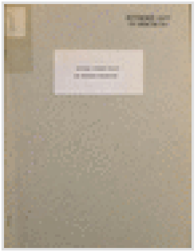

National Science Policy and Research Priorities: A Background Paper (1983)

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TI NATIONAL SCIENCE POLICY AND RESEARCH PRIORITIES

A Background Paper Prepared by

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for

The Ad Hoc Committee on Government-University Relationships
OR 2 in Support of Science

OR 1 NAS Committee on Science, Engineering, and Public Policy

National Academy of Sciences
National Academy of Engineering
Institute of Medicine

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A. Introduction

The U.S. R&D system is, and always has been, highly pluralistic, with wide diffusion of authority and relatively little central coordination. The United States has no clearly-defined, coherent national "science policy," no department or ministry of science, no single centralized planning mechanism for R&D.

The decentralization of the U.S. R&D system has long been regarded as a major source of its strength by observers of U.S. science policy.[1] Nonetheless, there has been a continuing debate in the scientific community during the past 35 years over the need for improved national policymaking, planning, and priority setting mechanisms for science, at least for that portion of activities funded by the federal government. Recently, this debate has received renewed attention as federal budget cuts combined with an inflationary economy have placed severe constraints on federal R&D funding. President Reagan's science advisor, Dr. George A. Keyworth II, has espoused the notion of priority setting within the context of a national science policy in several major addresses during the past six months. At the same time, voices have been raised in a number of other quarters regarding the need to revitalize or restructure the institutions of national science policymaking and planning.

This paper reviews briefly several key aspects of national science policymaking and planning in this country and highlights the problems of setting priorities in research. It is intended to help stimulate discussion of these matters and to assist the Committee in considering which, if any, merit further exploration. The paper should be viewed as a summary; many important issues and organizations are mentioned in only a cursory manner or are omitted entirely.

B. The Endless Frontier

The intensive application of R&D to government goals that occurred during World War II set the pattern for the post-war development of U.S. science and for government-science relationships. The well-known Bush report, Science: The Endless Frontier, submitted to the President after the war, stressed the public benefits that could accrue from investment in basic research and called for continuing government support.[2] At the same time, it pointed out that the practical benefits from basic research were often unpredictable and lagged behind the research by several years. Thus, rather than having government attempt to direct or plan basic research in detail, the report suggested that the best policy would be for government to provide the funds and formulate the broad outlines, while allowing the scientific community to set its own research directions.

The Bush report was submitted at a time in U.S. history when there was more or less consensus among U.S. political leaders of different affiliations regarding the desirability of a continuing government role in the support of research. It set the stage for a period of dramatic growth in American science. The report was based on the principle of substantial autonomy for the scientific community (a principle subsequently given operational meaning in the wide use of peer review for individual funding decisions), combined with the acceptance of government responsibility for the welfare of the scientific enterprise. Although there have been important changes in U.S. government-science relationships in subsequent years, these tenets have remained central.

Within this framework, a number of institutions have played major roles in setting and implementing national policies for science. These have included: the White House science advisory apparatus (OST, later OSTP; PSAC; the science adviser; FCST; as well as OMB); several key Congressional bodies (including the House and Senate science subcommittees, and more recently, OTA); a number of research-intensive agencies (especially NSF, but also NIH, DOD, NASA, AEC, later ERDA and DOE); "the Academy," (NAS/NAE/IOM/NRC); and, to a lesser extent, AAAS and other professional, scientific and higher educational associations. In general, the policies that have governed the development of U.S. science in the postwar era have resulted from the interactions of these institutions. Of particular relevance by virtue of their potential roles at the strategic level have been NSF and the White House structure.

C. NSF as a Science Policy Institution

The "National Research Foundation" envisioned by Bush in his report was intended to serve a dual purpose. First, it was to be a principal (but not the exclusive) funding source for basic research in universities. At the same time, it was to "develop and promote a national policy for scientific research and scientific education"--i.e., it was to be a central science policy and planning body for the federal government. When the new agency--the National Science Foundation--was finally created in 1950, its authorizing legislation provided for this dual role. In addition to funding basic research, NSF was directed:

> to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;
>
> ...to appraise the impact of research upon industrial development and upon the general welfare;
>
> [and] to evaluate scientific research programs undertaken by agencies of the Federal Government.... (42 U.S.C. 1862, Sec. 3(a).)

