[COMMITTEE PRINT]

THE NATIONAL INSTITUTES OF RESEARCH AND ADVANCED STUDIES

A RECOMMENDATION FOR CENTRALIZATION OF FEDERAL SCIENCE RESPONSIBILITIES

REPORT

OF THE

SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

TO THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
NINETY-FIRST CONGRESS
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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., April 15, 1970.

Hon. GEORGE P. MILLER,
Chairman, Committee on Science and Astronautics.

DEAR MR. CHAIRMAN:

Pursuant to the responsibilities of this committee to maintain continuing surveillance over research, development, and science education, I am hereby transmitting a report of the Subcommittee on Science, Research, and Development entitled "The National Institutes of Research and Advanced Studies," which is a recommendation for centralization of Federal science responsibilities.

I should like to point out that the subcommittee has been concerned with the problem of the organization of Federal science activities for a number of years, and it has devoted a concentrated effort to the matter during the past 10 months. The basic idea of the National Institutes of Research and Advanced Studies (NIRAS), as presented in this report, is thus the result of much consultation, investigation, and comprehensive hearings involving those from both within and without the scientific community.

In our judgment, the report suggests a reasonable beginning toward the solution of certain major problems now plaguing science and Government. It is a fresh approach. It employs commonsense. It is do-able. And it is an economical plan.

The fundamental concept of the NIRAS is valuable for an additional reason. It would, in our judgment, do much to refresh the spirit and morale of one of our greatest national treasures—the colleges and universities of the country. I do not speak here of the difficulties which have arisen due to social unrest and other student disorders. But rather, I refer to the somewhat jaundiced eye which higher education as a whole is beginning to cast on our Federal Government because of its unpredictable, hot-and-cold attitude toward the support of fundamental scientific study and research.

It is our belief that the NIRAS concept could greatly alleviate this obviously growing shakiness in the university-Government relationship—a shakiness the Nation can ill afford.

Sincerely yours,

EMILIO Q. DADDARIO,
Chairman, Subcommittee on Science, Research, and Development.

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I. BACKGROUND

The overview of Federal science organization has been a continuing responsibility of the Subcommittee on Science, Research, and Development since it was formed in 1963. Over the years, through hearings and reports on many related aspects of Federal science activity, the subcommittee has accumulated a broad informational base which it now brings to bear on the subject under consideration. Increased interest during 1968 and early 1969 in the efficacy of the current science organization resulted in a convening of the Research Management Advisory Panel (RMAP) in February 1969 to counsel with the subcommittee. The former Presidential Science Advisors also attended the meeting.[1] A consensus was reached that thorough study of the possibilities for centralization was in order.

From these discussions, a staff study was commissioned in the Legislative Reference Service and the resulting report [2] circulated widely for comment. Hearings were held involving 20 witnesses from the present and past administrations, universities, industry, and other private sector organizations.[3]

This time period (1968–70) has been one of major change in the context of Government patronage of scientific research and training in institutions of higher learning. The administration is in new hands but that is not an important influence since science policy has not been and is not a partisan issue. The significant changes which must be dealt with include the following:

(1) The public attitude toward science and technology has switched from believing that research automatically leads to net benefits to society. Now there is a popular misconception that the more science is applied, the worse off we are. However, the true relationship is that the quality and standard of living today for most of the world is vastly better due to science. New assessment procedures are being instituted to prevent the unanticipated and unwanted consequences of technology. Many serious problems of civilization demand increased scientific understanding and knowledge of nature so that prudent use of technology can maintain the human population and improve the chances for long-range stability and peace.

(2) Several years ago in its hearings on the restructuring of the National Science Foundation, the subcommittee concluded that the Foundation should be given appropriations to fulfill a balance wheel role in science funding. We realized that the support of academic

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[1] The Research Management Advisory Panel includes James B. Fisk, James M. Gavin, Samuel Lenher, Wilfred J. McNeil, Don K. Price, C. Guy Suits, and Jerome B. Wiesner. Michael Michaelis serves as Executive Director. The former Presidential Science Advisors are James R. Killian, Jr., George B. Kistiakowsky, Jerome B. Wiesner, and Donald F. Hornig.

[2] "Centralization of Federal science activities." Report to the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics. Prepared by the Science Policy Research Division, Legislative Reference Service, Library of Congress, May 29, 1969. 91st Cong. 1st Sess., H. Doc. 91–172, 108 p.

[3] "Centralization of Federal science activities." Hearings before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics. 91st Cong. 1st Sess. July 10, 22–24, 28–31, October 7, 9, 1969. 505 p.

science via large mission agency programs (DOD, NIH, NASA, AEC), would not be feasible in the long-term future as the major funding channel. Use of these programs in the past has prevented the Nation from coming to grips with the fundamental question of using tax revenues to buy something as nonquantifiable as research. This rationale has been acceptable as long as the huge technology programs were justifying increased support. It was predictable that when military and space expenditures began leveling off or decreasing, the reliance on these agencies for over 80 percent of academic science funding would not be possible. The Vietnam situation has only dramatized a policy deficiency which would have become increasingly apparent in any event.

The limitation that mission agencies support only that research which is directly and apparently related to specific operational objectives poses an impossible problem for basic science which inherently cannot guarantee the course of its investigations.

The subcommittee believes that all mission agencies must continue strong university ties for mutual benefit. A relevance requirement may be justified within certain limits, but the danger is that new funding channels will not be activated to pick up the worthwhile projects and proficient scientists dropped by the mission agencies.

(3) The conduct of science has become vastly more expensive as the "endless frontier" has expanded and the tools of measurement are more precise and elaborate. Choices on the basis of priorities among all the disciplines must be made and new programs of an interdisciplinary nature considered. Planning and coordination within individual fields or projects is not sufficient.

The health and vigor of American science vis-a-vis other nations remains a primary goal. But the likelihood exists that we will not be able to retain pre-eminence in all areas. Our scientific resources must be focused on our national objectives. The limitations of money, talent, and facilities require close management at the highest level of the executive branch.

(4) The universities are facing a serious financial crisis. All fields of knowledge are affected. But since science is the most expensive set of disciplines, its continual expansion creates budget problems for all departments. General inflation, sophisticated instrumentation, salary competition, and increasing enrollments are coincident with State legislature budget cutting and Federal agency restrictions and dislocations—thus threatening the actual solvency of many universities.

Tuitions can account for only a fraction of the actual cost of an education. Society must find a way to subsidize the remainder if it wants the highly trained men and women it will need to serve it in the future. Stable Federal funding of science programs in an amount appropriate to the Nation's dependence on advanced technology is the most direct and equitable means of meeting the university crisis.

(5) The United States has purposely chosen the universities as the principal site for performance of basic scientific research (as opposed to independent institutes or Government laboratories). The continual flow of new ideas and factual information is essential if decisionmakers are to have options and the opportunity to depart from the confinement of present knowledge. The existing haphazard arrangements by which society supports the universities are an ob-

stacle to creating and administering coherent campuses. Putting together bits and pieces from grants for research, training, or facilities from a number of different agencies may not add up to a whole program even if the money is sufficient. When funds are not available in the proper categories and amounts, a crisis such as the present one can be expected.

The Government should construct a funding mechanism to correspond to its policy for basic research performance. The Government must assure the strength of the nation's scientific institutions in order to assure the strength of U.S. science.

* * * * * * *

It is the responsibility of Government to reassess its institutions to make sure they are serving current needs. These new characteristics, within the fabric of political support and administrative management of Federal science activities, are the motivation for reorganization. The recommendations offered in this report stem from a long and thorough investigation. Other units of Government and the scientific community are also currently examining the possibilities for a new science agency. As far as we have been able to determine, most informed persons agree that increased centralization is indicated. Of course, the details of any proposal are subject to debate, but this general conviction is persuasive that some concrete realinement should be worked out.

The most practical approach, we believe, is to start with basic research, higher education, and advanced study; i.e., that part of the spectrum of scientific and engineering activity which is common to all technology programs. Our objective is to assure the continued flow of knowledge and understanding, and of skilled scientists so that the United States and, indeed the world, can find the means of survival.

