[66]Mark Reeve, "Scientific Uncertainty and the National Environmental Policy Act—The Council on Environmental Quality's Regulation 40 CFR Section 1502 .22," *Washington Law* Review vol. 60, No. 1, 1984-1985, p. 101.

[67]Caldwell, op. cit., p. 12.

[68]National Environmental Policy Act, Title 11, Section 205(5).

[69]Reeve, Op. cit., p. 101.

*To be discussed in more detail in ch. 5.

1970s, Congress created the Environmental Protection Agency, the Occupational Safety and Health Administration, the National Highway Safety Commission, the Consumer Product Safety Commission, the Mining Safety and Enforcement Administration, and the Equal Employment Opportunity Commission. In addition, the jurisdiction and enforcement powers of several existing Federal agencies (such as the Federal Trade Commission) were expanded. This explosion in protective regulation can be attributed to many things, such as changes in the underlying technology of industry or changes in perception about what constitutes potential risk, combined with increasing awareness and growing intolerance of risks. Traditional protections, especially market and liability laws, seemed inadequate to encourage socially responsible behavior. Moreover, the scientific research system—as it participated in the regulation—was becoming increasingly visible and more federally dependent. In addition to its use in forming regulatory policy, science was expected to comply with protective regulations and social programs originally directed at industry or the professions.

Perhaps the most significant science policy debate of the 1960s—in its long-term effects on public and political attitudes toward research and in resulting regulation—surrounded the use of human subjects in scientific experiments. The U.S. mass media had in the 1960s carried a number of reports about unsavory situations—here and abroad—in which prisoners, children, the poor, and the elderly were exposed to unwarranted risks in the name of "experimentation." The issue was politically volatile, and it touched on fundamental questions of who should set the standards for control of scientific research. In a 1966 article that captures the spirit of that debate, Henry K. Beecher wrote:[70]

> . . . it is absolutely essential to *strive* for [informed consent to experimentation] for moral, sociologic and legal reasons. The statement that consent has been obtained has little meaning unless the subject or his guardian is capable of understanding what is to be undertaken and unless all hazards are made clear. If these are not known, this, too, should be stated. In such a situation the subject at least knows that he is to be a participant in an experiment. . . . Ordinary patients will not knowingly risk their health or their life for the sake of "science."

Prior to 1963, investigational or experimental new drugs, for example, could be used in research involving human subjects if the drugs were labeled and intended solely for investigational use.[71] The Food and Drug Administration (FDA) had no direct control over the drugs, the investigators, or the research to be done; "there was no requirement that a patient be told that he or she was to receive an investigational drug."[72] That autonomy changed in 1963 when FDA, in response to the 1962 Drug Amendments (known as the Kefauver-Harris Amendments), issued Investigational New Drug regulations requiring that "any person or manufacturer seeking to study a new drug in human subjects . . . prepare and present to the FDA an acceptable plan for the investigation."[73] In 1966, the U.S. Public Health Service began to require all institutions (e.g., universities, commercial laboratories) to which it made grants to establish boards to review investigations involving human beings: ". . . to safeguard the rights and welfare of research subjects, to ascertain whether the methods used to gain their consent were appropriate, and to evaluate the risks and benefits of the experiment."[74] One analyst has characterized events of this time as the "legalization of ethical choices."[75] By the early 1970s, several legislative and administrative actions had attempted to implement such safeguards. Requirements for institutional review of research involving human subjects had gone from a matter of agency policy to one of Federal law. The institutional review boards required for each institution receiving Department of Health and Human Services (DHHS)

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[70] Henry K. Beecher, "Ethics and Clinical Research," *The New England Journal of Medicine*, vol. 274, June 16, 1966, p. 1360.

[71] Alexander M. Schmidt, "The Politics of Drug Research and Development," *The Social Context of Medical Research*, Henry Wechsler (cd.) [Cambridge, MA: Ballinger Publishing Co., 1981), p. 243

[72] Ibid.

[73] Ibid., p. 253.

[74] Stanley Joel Reiser, "Human Experimentation and the Convergence of Medical Research and Patient Care," *Annals of the American Academy of Political and Social Science*, vol. 437, May 1978, p. 18.

[75] Frank P. Grad, "Medical Ethics and the Law," *Annals of the American Academy of Political and Social Sciences, vol.* 437, May 1978, pp. 19-36.

funds became the principal means for enforcing national political and social expectations. The legislative intent, however, was to require the researchers and the grantee institutions to self-regulate so that detailed Federal Government regulations might not be necessary.[76]

[76] Dael Wolfle, Emeritus Professor, Graduate School of Public Affairs, University of Washington, personal communication, 1985.