From the outset, however, NSF was not anxious to take on such a government-wide planning role, and throughout its 30-year history the Foundation has generally resisted doing so. NSF leaders felt that a young, weak organization was in no position to undertake research planningand coordination involving the interests of larger, more influential agencies, and that such activities might make it more difficult for NSF to carry out its essential responsibilities for the support of basic research. Despite pressure from BOB (the predecessor of OMB) and even an executive order issued by President Eisenhower in 1954, NSF has done relatively little in the way of government-wide science policymaking--except during the 1973-76 period when the NSF director also served as science adviser to the President.[3]

NSF's policymaking body, the National Science Board (NSB), has had a similarly ambiguous position with respect to science policy issues which transcend NSF's domain. Its charter suggests a role in national science policy, but the Board has never fully exploited this role. Philip Smith's recent report to the Board examines the reasons for this hesitancy and their context, and describes several NSB ventures into areas of broader national science policy. The report suggests the conditions under which these ventures have been effective or not effective. It leaves the impression that the Board's most effective activities have been those directly related to NSF, but notes that much science policy of broader impact has resulted from the Board's concerns with NSF.[4]

D. Planning in the White House Science Office

Despite NSF's early reluctance to accept a broader science policy and planning role, no other agency was established to perform such functions for nearly ten years after the establishment of the NSF. What finally led to the creation of such an agency was the government's decision in 1957-58, following the launching of the first Sputnik by the U.S.S.R., to expand its R&D and science education efforts and its organizational apparatus for dealing with them. During the late 1950s and early 1960s, Presidents Eisenhower and Kennedy created the position of Special Assistant to the President for Science and Technology, the President's Science Advisory Committee (PSAC), and the White House Office of Science and Technology (OST). This interwoven structure was maintained through 1973, when OST was abolished by President Nixon and the functions transferred to the director of NSF. In 1976, Congress re-established the functions through the National Science and Technology Policy, Organization, and Priorities Act, which directed the establishment of an Office of Science and Technology Policy (OSTP) in the White House.

These events, as well as the accomplishments and shortcomings of the institutions involved have been discussed frequently in the U.S. science policy literature.[5] What is specifically important in the present discussion is the performance of the White House science policy structure as a mechanism for planning the development of science. In this regard, its record has been mixed. Both in its earlier (pre-1973) form, and in its more recent incarnation, the office has been a relatively small one operating within the Executive Office of the President. It is part of the White House staff and its effectiveness is measured in terms of its contributions to the needs and interests of the President. While the development and welfare of science may occasionally be of direct importance to the President, more often it is subordinate to concerns such as national security and economic well-being. The dynamics of political power which govern the setting of OSTP's agenda make it a less than ideal location for strategic planning for science, although it certainly is a participant in the process.

One partial exception to this relates to the budget process. In the past, the total government basic research effort has generally been an after-the-fact sum of individual agency efforts. OSTP, working in conjunction with OMB, has attempted to change this during the past several years by developing a budgeting system which permits monitoring of basic research components of agency budgets by discipline during the time the budgets are being reviewed. This means that agency research programs can be adjusted during the budget process not only in terms of their relation to other programs of their own agency, but also in terms of how they relate to research programs of other agencies and to overall funding levels. Thus, for example, the levels of funding and the substance of different fields of research can be shaped during the development of the budget, instead of being mainly an unplanned outcome of the process. This can be a powerful tool for an administration concerned with the health of the scientific enterprise, and indeed, during the FY 1981 budget formulation process it was used by the administration to give a significant increase, spread among several agencies, to basic research in fields which OSTP felt required special emphasis--mathematical and physical sciences and engineering.

E. Setting Priorities for Reserach

Throughout the foregoing discussion--and indeed throughout most discussions of strategic planning and policymaking for science--the operational content of the plans or policies in question has remained somewhat vague. One domain in which planning might be given some more tangible form, however, is that touched upon in the description of OSTP's budgeting role--the problem of allocating funds among scientific disciplines. This is the area which OSTP Director Keyworth has highlighted in several major policy statements.

Scientists active in public affairs have long been concerned with the problem of research priorities. Its conceptual dimensions were sketched out nearly 20 years ago by Alvin Weinberg in his essay, "Criteria for Scientific Choice."[6] Weinberg proposed two internal and three external criteria as guides to establishing priorities among fields of science "whose only common characteristic is that they all derive support from the government." His internal criteria are: (1) "Is the field ready for exploitation?" and (2) "Are the scientists in the field really competent?" His external criteria are: (1) technological merit--the usefulness of the ultimate technological application to which the research might lead; (2) scientific merit--relevance to neighboring areas of science; and (3) social merit--relevance to human welfare and values.