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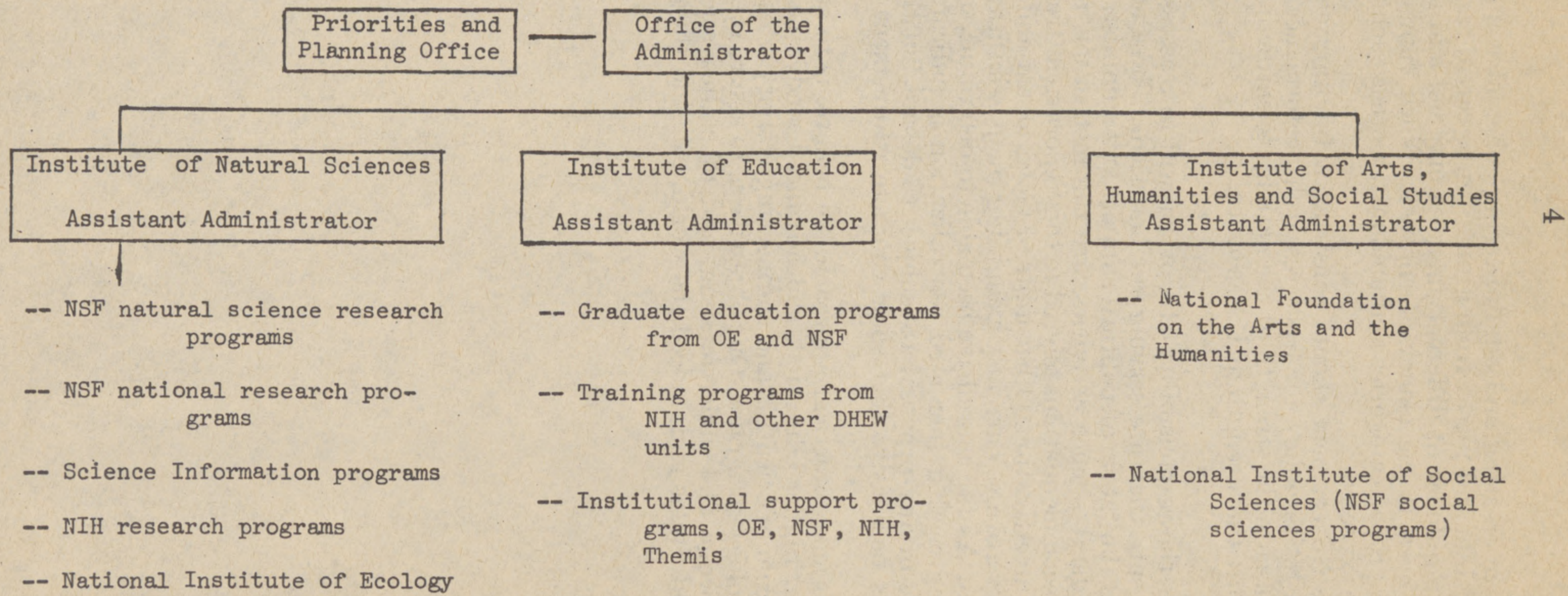
Chart 1

National Institutes of Research and Advanced Studies
(NIRAS)



II. RECOMMENDATIONS

In light of the findings set forth in the foregoing section, the subcommittee recommends and strongly urges the following action:

• The immediate establishment of a National Institutes of Research and Advanced Studies (NIRAS). This new agency would consolidate Federal responsibilities for basic research and graduate education, i.e., those scientific activities which are carried out in universities or similar institutions, and which are closely related to the total intellectual operations of higher education and advanced study.

The National Institutes of Research and Advanced Studies would be an independent agency but not at cabinet level. The Administrator would be appointed by the President subject to Senate confirmation.

Chart I shows the make-up of NIRAS. The present National Science Foundation charter is the basis for the new centralized organization. Thus the NSF in effect would be reconstituted into the NIRAS. Components of the present NSF would be distributed among the new Institutes with the exception of education programs at the undergraduate level or below, which would be transferred to the Office of Education, DHEW.

The administrative staff of NIRAS would include a Priorities and Planning Office. Advisory committees and boards already in existence for the units transferred into NIRAS would continue to serve, e.g., the National Science Board would advise the NIRAS Administrator.

At the present time it is not recommended that national laboratories and applied research and development programs (such as in AEC or in NASA) be considered for centralization. The NIRAS format will accommodate applied research which is an extension of basic investigations or which falls under the 1968 NSF amendment as broadly in the public interest. Other programs and parts of agencies could be added at a later date as logic may dictate.

Basic research projects determined to be no longer relevant to agency missions would be considered for transfer to NIRAS as they are identified by their present sponsors. Graduate education programs from various DHEW units (Office of Education, Environmental Health Service, Health Services and Mental Health Administration, etc.), and from other agencies (DOD Project Themis), would be transferred immediately.

The proposed National Institute of Ecology is being developed in detail under a contract from the National Science Foundation to the Ecological Society of America.

The concept of a National Institute of Social Sciences has been the subject of extensive hearings under the name National Foundation for Social Sciences.[1]

On the basis of fiscal year 1970 budget estimates the NIRAS components would command funding of about $2.3 billion annually. New

[1] "National Foundation for Social Sciences," hearings before the Subcommittee on Government Research of the Senate Committee on Government Operations. February, June, July 1967. 809 p. 3 pts.

institutes for ecology and social sciences would comprise some ongoing programs but would, by the very rationale of their establishment, call for increased expenditures in these areas.

• The strengthening of the science superstructure in the Executive Office of the President. While it may be inappropriate for a Congressional report to suggest specific details for this office, the testimony received suggests the following improvements:

(*a*) The staff of the Office of Science and Technology should be substantially increased.

(*b*) The Director of OST should be given Cabinet status similar to that conferred upon the special assistants to the President for national security and domestic affairs.

(*c*) OST should perform conscientiously the evaluation function transferred to it from NSF by Reorganization Plan No. 2 of 1962: "to evaluate scientific research programs undertaken by agencies of the Federal Government." Historically, both NSF and OST have eschewed this legal duty. The thorough performance of this task, however, should now become a major effort of OST. Increased staff should permit continuing evaluation even while attending to the day-to-day ad hoc assignments which are the inevitable lot of this office.

(*d*) The Federal Council for Science and Technology should make diligent efforts to become a more effective coordinating mechanism for government-wide activities; e.g., technology requirements of mission agencies; manpower; basic research level of effort; applied research, development, demonstration and testing; national laboratory redeployment; technology transfer among agencies and to the private sector; and priority setting among large technology opportunities.

(*e*) The Office of Science and Technology should be given serious consideration as the executive branch focal point for technology assessment. While assessments may be performed in many agencies and in the private sector, OST might well choose the projects, arrange for performance and transmit the results into the decisionmaking process.

(*f*) The OST should assume a planning, coordination and evaluation role for higher education programs of the Federal Government in all sciences, engineering and technological training.

• Stable, continuous, predictable funding of academic science and higher education on which the welfare of the United States depends. This policy should be implemented by the President and the Congress in conforming the annual budget process to the realities of long-term needs of universities and similar institutions. Two or three year projections of academic science funding, identifying likely budgetary support by scientific discipline and other pertinent categories, would greatly increase the efficiency of institutional planning for scientific research and education. The possibilities of a formula system should be investigated which would link funding for research and advanced studies to the total Federal expenditure for technological development.

• That the mission agencies continue to support basic research both in their own laboratories and in the universities. Governmental managers need the ideas and innovations of university scientists and the scientists need (and want) to be aware of the urgent social problems which can be solved through the expansion of knowledge. To isolate the missions of Government from the principal source of new ideas would be a grave error. Thus, the establishment of a NIRAS would by no means lessen the need for close liaison and actual contracts and grants between the universities and the mission agencies.

• That the Congress consolidate the jurisdictions of its committees dealing with research and education at the graduate level in all fields of learning. The NIRAS organization should undergo annual authorization hearings which will do much to coordinate congressional overview. Appropriations actions should be reasonably close to authorizations or the biggest single objection to centralization may prove to be deciding. That is the possibility that the present fragmented, piecemeal collection of programs under various agencies would fare better with the Congress than would a well-planned, coordinated NIRAS.

III. HEARINGS SUMMARY

This section of the report is an analysis of the testimony before the subcommittee during the hearings plus submitted written statements. The intention is to provide the reader with a concise summary of what the witnesses thought about the adequacy of the present Federal organization for science and technology, the various means by which changes might be effected, how the proponents of greater centralization would go about it, and what could be done to strengthen the present Federal organizational structure. Pertinent quotes are included in some cases to illustrate a point; in others, opinions are summarized. Additional detail may be obtained by referring to testimony of witnesses at page numbers in the hearings which are given in parentheses.

Witnesses Who Testified

Witnesses Who Testified—Continued

Witnesses Submitting Statements

A. Adequacy of Present Federal Organization for Science and Technology

1. *Consensus on need for changes*

Witnesses' testimony, both from within the administration and outside, agreed in one respect: That the complex, multitudinous department and agency involvement in Federal science and technology activities is in need of modification if the Nation's limited resources of funds, manpower, and facilities are to be utilized to the maximum extent. This fact is evidence of a shift in opinion within the past decade from the last time a committee of the Congress considered the question of Federal organization for science. At that time the Office of Science and Technology had just been established, the last of a series of reorganizations for science within the Executive Office of the President, and administration officials argued then for time to make the system work. In many important respects, the 1962 organization has been successful, but in 1969 even the most reluctant witness had to concede that changes were in order.

At heart of the discontent was concern with the leveling off of the Federal research and development budget, which had begun even before the demands of Vietnam and pressing domestic needs. Some way had to be found for a better ordering of priorities, for better top-level coordination, for continued, predictable, and stable support for academic science and graduate education needs.

Beyond these general areas of agreement, however, testimony of individual witnesses amply illustrated Congressman Brown's observation that "what is one man's objectivity is another man's bias" (p. 184). Witnesses tended to support modifications in areas with which they were most familiar, but in no case did they advocate giving up any presently held authority.