THE "LIMITS TO INQUIRY" DEBATE

These various controversies, protests, and political debates took their toll on both the complacency and the autonomy of the scientific community. And in the 1970s, many researchers themselves became actively engaged in an intense debate revolving around social accountability and the acceptability of limits on scientific inquiry. The 1960's "human subjects" debate was by no means resolved and had stimulated regulation of research procedures at both the Federal and State levels. Advances in molecular biology raised new questions about the risks of genetic manipulation. Social surveys of public opinion were showing that the American people did not have an unqualified faith in science and were willing to support some controls on the research process. And, finally, general political calls for increased fiscal accountability in government accounting led some politicians to focus attention on shortcomings in the research grants and contracts system. These and many other issues and controversies became the fodder for discussions throughout the scientific community—in journals and at meetings—about science's social responsibility, about ethical behavior of researchers, and about the appropriateness of limitations on scientific inquiry.

A central focus for one of the debates was how to balance the potential risks and benefits of the "new" biology. The controversy was heightened by two factors: the rapidity of advances in the research, and the connections—often pointed out by the researchers themselves—between the potential applications of the research and public policy. When, for example, a research team at Harvard Medical School successfully isolated a human gene in 1969, a scientific frontier with unusual potential had been extended, but biologists on that team also recognized that misuse of the techniques of genetic manipulation would be undesirable. A member of the team, Jon Beckwith, in fact, publicly voiced his concern over undesirable side effects. As molecular biologists began to develop exciting laboratory techniques for manipulating and recombining DNA across species barriers, more and more biologists began to discuss the potential outcomes. These discussions led to a dramatic example of self-regulation by the scientific community.

In 1973, immediately following a major research conference, biologists Maxine Singer and Dieter Soil wrote a letter to *Science*[77] in which they appealed to the National Academy of Sciences to establish a committee to study various problems of recombinant DNA research and to recommend specific actions or guidelines in the light of potential hazards.[78] That committee recommended the instigation of a voluntary moratorium on certain forms of rDNA research and the formation of what later became a national committee to review proposals for research using these techniques, the NIH Recombinant DNA Molecule Program Advisory Committee, organized in 1974. Molecular geneticists who voluntarily imposed the moratorium asked others in the world to do likewise. Fears that flaws in these techniques might allow ecological disaster or create "new diseases" were also the impetus for proposals for regulation at State and local levels.[79] In February 1975, however, an international group of biologists, meeting at the Asilomar Conference Center in Pacific Grove, California, agreed that the voluntary moratorium be lifted and that future research be conducted under a set of rigid guidelines to be developed by the NIH Advisory Committee.

[77] "Letters to the Editor," *Science*, vol. 181, Sept. 21, 1973.

[78] Daniel Callahan, "Recombinant DNA: Science and the Public," *Hastings Center Report*, vol. 7, April 1977, p. 20.

[79] Judith A. Johnson, "Regulation of Recombinant DNA Products," Issue Brief 85090, Library of Congress, Congressional Research Service, Science Policy Research Division, Apr. 3, 1984; and Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Contrivers.v* (Cambridge, MA: The MIT Press, 1982).

The justification for that moratorium—and for subsequent regulation of the research—is discussed in chapter 3, but it is important to emphasize that, in this case, researchers were generally supportive of formal government commissions and legislation; most accepted some regulation as inevitable and realized the importance of shaping the controls to fit their research needs. There was also relatively little public input to the early stages of the debate.[80] The result of the national scientific debate and congressional attention was the implementation in 1976 of a National Institutes of Health document *Guidelines fez-Research Involving Recombinant DNA Molecules,* which: 1) imposed restrictions on the types of experiments that might be performed at NIH grantee institutions, and 2) specified minimum levels of physical and biological containment for permissible recombinant DNA experiments. In 1977, in compliance with the National Environmental Policy Act, NIH adopted an environmental impact statement for the 1976 *Guidelines.*