Other writers subsequently elaborated upon some aspects of Weinberg's scheme and challenged others, but the basic ideas have survived and are reflected today in most writings about scientific priorities, including Keyworth's discussions of "excellence and relevance."[7]

In a more recent article entitled "The Problem of Research Priorities," Harvey Brooks discusses priority-setting among disciplines in terms of "scientific merit" (an internal criterion) and "utility" (an external criterion).[8] Brooks notes the difficulty of comparing scientific merit across disciplines. A frequently-cited device for doing so is "proposal pressure," a concept developed by program administrators to express the relationship between the potential of a field (in terms of the numbers of proposals received, weighted by peer review judgements of the quality of ideas and people) and the amount of funding available. Brooks describes the ways in which proposal pressure may be misused and misunderstood, but concludes that it is "an important signalling system that should not be ignored in the priority-setting process."

Assessment of utility is even more complex, according to Brooks. The public is the ultimate judge of utility, but often scientific expertise is needed to evaluate the practical implications of an area of research. The notion that the political process first sets priorities and the scientific enterprise is then deployed to meet these priorities is overly simplistic. Means and ends interact and new scientific opportunities often produce new social priorities. Thus research priorities are properly set not in isolation, but in the context of overall priority-setting in government.

The ideas of Brooks and Weinberg, and several others who have written on research priorities, are certainly thought-provoking. Their actual utility in policymaking is less than apparent, however. Apart from the special emphasis placed on mathematics, the physical sciences, and engineering in the FY 1981 budget and the targeting of the social and behavioral sciences for substantial reductions in FY 1982, explicit statements of priorities among fields of science by authoritative bodies are rare. (On the other hand, calls for increased funding for one field or another, without the suggestion of corresponding restraints on other fields are common. This obviously poses less of a problem in a period of expanding budgets than it does in a period of austerity.)

Nonetheless, priorities <u>are</u> set and hard choices <u>are</u> made in research budgets through interactions of a variety of participants. Philip Smith's discussion of "budget as policy" in his report to the NSB suggests, from an insider's viewpoint, how some of these complex interactions have shaped NSF's budget. Criteria like Weinberg's are there, as is "proposal pressure" (although Smith says he never found it of much use in practice), but on the whole, formalistic priority-setting seems subordinated to a broad interplay of social and economic trends (national and international), institutions, personalities, and political demands.[9]

F. Conclusion

It is likely that there will always be tension in the American R&D system, as in other areas of American society, between the desire to maintain pluralism and the demands for more comprehensive planning and management. Few U.S. policymakers would like to risk losing the many benefits that derive from the diversity of the existing system. Nevertheless, prospects for real growth in federal funding for research are not bright, and it is essential that the U.S. find more effective and efficient means for allocating its limited resources. It does not seem impossible to maintain the virtues of pluralism while improving the nation's capability for strategic planning in science and technology.

Many questions remain to be answered, however. Are the existing institutions of science policy, both those discussed above and those not dealt with, suited to the new economic and political environment? Can the lessons of the past be applied to the design of more effective institutions? Is priority-setting among disciplines the most useful way to think about the problem of resource allocation? Or should more attention be paid to other dimensions, such as the division of labor among institutions? These and a variety of other questions will need to be examined carefully as the Committee considers its agenda and the contribution it can make to the formulation of national science policy.

NOTES

1. A classic statement of this may be found in Don K. Price, *The Scientific Estate* (Cambridge, Mass.: Harvard University Press, 1965).

2. Vannevar Bush, *Science: The Endless Frontier* (Washington, D.C., 1945).

3. The executive order directed NSF to "recommend to the President policies for the federal government which will strengthen the national scientific effort and furnish guidance toward defining the responsibilities of the federal government in the conduct and support of scientific research." It ordered NSF to continue making "comprehensive studies and recommendations" of the nation's research effort and resources, and it ordered the heads of other federal agencies to consult NSF on policies relating to the support of basic research. (Executive Order No. 10521, Administration of Scientific Research, March 17, 1954.)

4. Philip M. Smith, *The National Science Board and the Formulation of National Science Policy* (Washington, D.C.: National Science Foundation, 1981) pp. 13-25.

5. Recent writings include William T. Golden (ed.), "Science Advice to the President," a special issue of *Technology in Society*, Vol. 2, Nos. 1 and 2 (1980); and James E. Katz, *Presidential Politics and Science Policy* (New York: Praeger, 1978).

6. Alvin M. Weinberg, "Criteria for Scientific Choice," *Minerva*, Vol. 1, No. 2, (Winter 1963), pp. 159-171.

7. Weinberg's original article and many of the writings it stimulated are collected in Edward Shils (ed.), *Criteria for Scientific Development: Public Policy and National Goals* (Cambridge, Mass.: MIT Press, 1968). For an example of Keyworth's thinking on the subject see his statement before the Committee on Science and Technology, U.S. House of Representatives, 10 December 1981.

8. Harvey Brooks, "The Problem of Research Priorities," *Daedalus* (Spring 1978), pp. 171-190.

9. Smith, *op. cit.*, pp. 52-62.