The range of witnesses' recommendations suggested for modification of the existing Federal structure is indicated below:

> Combine basic physical, biological, and life science research, graduate education, advanced studies in arts, humanities, and social sciences, and certain applied science facilities [essentially

the original National Institutes of Research and Advanced Studies proposed in the staff study] (Price, Dupree, and in large part, Handler and Reagan).

Build up existing capabilities of all departments and agencies (Seaborg, Wenk, Tribus, Seamans, Ink, Lenher, Harris, Long, Schriever, Stever).

Strengthen White House science structure (DuBridge, Seaborg, Wenk, Tribus, Harris, Long, Bennett).

NSF to have a larger role (DuBridge, Wenk, Dupree, Lenher, Brown).

Combine research and all of education (Keeney).

Combine research and higher education (Reagan, Shannon, Handler, Bennett, Fisk).

Research and development board assigned to President to keep track of goals, funding and allocation of resources (Seamans).

Central communication switchboard to facilitate interagency coordination and cooperation (Ash).

Department of Science (NSF, wet-NASA, institutional grant programs to begin with) (Piore).

Increased attention and/or support for applied research and engineering (Brown, Walker, DuBridge, Wenk, Stever).

Multidisciplinary institutes (Wenk).

2. *Current executive investigations involving science organization*

Organization for science is currently under consideration by a number of ad hoc groups which were established during 1969. Briefly, these include:

President's Advisory Council on Executive Organization (the Ash Council). Established by Presidential announcement of April 5, 1969, the Council will consider: "(1) the organization of the executive branch as a whole in light of today's changing requirements of government; (2) solutions to organizational problems which arise from among the 150-plus departments, offices, agencies, and other separate executive organizational units; and (3) the organizational relationships of the Federal Government to States and cities in carrying out the many domestic programs in which the Federal Government is involved."[1] Within this very broad framework, matters relating to sci-

[1] Announcement. Weekly compilation of Presidential documents, vol. 5, Apr. 14, 1969, p. 530. Members of the Council are: Roy L. Ash, president of Litton Industries, Inc., Beverly Hills, Calif., Chairman; Dean George Baker, of Harvard University's Graduate School of Business Administration, Boston, Mass.; former Texas Gov. John B. Connally, now a member of the Houston law firm of Vinson, Elkins, Weems & Searls; Frederick R. Kappel, chairman of the executive committee, American Telephone & Telegraph Co., New York; and Richard M. Paget of the New York management consultant firm of Cresap, McCormick & Paget.

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ence which have been identified for Council concern include the proposal made by the Commission on Marine Science, Engineering and Resources, that there be a new Federal agency created, the National Oceanic and Atmospheric Agency (Ink, p. 127). In response to a direct question concerning other areas relating to Federal science that the Council planned to consider, Bureau of the Budget witness Dwight Ink replied:

> The organization studies which are underway are at various stages of completion. These include, for example, studies of the Executive Office of the President, the social agencies, and the Federal structure for dealing with organized crime. Study plans have been drafted for many other subject areas, and the Council intends to consider the organizational issues related to Federal science efforts. However, these have not yet been specifically defined.[2]

More recent information reveals that the Council has also established study groups in two other areas which involve science: Federal regulatory agencies; and programs dealing with natural resources and the quality of the environment.

Reports are submitted to the President as they are completed. A report recommending reorganization within the Executive Office of the President has been completed and was cited by President Nixon as the partial basis for Reorganization Plan No. 2 of 1970 which he submitted to the Congress on March 12, 1970. (See discussion of plan at pp. 47–48.) It is expected that the bulk of the Council's recommendations will be transmitted to the President during 1970.[3]

Presidential Task Forces

Among the series of task forces which were established in accordance with the Presidential announcement of September 22, 1969, were the following:

Task Force on Science Policy (established October 6, 1969), to review the Federal Government's present science policy and make recommendations as to its future scope and direction.

Task Force on Priorities in Higher Education (established October 6, 1969), to "study problems such as imbalance in the present development of higher education in the United States, the assurance of adequate support for colleges and universities, campus conditions, and larger opportunities for students from minority and low-income backgrounds."

Task Force on Oceanography (established October 10, 1969), to "review the efforts of both the public and private sectors in the fields of oceanography, and suggest actions to accelerate the development of this increasingly important area of exploration".

Each of the task forces was established to assist the administration with ideas and recommendations for 1970 and beyond.

National Goals Research Staff

The establishment on July 12, 1969, of a National Goals Research Staff within the White House was hailed by one witness as "of great historical significance." (Wenk, p. 175.) The Presidential announce-

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[2] p. 134.

[3] "Supplemental appropriations, 1970" hearings before the House Committee on Appropriations, 91st Congress, 1st sess., November 25, 1969. Testimony by Council witnesses, at pp. 187–88.

ment noted that the Nation "can no longer afford to approach the longer range future haphazardly." Tools and techniques to project future trends are available and are being used in business, and in the social and physical sciences. They should and must be applied "systematically and comprehensively to the science of government." [4]

The small, highly technical staff will be made up of experts in the collection, correlation, and processing of data relating to social needs, and in the projection of social trends. Its functions will include:

Forecasting future developments, and assessing the longer range consequences of present social trends;

Measuring the probable future impact of alternative courses of action, including measuring the degree to which change in one area would be likely to affect another;

Estimating the actual range of social choice—that is, what alternative sets of goals might be attainable, in light of the availability of resources and possible rates of progress;

Developing and monitoring social indicators that can reflect the present and future quality of American life, and the direction and rate of its change; and

Summarizing, integrating, and correlating the results of related research activities being carried on within the various Federal agencies, and by State and local governments and private organizations.

The National Goals Research Staff is not a substitute for other research activities within the Federal Government. Its aim is to "help us make better use of the research now being done by bringing together, at one central point, those portions of it that relate directly to future trends and possibilities." [5]

That the National Goals Research Staff is not to be a planning agency and will not usurp or replace the political processes of decision-making was made clear. Rather it is intended to provide the information about alternatives and options, such as they exist, upon which decisions can be made.[6]

National Science Board report on the future of the NSF

An eight-member planning committee under the chairmanship of Dr. Emanuel Piore was created by the National Science Board late in 1968 to consider what the appropriate role of the National Science Foundation should be in the next decade. Among the various subjects which the committee has under consideration is the issue of centralization of Federal science and its relationship to the Foundation.

3. *Principal strengths and weaknesses of the present diffuse science organization*

Strengths

Several witnesses identified favorable aspects concerning the science organization as it has evolved. The theme of these defenses was that despite its faults, the system had produced scientific achievements that are admired and envied all over the world. (DuBridge, p. 20) The broad scope and general excellence of U.S. science were attributed to

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[4] Statement by the President upon announcing the establishment of the staff within the White House, July 12, 1969. Weekly Compilation of Presidential Documents, vol. 5, July 21, 1969 : pp. 982–3.

[5] Ibid, p. 983.

[6] News briefing by Dr. Daniel P. Moynihan, July 12, 1969. Weekly Compilation of Presidential Documents, op. cit., p. 985.

a pluralistic system in which the bulk of research emanated from the mission agencies. (Shannon, p. 283)

The present Federal science organization was defended for permitting active participation by hundreds of thousands of individuals in a wide variety of governmental, educational, business, and nonprofit institutions. Whatever form a reorganization might take, it should make it possible for the total scientific and engineering resources of the United States to contribute even more toward the attainment of national goals. (Harris, p. 237.)

In another view, our preeminent world position in science is due not to the methods of science but to the processes of democracy. In an open society, disagreements and debate are possible in seeking im provement in the human condition. Communication is fostered through all sectors of our society. Mobility is encouraged, and education for all is a national goal. The defense concluded, "These are our strengths. No sensation of riding over a corrugated road during this interval of strenuous budgets should undermine our confidence that we are headed in the right direction." (Wenk, p. 177.)

A most important aspect of the present system is that it has provided the freedom, diversity of choice, and opportunity which are necessary prerequisites to scientific pursuit of new knowledge. Dr. DuBridge spoke to this question:

> * * * Science is basically a human intellectual endeavor. New ideas in science emerge not from a machine, not from a computer, not from an organization chart, but from the imaginative, talented minds of individual human beings. Science flourishes when talented individual scientists have the maximum opportunity to use their talents in the pursuit of new knowledge.
>
> The three things that scientists need to pursue their investigations effectively are (1) freedom, or independence; (2) diversity of choice; and (3) opportunity.
>
> Freedom allows the individual to pursue his research in his own way without rigid or authoritarian controls * * *
>
> Diversity * * * means that a scientist will have a choice among many alternatives—as to what kind of a place in which he works, the field of science he pursues, and the way in which he pursues it.
>
> Opportunity means that when his choice has been exercised, the scientist will find the facilities, the congenial atmosphere, and the financial support which he requires.
>
> Our present great research institutions and our present pattern of private and Government support have provided these three prerequisites to a large number of competent scientists in this country. Whatever we do in Government must be aimed at enhancing and not degrading this situation. (DuBridge, p. 5.)