At about this same time, a number of public opinion surveys appeared to be indicating a decline in the public's traditionally high support for and confidence in science .81 (See app. B for a general discussion of public attitudes toward science.) Some survey data indicated that more and more non-scientists were inclined to question science's traditional autonomy or to express a lack of confidence in science's ability to solve social problems through research. People seemed to confuse science with technology, and to see science "in a very technological, instrumental light. "[82] As a part of its new *Science Indicators* series, the National Science Board (NSB) decided to include a chapter on public attitudes toward science. Using data from Opinion Research Corporation surveys in 1972, 1974, and 1976, the chapters of the NSB reports described a public that, although still holding science and technology in high regard, was much less supportive than it had been in 1957, the date of the last previous comprehensive survey. While 90 percent of the public thought that the world was "better off" because of science in 1957, only **70** percent of the public held the same view in 1972.[83] Similar results were obtained in the 1974 and 1976 studies.[84] The percentage of those willing to say that the world was worse off because of science did not increase significantly, but the percentage of persons who were uncertain, undecided, or felt that things were about equal did increase substantially over the 15-year period spanned by the four studies.

In a 1979 national study also sponsored by the National Science Board, several of the 1957 questions were repeated, offering an opportunity for comparison across two decades. In 1979, 81 percent of the public still agreed that scientific discoveries were making their lives "healthier, easier, and more comfortable" and 86 percent expressed the view that scientific discoveries were "largely responsible" for the standard of living in the United States.[85] In a comparable national study in 1983, Jon D. Miller found that 85 percent of American adults continued to agree that science made their lives healthier, easier, and more comfortable.[86] Contradictory evidence, however, was provided by other surveys sponsored by NSB, which had asked respondents to assess the relative benefits and harms of science and to weigh the two.

The data from the 1970s thus indicated that although only about one in 20 Americans believed that science does more harm than good, about one-third were not sure where the balance fell. Some of this uncertainty may have reflected a wary attitude toward science; some may have been due to a lack of interest or information. In the 1970s "limits of inquiry" discussion, however, the scientists found the potential "wariness" frightening.

If there was a significant change in public opinion, why did it occur? Some argue that respect

[80] Callahan, op. cit., p. 20.

[81] Amitai Etzioni and Clyde Nunn, "The Public Appearance of Science in Contemporary America, " *Daedalus,* vol. 103, summer 1974, pp. 191-206.

[82] Ibid., p. 203.

[83] *Science Indicators—1972* (Washington, DC: National Science Board, 1973).

[84] *Science Indicators — 1974* (Washington, DC: National Science Board, 1975); and *Science Indicators–1976* (Washington, DC: National Science Board, 1977).

[85] Jon D. Miller, et al., *The Attitudes of the U.S. Public Toward Science and Technology* (Washington, DC: National Science Foundation, 1980).

[86] Jon D. Miller, "A National Survey of Adult Attitudes Towards Science and Technology in the United States, " Annenburg School of Communications, University of Pennsylvania, Philadelphia, 1983.

for scientists diminished because the scientific establishment became "identified with the general power structure"; others believe that it was because of "an exchange of roles between science and religion in relation to the stability of the prevailing political system."[87] Some senior scientists, unaccustomed to public criticism, sincerely believed at the time that scientific values and traditions were under serious attack.

Many linked the change to science's new status as a visible target in the Federal budget. Congressional attitudes—which were moving away from relatively unquestioning support—may have been influenced by the social discussion. Some criticism was undoubtedly prompted by the scientists' own doubts about "the omnicompetence of science in human affairs. " But political scientist Don K. Price speculated in 1972 that the politicians' questioning resulted most "from the normal disposition of anyone who lends or grants money to want to know what use is being made of it, and whether the terms of the bargain are being kept."[88]

Such normal policy questions received widespread publicity when, in 1975, Senator William Proxmire (D-WI) launched an unprecedented attack against National Science Foundation funding of social science research. Proxmire, then Chairman of the Senate Appropriations Subcommittee that reviews the NSF budget, established the "Golden Fleece of the Month" awards to illustrate what he regarded as examples of waste in the government—occasionally attacking projects that he asserted "at best, of nominal value to the American taxpayer. " Scientists, angered at the attack, countered that projects with obscure titles and subjects may nevertheless deal with relevant and important problems, They feared a dangerous precedent if immediately applicable science was perceived to be the only worthwhile science.

The political momentum of the "Golden Fleece" awards was eventually slowed when a behavioral scientist who had received such an award filed suit against Proxmire, arguing that, as a result of Proxmire's actions, he had suffered a loss of respect in his profession, was "held up to public scorn, and suffered a loss of income and ability to earn income in the future. " A Federal district court in Madison, Wisconsin, granted a summary judgment in Proxmire's favor on the grounds that he enjoyed absolute immunity under the Speech and Debate Clause of the Constitution; but in 1979 the Supreme Court held that the researcher was not a public figure simply by virtue of receiving Federal funding, and that congressional immunity did not extend to statements made outside Congress.