Weaknesses

Whereas the strengths of the present system were generally framed in broad terms applicable to the whole of the present science organization, many of the weaknesses of the system related only to particular segments; that is, government-university relationships, research and education, applied science and technology, et cetera.

Many witnesses spoke to one or more difficulties of the present system which were enumerated in the following excerpt:

> * * * From the standpoint of the Congress there has been increasing concern with respect to the amount of overlap and duplication of effort in this relatively uncoordinated system administered by a series of Federal agencies, with the possibility of inequities in the geographic distribution of funds when, for no one major agency, certainly no "mission agency," is this a major responsibility, with the difficulties of liaison and of information storage and retrieval, concern with respect to the contents of these diverse programs, and with respect to the efficiency of use of federally owned and operated laboratories. Meanwhile, the OST in the White House, charged with "coordination" of the Federal science effort, is woefully understaffed for this task and can hope only to achieve a few major planning efforts and the day-to-day "firefighting" as problems arise. From the standpoint of the administrators of some agencies, overlapping jurisdictional authority has presented serious problems with respect to long-term planning and program development, particularly with respect to science education, while the universities and their faculties are confronted with a maze of differing ground rules and regulations and administrative practices.
>
> Because the United States has, again without a truly overt decision carefully spelled out, accepted the premise that the universities should be the primary seat of fundamental research—rather than the independent research institutes characteristic of science in other nations—the problem of science support has become inextricably intertwined with the problem of financial support to the educational institutions wherein science is conducted.
>
> The final thread in this fabric stems from the fact that both the Congress and the mission agencies become decreasingly comfortable with both laboratories and research support programs which appear to be relatively remote from the agency missions; for example, the support of high-energy particle physics both by the Atomic Energy Commission and the Office of Naval Research, the support of materials science laboratories by the Advanced Research Projects Agency of the Department of Defense, the support research in chemistry and in fundamental biology by the National Institutes of Health, as well as those programs of the Bureau of Standards which seem otherwise unrelated to the classical functions of the Department of Commerce. To this list should be added the fact that the space agency is, in its entirety, a science conducting and supporting agency. The proponents of an amplified Federal undertaking in oceanography and marine science suggest that yet a new agency be created with exploration of the oceans as its primary mission, and, in other quarters, there is a substantial feeling that current understanding of ecological principles and phenomena is so primitive at a time when such understanding is imperative to intelligent planning for conservation, highway construction, pollution abate-

ment, and urban renewal that yet another agency is required to assure progress at a rate commensurate with national needs.

Meanwhile, the more painful aspects of American life in this decade have suggested to another group that an intensive and substantial program, by yet another agency, in support of the social sciences, so that the latter may contribute more effectively to the solution of national problems, represents yet another significant and seriously unmet need. (Handler, pp. 193–94.)

In general, there is too little public understanding of the relationship of research to ultimate social purposes. This is particularly true with respect to mission-oriented basic or fundamental research. While essential to an agency's mission, it has not been presented as an essential part of the agency's program, nor has it been effectively related to the general social purposes of the agency. (Shannon, pp. 283, 288–89.)

The present multiplicity of organizational structures, each pursuing research programs essentially independently from the others presents a serious problem.

* * * We, in Government, like to see neat organizational and management structures. The present multiplicity is admittedly confusing to Government administrators and legislators. We worry about coordination and efficiency and budgetary management.

Second, we find * * * that in a number of fields of science of broad national interest—such as, marine science, atmospheric science, environmental science, and other areas—it is hard to bring the several agencies with responsibilities in such fields together to implement an adequate and an adequately balanced national program. The various mission agencies have other responsibilities and priorities, and these may not add up to an adequate total program. From the point of view of my own responsibilities, this is a most serious defect in our present system. (DuBridge, p. 7.)

These criticisms of the system relate specifically to the Government-university relationship, and to research and education.

> * * * We are now seeing that a system designed fundamentally to meet the needs of Federal agencies for science and technology is not an adequate means of meeting the emerging responsibilities of the Federal Government for the support of universities, and particularly for the support of graduate education. (Bennett, p. 258.)

* * * * *

The most important weakness of U.S. science is derived from the progressive decoupling that has occurred between research and education. Such decoupling results in part from the mechanisms utilized in support of academic research, but more importantly from the lack of sufficient direct concern for the health and vigor of our institutions of higher education. (Shannon, p. 283.)

* * * * *

> * * * One problem is the occasional awkwardness that comes from having a large fraction of the university effort supported by mission-oriented agencies. There is the danger that the various mission-oriented agencies will not be willing to support all of the important fields of science and there is the danger of undue support of and emphasis on research as compared with teaching. Finally, there is the danger of fluctuating support depending upon the needs of the Federal agencies. These comments should not * * * be taken to imply that universities do not want or should not accept research grants from mission-oriented agencies * * * The problem * * * is not one of withdrawal but rather of program balance, of program continuity and of integration of the efforts of the various agencies. (Long, p. 310.)

4. *Recurrent linking of organizational format to ability to obtain funds from BOB and the Congress*

So long as the Federal research and development budget was increasing at a rate sufficient to cover the increasing costs due to inflation, increased sophistication of equipment, and higher salaries, the funding situation was not critical. There was money enough to support worthwhile on-going research, to finance some new research programs, and provide support to larger numbers of worthwhile investigators. Public acceptance of large military, space, and atomic energy and health programs included proportional increases for basic research. True, agencies and the educational institutions said that they could have used more money. Some worthwhile research proposals and fellowship applications have always had to be declined, and for several years the NSF appropriation was consistently below the amount requested.

The leveling off and actual cutbacks in research funding in recent years in the face of a constantly larger Federal budget indicate that the immediate and shorter range demands related to national defense and social needs are being given priority over activities whose estimated benefits are estimated to be longer range. This could be a dangerous course for the nation to take, particularly in view of the rising technological capability in other parts of the world.

The following research and development overview prepared in the Bureau of the Budget shows present allocations of funds in terms of selected factors, and offers at least a partial key to the basis for allocation of the research and development budget. (Ink, pp. 133, 135–37.) It appears to be primarily in those areas where the benefits are expected to be realized in from 5 to 25 years that the largest reductions in the Federal research and development budget have been made.

RESEARCH AND DEVELOPMENT OVERVIEW 1/

Program	Agency	Obligations, fiscal year 1970 (millions)	Expenditures, fiscal year 1970 (millions)	Major performers, by Institutions	Estimated percent	Performers by field	Estimated percent	Objectives (goods and services)	When benefits realized (estimated percent) 0 to 5 yrs.	5 to 15 yrs.	25 yrs.
SPACE											
Manned flight	NASA	$2,368	409	Federal Government	16	Physical sciences	2	Extended capability for manned space flight.	50	50	----
				Industry	83	Environmental	----				----
				University	1	Life	1	Manned lunar exploration			----
				Nonprofit	0	Engineering	97				
Sciences	NASA	455	455	Federal Government	21	Physcial sciences	10	Collection of basic research data on space environemnt and on bodies of solar system and cosmos.	----	----	100
				Industry	57	Environmental	----				
				University	21	Life	----				
				Nonprofit	1	Engineering	90				
Space applications	NASA	162	146	Federal Government	17	Physical sciences	5	Advance technology for application of space vehicle to economic systems such as weather prediction communications etc.	----	50	50
				Industry	77	Environmental	5				
				University	6	Life	----				
				Nonprofit	0	Engineering	90				
Space technology	NASA	328	146	Federal Government	56	Physical sciences	2	Advance technology of designing and developing space vehicle.	----	50	50
				Industry	34	Environmental	2				
				University	9	Life	2				
				Nonprofit	1	Engineering	94				
Aircraft technology	NASA	160	159	Federal Government	55	Physical Sciences	2	Advance technology of aircraft and engine design and operation.	----	50	50
				Industry	44	Environmental	----				
				University	0	Life	1				
				Nonprofit	1	Engineering	97				
Supporting operations	NASA	358	373	Federal Governemnt	26	Physical Sciences	5	Support other programs listed by tracking and data requisition and other general activities.	(1)	(1)	(1)
				Industry	64	Environmental	----				
				University	10	Life	----				
				Nonprofit	0	Engineering	95				
DEFENSE											
Research	DOD	444	420	University	40	Life	6	Exploration of phenomena exploitable in designing future weapon system and tactics.	10	80	10
				In-house	40	Psychological/ sociological.	2				
				FCRC's	10	Physical	87				
				Industry	10	Other	5				
Exploratory development	DOD	1,012	965	University	10	Life	10	Solution of military problems through demonstration of feasibility of technology (component and subsystem oriented).	25	70	5
				In-house	60	Pyschological/ sociological.	5				
				FFRDC	5	Physical	80				
				Industry	25	Other	5				
Advanced development	DOD	1,271	1,189	University	2	Physical sciences	10	Proof of feasibility of weapon systems and evaluation of their concepts.	25	75	----
				In-house	25	Engineering	90				
				FFRDC	8	----	----				
				Industry	65	----	----				

(1) Not available.

1/ Source: U.S. Bureau of the Budget

RESEARCH AND DEVELOPMENT OVERVIEW—Continued

Program	Agency	Obligations, fiscal year 1970 (millions)	Expenditures, fiscal year 1970 (millions)	Major performers, by institutions	Estimated percent	Performers by field	Estimated percent	Objectives (goods and services)	When benefits realized (estimated percent) 0 to 5 yrs.	5 to 15 yrs.	25 yrs.
Engineering development...	DOD	1,083	1,000	University	0	Physical sciences	1	Full-scale development of improved weapon systems.	80	20	
				In-house	12	Engineering	99				
				FFRDC	1						
				Industry	87						
Operating systems development.	DOD	3,107	2,975	University	0	Physical sciences	1	Full-scale development of improved weapon systems approved for deployment.	90	10	
				In-house	9	Engineering	99				
				FFRDC	1						
				Industry	90						
Management and support...	DOD	1,679	1,706	University	1	Physical sciences	3	Operation and construction of laboratories, test and evaluation of installations, and intermediate headquarters and other overhead which can't be directly allocated.	90	10	
				In-house	53	Engineering	27				
				FFRDC	6	Other	70				
				Industry	40						
Emergency fund	DOD	50	15	In-house	25	Engineering	100	Exploitation of new technical opportunities.	75	25	
				Industry	75						
Weapons	AEC	582	597	Industry	43	Physical sciences	60	Improved nuclear weapons	50	50	
				FFRDC (industrial)	30	Engineering sciences.					
				FFRDC (university)	26						
				FFRDC (nonprofit)	1						
ATOMIC ENERGY											
Special nuclear material	AEC	39	35	Industry	30	Engineering sciences		Cheaper production methods	100		
				FFRDC (industrial)	67		100				
				FFRDC (university)	3						
Reactor development	AEC	528	544	Industry	30	Engineering sciences		Cheaper electricity (52 percent)	10	20	70
				FFRDC (industrial)	42		89				
				FFRDC (university)	19	Physical sciences	10	Improved naval propulsion reactors (28 percent).	30	70	
				FFRDC (nonprofit)	9	Environmental sciences.	1	Improved space propulsion stage, nuclear rocket (11 percent).		15	85
								Improved space electric power generators (8 percent).	15	65	20
								Improved terrestrial power generators (1 percent)	20	80	
Biology and Medicine	AEC	97	100	FFRDC (industrial))	15	Life	93	Basic knowledge and understanding of biological effects or radiation on man and the environment.	33	50	17
				FFRDC (nonprofit)	10	Environmental sciences	7				
				FFRDC (university)	28	sciences.					
				Industry	3						
				Nonprofit	7						
				University	35						
				In-house	2						
Physical research	AEC	420	379	FFRDC (industrial)	10	Physical sciences	92	Basic knowledge and understanding of physical phenomena related to atomic energy.	20	60	20
				FFRDC (university)	70	Mathematical	2				
				University	20	Engineering	6				

Plowshare	AEC	14	14	FFRDC (university)	100	Physical sciences	50	Cheaper public works projects and ore recovery techniques.	20	30	50
						Environmental sciences.	10				
						Engineering	40				
Isotope development	AEC	7	7	FFRDC (industrial)	30	Engineering	60	Variety of peaceful applications of radioisotopes and radiation processing.	50	25	25
				FFRDC (university)	20	Physical sciences	30				
				FFRDC (university)	20	Physical sciences	30				
				Industry	30	Environmental sciences	10				
R. & D. IN SELECTED CIVILIAN AGENCIES—AGENCY											
National Institutes of Health.	HEW	1,092	910	University	59	Life	90	Treatment and cure of disease	15	40	45
				In-house	17	Other	10				
				Nonprofit	16						
Health Service and Mental Health Administration.	HEW	100	90	University	43	Life	40	Improvement of mental health	15	40	45
				In-house	24	Social sciences	19				
				Non-profit	16	Psychological	40				
				Other	17	Other	1				
Consumer Protection and Environmental Health.	HEW	117	100	University	20	Life	50	Improve environment (68 percent)	30	45	25
				In-house	60	Physical sciences	21	Protect consumers (32 percent)			
				Nonprofit	20	Engineering	24				
						Other	5				
Office of Education	HEW	91	94	University	45	Psychological	50	Improved education	15	75	10
				FFRDC	36	Social sciences	50				
Office of Economic Opportunity.		51	41	University	45	Psychology	50	Community development	55	35	10
				FFRDC	36	Social sciences	50				
National Science Foundation.		267	307	University	85	Physical sciences	64	Basic scientific knowledge		30	70
				Nonprofit	10	Biological	20				
						Engineering	9				
						Social sciences	7				
Housing and Urban Development.		31	19	University	8	do	77	Better housing and urban development.	40	60	
				In-house	10	Engineering	22				
				Industry	29						
				Nonprofit	46						
Department of Transportation.		234	220	Industry	72	Environmental sciences.	10	Better transportation	80	15	5
				In-house	18	Engineering	80				
						Social sciences	10				
Department of Interior		206	212	University	13	Physical sciences	15	Resource conservation	20	50	30
				Industry	23	Environmental sciences.	25				
				In-house	58	Life	25				
						Engineering	30				
Department of Agriculture		275	275	University	24	Social sciences	12	Improved agricultural production	50	40	10
				In-house	72	Life	65				
						Physical sciences	15				
						Engineering	5				
Department of Commerce		85	86	University	16	Physical sciences	25	Environmental prediction control; improved industrial productivity.	30	40	30
				Industry	11	Social sciences	25				
				In-house	62	Environmental sciences.	25				
				Other	8	Engineering	25				

The incidence of reduced funds has given rise to a series of related concerns which affect both the agencies' operations and those of their grantees.

(*a*) Agencies are forced to reduce on-going programs, and to postpone or give up entering on new programs.

(*b*) Institutions are being given abrupt notice of reduced funding for previously agreed projects. New proposals and requests face tougher competition and less than full funding if approved. Severe dislocations occur when previously made commitments cannot be honored.

(*c*) There is increasing concern whether resources which are available are being allocated to the most important problems. In the absence of any central source to consider all requests, no one, other than the overworked Bureau of the Budget, decides among competing requests. The staff of BOB is not chosen for competence in this sort of allocation. The Office of Science and Technology has no authority to do this and is now reportedly actually excluded from final budget-shaping decisions.

A part of the funding problem is due to political response to an assumed public disenchantment with science because some of its technological applications have had harmful side effects. This popular misconception—that the more science is supported, the worse off we will be—has been reflected in certain congressional actions also.

5. *The issue of relevancy*

The funding of academic science became a critical issue in 1969 with the inclusion of section 203 in the Military Procurement Authorization Act for fiscal year 1970 (Public Law 91–121) which states—

> None of the funds authorized to be appropriated by this act may be used to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function or operation.

By this action, Congress made mandatory the immediate examination of all research sponsored by the Department of Defense for relevancy to the Department's mission. The Department has now been forced to accelerate the process of ceasing the support of worthwhile but less relevant basic research which it had begun as far back as 1965.[8] The

[8] It was in 1965 that the idea of a "balance-wheel" function for the National Science Foundation was first enunciated. See extended discussion of the concept in "The National Science Foundation; Its Present and Future," report of the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, 89th Cong., 1st Sess. H. Rept. 1236, at pp. 80–88, and this summary statement from p. xiii:

> Thirdly, it is now apparent that as the Nation's scientific resources, including manpower, become more and more in demand to meet the exigencies of modern living, the Federal departments and agencies will depend more heavily on the Foundation to pursue avenues of research which they themselves cannot provide or afford. At the same time, the Government will need better overall evaluation of the status of our science resources and of individual scientific disciplines and their potential. The Foundation is the logical Government component to provide such assistance. It should be ready and able to do so. This "balance-wheel" function which NSF is being required to assume promises to become increasingly critical. Moreover, its parameters are not likely to encompass only the natural sciences. The social sciences and a better understanding of human behavior promise to be equally important and possibly a far more difficult field in which to achieve those breakthroughs essential to our collective and individual welfare in the future.

action signified an end to general congressional support for a previously accepted policy that mission agencies should support basic research both to improve the quality of their work and to provide a proper research base for long-term mission objectives.

The implications of the effect of the cessation of support of basic research by the mission agencies on academic science and on the National Science Foundation were discussed by several concerned witnesses and subcommittee members. (DuBridge, p. 29; Seaborg, pp. 45–59; Seamans, pp. 94–96; Dupree, p. 170; Lenher, pp. 223–24; Harris, p. 245; Piore, p. 345.)

From 1965 to 1969, the National Science Foundation has attempted to assume support for programs dropped by the Department of Defense and other agencies. The total pressure of these commitments will amount to approximately $19 million in fiscal year 1970,[9] and upwards of $50 million the following year. For fiscal year 1971 the Foundation has requested an increase of $15 million for scientific research project support, part of which is intended to finance a "significant" number of projects which it anticipates will be dropped by other Federal agencies. There are indications that in actuality the modest increase requested by the Foundation, even if fully approved, will be grossly inadequate to finance these cutbacks, which are expected to far exceed present estimates.