Despite a lessening of political criticism following the Supreme Court decision, the scientific community reacted as if the integrity of all science in general had been questioned. Many researchers seemed to be underestimating the demand for accountability inherent in acceptance of public funding.[89] "Those [scientists] who came of age during the fifties and sixties, " Robert S. Morison observed in the 1970s, "may never quite understand why they have suddenly become 'accountable' to a 'participatory democracy'."[90]

Insensitivity may not be the entire explanation, however, for public perceptions of science in general were also changing. Only a decade before, science had had unquestioned social authority in the culture and its research funding was ample, growing, and relatively easily acquired; by the 1970s, research was being conducted in a social climate that admitted scientific authority to questioning and in which other demands were biting into science's portion of the Federal budget. Scientists who had been trained before the war probably also could not have imagined the extent of regulation of the research process which had begun to occur.

Some scientists who took part in these discussions reacted negatively to the proposal of citizen participation in what were traditionally considered to be "scientific" matters.[91] "How, " one commentator asked, "can public participation be arranged without clashing with the very meaning of science as a consensual activity among

[87] "Limits of Scientific Inquiry " *Daedalus*, spring 1978, p. vii.
[88] Price, op. cit., p. 80,

[89] Robert S. Morison, "Commentary on 'The Boundaries of Scientific Freedom '," *Newsletter on Science, Technology. & Human Values*, June 1977, pp. 22-24.
[90] Ibid., p. 2-I.
[91] "Limits of Scientific Inquiry, " op. cit., p.viii.

trained specialists?”[92] Scientists who had previously assumed total control over their research now talked about being at the “mercy of citizens’ groups” who were seeking input to the decision-making process .93

Despite this reaction—or perhaps because of it—many leaders of the scientific community appear to have believed that public scrutiny inevitably implied restrictions. According to Dorothy Nelkin, by the 1970s, it was no longer a question of *whether* there would be public control, but of who would participate, how control would be organized, and how much they would influence research decisions.[94] The discussions then moved to consideration of how the situation could be shaped to “protect” basic science, and to when and how much the public representatives would actually be involved.[95]

The scientists, philosophers, and policy analysts were not, however, always in agreement about the question under debate. Some regarded it as a debate over “limits to free scientific inquiry, ” viewing proposed regulation as an attempt to inhibit researchers’ freedom to pursue intellectual inquiry. Others began to frame the debate in terms of funding priorities. Andre Hellegers once made this point forcefully, arguing that freedom of inquiry was not under assault because science was, in fact, “royally” funded.[96] Hellegers cited the two central issues for science as: 1) “Given finite resources, how much should the public invest in an enterprise such as science?; and 2) “How far (if at all) should any enterprises, in the name of freedom of inquiry, be allowed to infringe on the freedom of others?”[97] Should low priority be given to those activities that have adverse consequences?[98] To Hellegers, the real topic of importance was “the ordering of priorities in things which affect both science and human values.’’”

Don K. Price has observed that in the 1970s scientists were often inclined to blame their problems on politicians. This tendency was exacerbated by historic differences in the outlooks of the two groups. Scientists and politicians operate in different time frames—Congress in the short term and scientists in the long term. Conflicts often arise from the imposition of a political paradigm onto the agenda of the scientific community. But Price believes that the problems themselves evolved from three other factors. First, the political strategy for the support of science was devised by scientists themselves and was based on the experience of private philanthropy before World War II. Second, the political authorities had accepted science “as the dominant intellectual approach to public issues, which scientists and other liberal intellectuals agree must therefore be regulated in the public interest.” And third, the U.S. constitutional structure is “too decentralized to sustain the integrated and long-term view of public policy which might justify the support of science as an intellectual and educational enterprise. “[100]

The academic debate over “limits to scientific inquiry” can be seen as a response to social pressures, to events and progress within science, and to the scientists’ fear that public support for science was declining. The academic scientific community believed that it was necessary to defend the very core of science—which they perceived as under attack. They saw the humanists’ criticism and the attempts to regulate as threats to the legitimacy of modern science.

“Ibid., p. 232.

1 bid., p. viii.