Dr. DuBridge pointed out that the transfer of research from one agency to another is a "very delicate" matter and requires coordinate congressional action. Unless the Congress understands and approves the funding arrangements, the net effect of such transfer of responsibility without funds is to decrease Federal support for necessary basic research effort.

Dr. Seaborg submitted for the record a lengthy account of AEC action relevant to the termination of DOD university research programs in high-, medium-, and low-energy physics (pp. 47–59). He testified that when the Department of Defense decided to transfer its high energy physics programs to some other agency, the Atomic Energy Commission was first approached to take it on. He said the Commission would have liked to support this research, but because it was budgeted on a line-item basis, it had no funds to accommodate new activities of this kind. Then the National Science Foundation was approached.

The Foundation was permitted to request an increase in its fiscal year 1969 budget to cover funds for Defense-terminated research but the amount of the increase was wiped out by the appropriations cuts and funding limitations which the Foundation sustained that year. Nevertheless, the Foundation has continued to support at reduced levels the majority of the Defense-terminated university research programs. The effect has been that the Foundation has been unable to support other worthwhile scientific research efforts.

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[9] A list of projects taken over from other Federal agencies since 1965 by NSF is found at pp. 1009–1011 of the Senate Committee on Appropriations hearings "Independent offices and Department of Housing and Urban Development appropriations, fiscal year 1970", 91st Congress, 1st Sess.

6. *Adequacy for applied research and development vs. adequacy for academic science and graduate education*

In the view of a majority of the witnesses, the organizational issue was more serious with respect to academic science and graduate education than for applied research and development. There was universal agreement that the mission agencies must be permitted to support applied research and development necessary to achieve their missions. Questions were raised as to whether certain research facilities under individual agencies are in fact related only to that agency's primary mission; whether some of the research facilities should more properly be regarded as national research facilities and be allowed to undertake research in other fields for other agencies; whether new organizational structures, such as applied science or multidisciplinary institutes, should be considered; and finally, whether the level of support of applied research and development effort was adequate.

Dr. Walker expressed the opinion that technology was not receiving sufficient attention either within the scientific community, the universities, or the Government. He raised the question whether basic knowledge is accumulating at such a rate that science is getting too far ahead of technology. The process of putting basic knowledge to practical use is usually lengthy and expensive and if the prospects of profit do not stimulate industry to enter areas of public need, then the Government must step in. He felt there are many areas of public need where the necessary applied research and development effort is not adequate, and although the National Science Foundation has authority to support projects in this area, it lacks the necessary funds (pp. 326–29).

Dr. DuBridge reminded the subcommittee that very different problems are presented when the management of science and of technology are considered. He said a prime motto which we in Government must keep in mind is: "We manage technology but we do not manage science. Or to put it another way: we must manage the process of technology; but we manage only the support of science. In technology we manage people; in the support of science, we only manage money" (p. 8).

His view was supported by Dr. Tribus who drew the line against or for management between research (which he maintained must not be controlled) and development (which requires it) (p. 118).

It is clear that a centralized agency which included even a limited amount of applied research and development activity along with academic science and graduate education responsibilities would be much more complex organizationally and difficult to establish than would an

agency concerned with the latter responsibilities only because it would—

1. Have granting, contracting, and operating responsibilities, each requiring different management;
2. Have a more widespread organization to consolidate;
3. Require liaison with a larger number of congressional committees;
4. Be greatly disrupted throughout its subagencies and in related departments by centralization;
5. Have necessarily larger funding problems.

The inclusion of certain commonly useful applied science and technology functions might be considered as a further step after an initial centralization of academic science and graduate education activities has taken place (Bennett, p. 281).

Multidisciplinary research institutes.—There is an increasing recognition of the need to call on the capabilities of both scientists and engineers from several disciplines including the social sciences in order to formulate a course of action to deal with many problems of broad social significance. Topic areas suggested as warranting creation of multidisciplinary institutes should include: city planning sciences; housing technology; urban transportation; environmental management; coastal zone management; educational research; technology for developing nations; marine affairs; technology for public administration; and safety and standards (Wenk, pp. 182–183).

The suggested role of such multidisciplinary research institutes was—

1. To develop a multidisciplinary base of technical competence that would provide facts and analysis for subsequent decision-making.
2. To conduct research needed to fill gaps in that knowledge.
3. To provide an improved coupling between the different institutional interests related to the issues; i.e., Federal and State governments, industry and academia.
4. To provide a meeting place between the general public whose welfare is intimately involved in each of these topic areas and those who will make the decisions concerned (Wenk, p. 189).

Federal laboratory utilization.—Many of the witnesses spoke to the unresolved question of the optimum utilization of federally owned laboratories which the subcommittee explored at length in 1968[10] (Harris, pp. 242–244; Ink, pp. 129–130; Lenher, p. 219; Long, pp. 312–321; Shriever, pp. 324–325; Tribus, p. 122; Seaborg, pp. 40, 43, 67–68).

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[10] "Utilization of Federal Laboratories", hearings before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, March 26–28, April 2–4, 1968, 90th Cong., 2nd Sess. 457 p. *See also:* "Utilization of Federal Laboratories", report of the Subcommittee on . . . of the House Committee on Science and Astronautics, 90th Cong. 2nd Sess. 1968, 68 p. Committee print.

The question of laboratory utilization is of continuing concern to the subcommittee. During its subsequent examination of the problem, the testimony of witnesses at the centralization hearings on this subject will be seriously considered.

B. Methods of Effecting Changes in the Federal Organization for Science and Technology

A considerable range of options exists for improving the present organization for science and technology.

1. *Reorganization*

The most extreme action would be to combine all Federal scientific, research, and technological functions into a single department of science and technology. None of the witnesses supported the establishment of so comprehensive an organization. Nor does the subcommittee know of anyone who advocates this kind of organization at the present time.

However, it is a favorite tactic of opponents of any form of centralization to attempt to discredit the idea by pointing to the disadvantages of a totally centralized organization. Some of the witnesses at these hearings presented as an argument against the model centralization proposal presented by the subcommittee the need for mission-related research and development to remain with the mission agencies. In fact, this point has never been at issue, as the subcommittee has been careful to stress. The arguments for and against centralization would have been more meaningful if increased attention had been directed to evaluating the NIRAS model or some other organization equally not all-inclusive.

There is pending in the Congress a proposal to establish a Cabinet-level Department of Science, Research and Technology (H.R. 464, Rep. James G. Fulton, 91st Cong., Jan. 3, 1969). Representative Fulton discussed his proposal during the hearings. He sees his organization as a "policy forming department rather than an administering department." He stated categorically that "it should not supersede or cancel out any of the present agencies." Its main job would be to coordinate and correlate science policy in the several departments and agencies (pp. 385–392).

Several witnesses suggested the establishment of various other organizations in which certain activities would be consolidated, principally, research and higher education (Long, p. 315; Handler, p. 195; Reagan, p. 151; Shannon, p. 285; Bennett, p. 262), applied science (DuBridge, p. 19). The original NIRAS proposal which would combine basic research, graduate education and certain applied science facilities was approved by Price (p. 156), and Dupree (p. 146).

Reorganization can also be accomplished by regrouping and adding to already existing portions of programs scattered throughout several

agencies, and giving the major responsibility to the agency with the largest responsibility. Examples are the Environmental Control and the National Air Pollution Control Administrations in Environmental Health Service of HEW and the Federal Water Pollution Control Administration in the Department of the Interior. The establishment of the multidisciplinary research institutes proposed by Dr. Wenk (p. 81), would fall within this category.

Finally, reorganization can be accomplished by creating new single-purpose agencies to deal with a well-defined problem area. The creation of the Atomic Energy Commission and the National Aeronautics and Space Administration are cases in point. The current proposal for a National Oceanic and Atmospheric Agency is another example.

Reorganization may take place as a result of Executive initiation (by means of submission of a reorganization plan to the Congress which goes into effect 60 days after presentation unless specifically disproved by either House of Congress), or as a result of legislation. The legislation may be proposed by the administration and be introduced by request or the initiative may come from the Congress. In either case, the proposed reorganization must have the explicit or implied consent of both legislative and executive branch.

Generally, witnesses suggesting reorganizations did not discuss the method of implementation. However, when Dr. Bennett presented the alternatives of establishing a Council of Advisers on Education and Science or the broadening of the charter of OST to include graduate education, he expressed a clear preference for legislation, rather than reorganization plan, for the council, but none between presidential action or legislation for the revision of OST. He explained, "science and education are now as significant to the national welfare as economic development and the Federal role in these areas is expanding and becoming more complex. It is important that Congress ratify this estimate. * * * Establishment of a council by law would expose issues to broad public debate and would ratify the operation in the eyes of Congress" (p. 263).

2. *Strengthening existing mechanisms*

Changes can come about through a gradual process of modification in the existing Federal structure for science, technology, and higher education. The system can be examined for areas of overlap or duplication. Relatively small increases of staffing and funding at critical points, e.g., in OST, yield disproportionate gains. Internal reorganizations can help increase efficiency. Interagency committees can be made more effective in achieving better coordination. Witnesses who supported this course of action as the principal means of improving the situation were DuBridge (p. 20), Seaborg (p. 37, 45), Tribus (p. 106), Wenk (p. 188), Stever (p. 367), Ash (p. 409), and Brown (p. 417). The remainder of the witnesses supported the strengthening of the Federal structure in general in conjunction with their various other proposals for reorganization of designated activities.

This type of change can be accomplished through departmental orders or agency memoranda, by executive order, by budgetary approval of proposed actions, where funding is involved, or by legislation.

3. *Increased funding*

Significant results without reorganization are possible with a funding action which permits continuation of current activities with provision to allow for an adequate rate of growth over and beyond the costs of inflation, more expensive equipment, etc. Dr. DuBridge spoke to this point:

> * * * I sometimes think that there isn't anything wrong with the present structure that a lot more money would not cure. I hope that a major goal of any restructuring that may be proposed by the deliberations of this committee will be to insure adequate financing of the Nation's essential scientific activities. The most beautiful organizational diagram in the world would be meaningless if no one provided any money. A prime purpose of a plan must be to insure [to] the maximum extent possible the continuous stabilized flow of adequate financing. The other desirable features of a good organizational plan—efficiency, coordination, communication, balance, flexibility, and the rest—are meaningless if there is no lifeblood in the system (p. 4).

The Chairman reminded Dr. DuBridge that sufficient funding did in fact overcome a lot of problems, but also "when there is plenty of money the inefficiencies are submerged" (p. 13). It is precisely because funding has become limited that the need for examination into the present organization has become necessary.

C. The Case for Further Centralization

The testimony covers an enormous spread of opinion and is not focused on a single organization concept. Nevertheless, weighing the "apples and oranges" produces a substantial balance in favor of centralization.

Suggestions for centralization which were proposed in the course of the hearings, or commentary concerning centralization proposals suggested by others are analyzed in this section. The discussion is organized around the areas which should be considered for centralization, the position of a proposed agency in the executive branch hierarchy, and the principal kinds of centralized bodies suggested. A summary of the pro and con arguments, specifically applicable to the original NIRAS proposal, from the testimony of the witnesses concludes the section.

1. *Focus of centralization*

The difficult question that must be answered at the outset is: "What are we organizing for?" The difficulty arises because the objectives are so broad. One witness suggested that the problem has arisen because our organization for science and technology has not yet resulted in the fulfillment of national aspirations in relation to social goals and to bettering American science (Wenk, p. 76). A further dimension of the problem relates to its future aspects. As the chairman pointed out, "* * * changes are taking place * * * that * * * must be considered in any review of the way in which our science resources are not only being handled, but [also] how they will affect all of us in the time ahead" (p. 76).

There was a wide range of opinion concerning what should be the area of concentration for centralization. As noted above (sec. A, pp. 10–11), several different kinds of centralized bodies were suggested.

The original NIRAS proposal would have combined academic science, graduate education, support for the arts and humanities, and a limited number of applied science facilities. Dr. Dupree who supported the NIRAS proposal saw it as an improvement in the following four respects in which any new arrangement had to be better:

> (1) It must emphasize the chain of connections, and not the disconnections, between long-range basic research and applied science generally, both in the interest of national security and of the alleviation of the social and medical problems which beset mankind. * * *
>
> (2) The new arrangement must take account of the humanities and social sciences as well as the physical and biological sciences. * * *
>
> (3) The new arrangement must recognize the connection of research and education in all fields more effectively than any present agency. * * *
>
> (4) The new arrangement must not be utterly dependent on the universities for the performance of research * * * (p. 146).

Dr. Walker observed a considerable degree of "loose thinking" in proposals which would bring together "science" and "technology". In his view no one makes a clear distinction between science and technology and the latter "always seems to be thrown in as an afterthought."

> Let me say that I think there will be quite a difference in meaning and scope between a Department of Science and a Department of Science and Technology. * * * To me in basic terms the job of science is to inquire into the workings of nature and to seek an understanding of it, to accumulate scientific facts for the sake of accumulating scientific facts. The task of engineering and technology is to use this information in the most practical and effective way possible to create

> the devices and systems that are needed for the comfort, convenience, and progress of man. * * * It is my impression that we, and the universities and Government, don't give enough attention to the technology end of it (pp. 325–326).

He cautioned that if any serious attempt to combine science and technology is made, it will be necessary to be explicit. It is not enough to imply engineering as part of science. Engineering and technology must be written into any proposal, and "not only in its title but in its procedures" as well (p. 328).

Dr. DuBridge, who expressed several doubts concerning the NIRAS proposal, suggested that consideration be given to the idea of an Institute of Applied Science and to the question "* * * whether a single agency operating a variety of laboratories established for a variety of different purposes and carrying on a variety of different kinds of applied science work would provide more effective management than if these laboratories were left with the existing agencies which are responsible for them" (p. 20). He expressed doubt that it would, for several reasons (p. 20), but he later referred to the idea as a "conceivable structure to think about" (p. 24).

By far the largest consensus concerning the focus of a centralized effort was toward the amalgamation of academic science and graduate education activities (Reagan, Shannon, Handler, Bennett, Fisk, Dupree, Price). One other witness, Dr. Keeney, advocated the amalgamation of education and research, but at all levels of education and with particular attention to educational research (p. 353). A majority of the above witnesses supported the inclusion of the social sciences and the humanities and, to some extent, the arts in any centralized agency which combined research and graduate education.

2. *Organizational position of proposed centralized bodies*

Independent agency status.—The NIRAS concept put forth by the subcommittee for discussion purposes suggested independent agency status for the new agency. The rationale was that if the agency were accorded Cabinet status, its head might then be regarded as the executive branch spokesman for science. This situation would place the Director of the Office of Science and Technology in an anomalous position. As a matter of fact, since only part of Federal science activities would be placed within NIRAS, its head could not be regarded as a spokesman for the whole of science.

Dean Price alluded to the "less hierarchical and less centrally administered" character of the NIRAS concept as preferable to an organization with "department" status which he thought suggested "too close a connection with the inner political councils of the President than is appropriate for this proposed agency with its mission" (p. 156).

Dr. DuBridge expressed the opinion that the establishment of an agency which combined the activities of the National Science Foundation with other agencies would result "in a lowering of the stature of the Foundation and its Director":

> The NSF Director now reports directly to the President, and under any of the new arrangements proposed he would

> report to another officer who in turn would report to the President. In view of what I have previously said, you can understand why I would not consider this an elevation or strengthening of our most important general science agency, the NSF (p. 12).

Cabinet department status.—The principle for and the problem caused by the establishment of a new Cabinet department were summarized by Dr. Bennett in connection with with his suggestion that consideration might be given in the future to setting up a Cabinet Department of Higher Education and Science:

> * * * As a general principle, it is desirable to place as many of the functions of the executive branch as possible in operating departments and agencies in order to keep the responsibilities of the Presidency within manageable bounds. However, as you know, it is a great problem to define the functions of a new department in a manner that will provide a broad, coherent set of tasks while keeping to a minimum the interfaces and points of overlap with other agencies (p. 263).

Dr. Piore supported the creation of a Cabinet department with operating responsibility, for several reasons (pp. 344–349): It would be in a better position to adjust to budgetary cutbacks because, unlike an organization like the NSF, it would have the power to make adjustments in relative priorities, or as Dr. Piore put it, "move pockets of money from one place to another." To get things done, an agency needs leverage. But to move on any problem is very difficult if action depends on waiting for a consensus to be reached. What is needed is both leverage and operational responsibility. Another argument in favor of a Cabinet department would be to give American science the exposure it needs in order to "let the people see and let the people be committed to a national policy that they want to support science. We lack this instrument at the moment."

Representative Fulton supported the creation of a Cabinet department to serve a coordinating and correlating function, thereby placing the force of the President directly behind the activities of the Cabinet member who would have the duty of overseeing science policy. He argued that decisions on priorities of action and funding would then be made at an administrative level according to scientific need rather than by people in the Bureau of the Budget on an accounting basis (pp. 385–391).

Operating status.—The original NIRAS proposal would have placed both operating and supporting functions under the Administrator. Objections to this dual role were raised by at least two witnesses. Dr. DuBridge observed, "I think experience has shown that when an agency has both operating and supporting functions, its operations must of necessity take precedence over its supporting activities. * * * The needs of a university for more funding of science can hardly take priority over the needs of an important Government laboratory for which an agency is fully and solely responsible" (p. 12).

Dr. Shannon also objected to giving an agency both policy formulation and program execution responsibilities, which he said was partially responsible for the deficiencies which characterize both the NSF programs and the development of our national science policy. "A science policy agency can scarcely have a broad operational program and be free of conflicts of interest" (p. 284). Giving a centralized agency operating responsibility would, in his view, serve as deterrents—

> To effective service as a focal point for the evolution of science policy;
>
> To the objective consideration of the Nation's science programs;
>
> To general acceptance of its leadership role by other elements of the Federal research and development establishments; and
>
> To its acceptance by the public and the Congress as an unbiased source of advice on the best manner by which our scientific resources can be utilized to satisfy our public (social) purposes (p. 284).