[94] Dorothy Nelkin, “Intellectual Property: The Control of Scientific Infor,mation, ” *Science*, vol. 216, May 14, 1982, p. 207.

“Andre Hellegers, “The Ethical Dilemmas of Medical Research” and Barry Casper “Value Conflicts in Restricting Scientific Inquiry, ” *Regulation of Scientific Inquiry*, Keith M. Wulff (cd.) (Boulder, CO: Westview Press, 1979).

“Ibid., p. 9.

“Ibid., p. 11.

“Ibid., p. 22.

[99] Ibid., p. 29.

[100] Price, Op, cit., p. 76.

RECENT RESTRICTIONS ON SCIENTIFIC COMMUNICATION

From the earliest days of the Nation, Federal policy has largely been supportive of open communication, free exchange of information, and wide publication in scientific research.[101] From time to time, however, recognition has been given in Federal law to "circumstances that constitute what have been thought to be obvious and compelling reasons for imposing official secrecy on research or restrictions on the dissemination of certain kinds of research findings ."[102] For example, the first War Powers Act, signed 11 days after Pearl Harbor, gave the President the authority to censor all communications with foreign countries. But the scientific community has also made some attempts at voluntary control. In 1940, for example, editors of various professional journals cooperated with a special committee of the National Research Council to review papers for possible defense information. [103] This combination of Federal support for open communication, defense-related restrictions imposed on a case-by-case basis, and occasional voluntary cooperation by the scientific community continues today.

Because of this history, it is noteworthy therefore that the most controversial regulatory issue for science in the 1980s has been the imposition of restrictions on the communication of basic science. In part, the new restrictions have resulted from the changing nature of information, especially its status as a valuable property or national commodity, and from the growth in modes of dissemination of information. The decreasing distinction between basic and applied research added to the difficulty of assigning national security classification according to the information's potential for application. And, especially in the last few years, there is an increased perception that the export of U.S. technology is weakening this country politically and economically on a worldwide basis.[104]

This series of disputes first arose in the late 1970s, when the National Security Agency (NSA) and later the National Science Foundation attempted to prevent university-based cryptology researchers from publishing their unclassified work on encryption schemes. In these cases, the Federal Government invoked the Invention Secrecy Act and the International Traffic in Arms Regulations, regulations intended to control the export of munitions and related technology. The result of discussions between the universities and the government was the adoption of a voluntary prepublication review process, under which copies of manuscripts on cryptology are sent to NSA at the same time they are circulated to colleagues or submitted to journals.[105] This system of voluntary prior restraint was endorsed in 1980 by the American Council on Education, and in 1981, NSF amended its policies on research grants to require similar prior restraint on "potentially classifiable results ."[106]

At about the same time, the Department of Defense—concerned especially about the leak of information on Very High Speed Integrated Cir-

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[101] Harold C. Relyea, "Shrouding the Endless Frontier—Scientific Communication and National Security: The Search for Balance, " *Striking a Balance: National Security and Scientific Freedom*, Harold C. Relyea (ed.) (Washington, DC: American Association for the Advancement of Science, 1985), p. 75.

[102] Ibid,

[103] Harold C. Relyea, "Increased National Security Controls on Scientific Communication, " *Government information Quarterly*, vol. 1, No. 2, 1984, pp. 187-188, See also Michael M. Sokal, "Restrictions on Scientific Publication, " *Science*, vol. 215, Mar. 5, 1982, p. 1182; and Michael M. Sokal and Janice F. Goldblum, "From the Archives, " *Science, Technology, & Human Values*, vol. 10, spring 1985, pp. 24-27.

[104] *Interim Report of the Committee on the Changing Nature of Information* (Cambridge, MA: Massachusetts Institute of Technology, Mar. 9, 1983).

[105] John C. Cherniavsky, "Case Study: Openness and Secrecy in Computer Science Research, " *Science, Technology,, & Human Values*, vol. 10, spring 1985, pp. 99-104.

[106] See sec. 794 on National Security in the NSF Grant Policy Manual.

cuits —began to use the Export Administration Regulations to restrict public communication of results and to control the access of foreign scholars to U.S. university research,[107] The presidents of five major universities objected to these restrictions and to the trend of increased control that they represented. That protest and the prior debate over restrictions on cryptology research were principal factors in the initiation of a special National Academy of Sciences-National Academy of Engineering-Institute of Medicine panel, under the direction of Dale Corson, which issued its seminal report "Scientific Communication and National Security" in 1982.[108] The Corson panel report has been a touchstone for subsequent reaction to government actions to restrict scientific and technical communication.

[107] Ibid., p. 102.

[108] *Scientific Communication and National Security,* report by the Panel on Scientific Communication and National Security Committee on Science, Engineering, and Public Policy (Washington, DC: National Academy Press, 1982).

POLITICAL INFLUENCES ON REGULATION

The science policy developed over the last 40 years reflects certain assumptions about the nature of science, the character of scientists, and the political management of science. There have been important assumptions about the ability of scientists to govern their own affairs; often, discussion of the peer review system will figure prominently as evidence of whether or not this governance "works." Other assumptions are made about whether, given the current structure of science, effective and equitable regulation is possible; and related to that are a host of assumptions about the nature of expertise—especially the belief that, on scientific matters (even those with heavy policy components), scientists alone can best identify promising projects and areas of research. Historian Alex Roland, in his March 7, 1985, testimony to the Science Policy Task Force of the House Committee on Science and Technology, articulated this perspective well when he observed that "scientists understand nature's laws better than anyone else; they are in the best position to see the potential applications of their undertaking. "

Some assumptions relate to the conduct of research—such as where it is best performed—or to the appropriate relationship between research and university education. Other assumptions relate to the process of regulation. There are, for example, strong opinions about how far government "interference" should extend in all aspects of science policy and about who should participate in the development of policy about controls. Assumptions about who should control research and at what stage are also inextricably linked to the question of who is the best judge of science, who is the expert, and who evaluates science.

How are changes in these assumptions—and in the social relations of science—affecting the intensity and extent of the regulatory environment for research?

Without doubt, there is new pressure for a balance between the push for scientific and technical progress and the demand for regulation. Congressional management of science and technology today may require special legislative effort to reconcile the complexity and sophistication of new technological challenges with society's regulatory capabilities.

Another important force shaping enforcement of Federal regulation on scientific research is a national fear of failure, especially in international technological competitiveness. Science policy leaders argue for increased funding in order to keep the United States from "falling behind" in certain scientific fields. But these same arguments are used by the executive branch to justify increased restrictions on scientific communication. Such attitudes have repercussions on scientific research through the setting of national research priorities and through pressures to achieve competitive status (or to "maintain the lead") in all areas of science.

One of the most visible changes—to be discussed in chapter 4—is in the creation of specific political or bureaucratic mechanisms for implementation of social controls on research. As a handle for enforcing regulation, the requirement for financial accountability inherent in the research system has been successful. The post-war contract between scientists and government had allowed the scientists, through the process of peer review, to make decisions about the allocation of government funds to specific projects but required the universities to be accountable financially to the government. Thus, regulatory requirements—committees to review research for ethics, regulations on the disposal of hazardous materials—could be tied to the award and management of money.

Changes have also occurred in the amount and type of public participation in decisionmaking on issues related to science and technology. Changes in public beliefs about the value of "expert" v. lay opinions on political or social issues involving science or technology have reinforced the trend toward less autocratic control of science by scientists. Until the last decade or so, when policymakers turned to scientists for advice in making decisions on technically-intensive public policy issues, the practice was to distinguish between the technical and the political, or normative, aspects of a problem.[109] Today, the involvement of more laypersons in that decisionmaking process on regulating research has not only shifted some control from the scientists but has introduced more sensitivity to normative concerns,

These and other influences on U.S. research have helped to change the nature and character of the politics within which research is conducted, When the Bush and Steelman reports outlined their visions for how the Federal Government should sponsor and finance a national structure for scientific research, there was little reason to believe that those same arrangements could become the vehicles through which research might be regulated according to prevailing social or political attitudes. Science was to be managed with loose reigns. It was not perceived as either requiring suspicious administration or warranting externally-imposed controls. The specific links between the events that stimulated much of the current regulation and the concurrent shifts in public attitudes are not well understood, but it is clear that, in the 40 years since Bush, something has changed. That shift is linked in some way to the original assumption that guided the design of the system as well as to the assumptions that now underpin priority-setting and funding today. Science is now clearly conducted within a regulatory environment that affects its agenda, its procedures, and its communications. The next four chapters describe the existing situation—why regulation occurs, how it occurs, and where it occurs.

[109] Loren R. Graham, 'Comparing U.S. and Soviet Experiences: Science, Citizens, and the Policy-Making Process," *Environment*, vol 26, September 1984, p. 8,