Advisory status.—At least four witnesses expressed a preference for the establishment of high-level advisory mechanisms to assist on policy matters relating to education, science, and their interrelationships (Seamans, Bennett, Shannon, Long). These proposals appear to resemble more closely ways of strengthening the science advisory mechanism which is already in existence in the Executive Office than they resemble the broader proposals for centralization mentioned above. A major aspect of these proposals is the inclusion of education (particularly graduate education) as a subject of continuing concern in the Executive Office of the President along with the already existing advisory bodies relating to national security, economic affairs, space, science, and urban affairs.

3. *Details of centralization proposals proposed by witnesses*

Details of the various proposals presented or supported by the witnesses are summarized in table 1. Not all the witnesses advocated the organization they suggested. Dr. DuBridge, for example, said only that consideration should be given to the idea of establishing a central institute of applied science. Dr. Bennett favored the establishment of a Council of Advisers on Education and Science; his second alternative was to strengthen OST, and his final recommendation was to continue to study the establishment of a new Cabinet Department of Higher Education and Science. The table is useful in showing the areas and the extent of consensus among the witnesses on the content and status of a centralized agency.

4. *Major pro-and-con arguments which are applicable to a NIRAS-type agency*

The hearing record would not be complete without a summary of the major arguments for and against a NIRAS-type or similar centralized agency. The compilation which follows consists of extracts from testimony of witnesses who spoke to various points. The objective was to select quotations which best presented the principal strengths and weaknesses which should be weighed when considering a reorganization of this scope.

TABLE 1

REORGANIZATION PROPOSALS SUGGESTED BY WITNESSES AT THE HEARINGS (NOT NECESSARILY ENDORSED FOR IMMEDIATE IMPLEMENTATION)

[x=totally applicable; xp=partially applicable]

	Witness	Title of proposed organization	Status			Responsible for—										Page references in hearings	
			Cabinet	Indep.	Advisory	Operating	Basic research	Academic science	Graduate education	All education	Arts	Humanities	Social sciences	Applied science			
1	DuBridge, Lee A	Institute of Applied Science				x								xp		1	19, 20, 24–25.
2	Wenk, Edward	Multidisciplinary research institutes			x									xp		2	81–83, 180–83, 189.
3	Seamans, Robert C	Research and development board in EOP			x											3	97–98.
4	Dupree, A. Hunter	NIRAS		x		x	xp	x	x		x	x	x	xp		4	145–47.
5	Reagan, Michael D	Department of Research and Higher Education.	x				xp	x	x		x	x	x	xp		5	147–55.
6	Price, Don K	NIRAS		x		x	xp	x	x		x	x	x	xp		6	155–59.
7	Handler, Philip	National Foundation for Research and Advanced Studies.		x?				x	x		x	x	x			7	196–99.
8	Lenher, Samuel	[See general comments on centralization]					x							xp		8	216–17.
9	Bennett, Ivan L	(1) Council of Advisers on Education and Science.			x			x	x	x				xp		9	262–63.
10	do	(2) Department of Higher Education and Science.	x					x	x							10	263–64.
11	Shannon, James A	Council of Advisers on Education and Science.			x			x	x	x				xp		11	284, 292, 299, 305.
12	Long, Franklin A	Planning Bureau for Federal Science Programs.			x		x							x		12	311, 317.
13	Piore, Emanuel R	Department of Science	x			x		x								13	344, 346–47.
14	Fulton, James	Department of Science and Technology	x													14	385–91.
15	Fisk, James B	NIRAS (research and higher education only)		x			xp	x	x		x	x	x			15	410.

TABLE 1—Continued

REORGANIZATION PROPOSALS SUGGESTED BY WITNESSES AT THE HEARINGS (NOT NECESSARILY ENDORSED FOR IMMEDIATE IMPLEMENTATION)

[x = totally applicable; xp = partially applicable]

	Witness	Title of proposed organization	Government agencies or units to be included in proposed organization												Page references in hearings
			EOP	OST	AEC	NSF	OE	NIH	NFAH	NFSS*	NIE**	Other	Not specified		
1	DuBridge, Lee A	Institute of Applied Science										x [1]		1	19, 20, 24–25.
2	Wenk, Edward	Multidisciplinary research institutes											x	2	81–83, 180–83, 189.
3	Seamans, Robert C	Research and development board in EOP	x											3	97–98.
4	Dupree, A. Hunter	NIRAS			xp	x	xp	x	x	x	x	x [2]		4	145–47.
5	Reagan, Michael D	Department of Research and Higher Education.			xp	x	xp	x	x	x		x [3]		5	147–55.
6	Price, Don K	NIRAS			xp	x	xp	x	x	x	x	x [2]		6	155–59.
7	Handler, Philip	National Foundation for Research and Advanced Studies.				x	xp	xp	x					7	196–99.
8	Lenher, Samuel	[See general comments on centralization]				x								8	216–17.
9	Bennett, Ivan L	Council of Advisers on Education and Science.	x	x										9	262–63.
10	do	Department of Higher Education and Science.				x	x		x			x [5]		10	263–64, 281–82.
11	Shannon, James A	Council of Advisers on Education and Science.	x	x										11	284, 292, 299, 305.
12	Long, Franklin A	Planning Bureau for Federal Science Programs.												12	311, 317.
13	Piore, Emanuel R	Department of Science				x						x [4]		13	344, 346–47.
14	Fulton, James	Department of Science and Technology											x	14	385–91.
15	Fisk, James B	NIRAS (research and higher education only).				x	xp	x	x	x				15	410.

*National Foundation for the Social Sciences (proposed).
**National Institute of Ecology (proposed).
[1] Some of the laboratories of NASA and the laboratories of the National Bureau of Standards and of the Environmental Science Services Administration.
[2] Laboratories of the National Bureau of Standards, and of ESSA and the proposed NOAA.
[3] NBS, ESSA, Geological Survey.
[4] Proposed oceanographic agency.
[5] In expanded groupings include Federal laboratories such as NBS, ESSA, proposed Social Science Foundation, life science programs from NIH and the VA research program.

Effect on NSF

PRO

* * * An amalgamation [of research and higher education] would be very healthy for the pure research community and for NSF: they have been living too unrealistic a life, through NSF's mistaken notions of "independence" from politics. Independence from partisanship is of course to be desired; but independence from the political purposes of the Government (which is close to what NSF's clientele have demanded) is both wrong and—as NSF has discovered in the past two appropriations seasons—ineffective even for serving the special interests of scientists. (Reagan, p. 149.)

CON

This arrangement would result * * * in a lowering of the stature of the [National Science] Foundation and its director. The NSF director now reports directly to the President, and under any of the new arrangements proposed he would report to another officer who in turn would report to the President. * * * You can understand why I would not consider this an elevation or strengthening of our most important general science agency, the NSF. (DuBridge, p. 12.)

Funding

If temporarily, reorganization also engenders a *small* degree of fiscal trauma * * * the fact remains that over historic time such an agency would be in a better position to assure that science and technology it makes possible are appropriately supported and managed so as to make maximal contribution to the welfare of the American people. (Handler, p. 199.)

* * * The chief argument [against a new major science agency]—at least within the scientific community—is the grave concern that, having failed to support the National Science Foundation in a manner commensurate with its potential contribution to American society, the Congress is unlikely adequately to support a yet more all-embracing science agency, and, hence, provide less support than the organizational components from which it had been fabricated might otherwise have commanded independently. I cannot help but share that concern. (Handler, p. 195.)

Timing

The desirability and the need for a Department of Science on the Cabinet level has been debated for the last 20 years. Until recently, the outcome of these debates could be summarized by stating that it has neither appeared

* * * I believe that the Federal Government does need additional centralized arrangements for handling its programs in basic and applied science and therefore commend the committee's investigations in this area. * * * At

desirable nor in the national interest nor important to the support of science to have a Department of Science. This feeling was very strong in the scientific community.

During the last few years, however, the scientific community's opposition to a Department of Science has been gradually eroding. This change in the general feeling toward a Department of Science has been due, in large part, to the modification of budgets, the shifting of support among various fields and the very large dependence upon Federal financing for the continued world leadership in scientific fields. (Piore, p. 342.)

the same time, I am doubtful whether it is yet time to take the full step of setting up either a Department of Science or a major National Institute of Science. Instead I think the Government should move toward greater centralization in this area but do it at a somewhat slower pace, learning as it goes. (Long, p. 310.)

Functions

* * * In the minds of some, a new major science agency could alleviate many of these ills, thereby easing the concerns of the Congress, providing for the support of inadequately nourished scientific disciplines and an appropriately balanced national program, enabling flexibility of response as new scientific vistas are opened and coming to grips with the perpetual problem of determination of priorities, meanwhile minimizing the difficulties of both investigator and academic science adminstrator occasioned by our pluralistic system, and assuring that science will be highly visible and sufficiently represented within the councils of Government. Moreover, such an agency, with its manifold listening posts, its links to all elements of the scientific and technological community could serve as a focus for efforts to assure that advancing technology could be brought to bear on the domestic problems of our society. (Handler, pp. 194–195.)

Another aspect of such an agency or institute arrangement is that it combines two different kinds of functions: First, the support of science, largely in universities and research institutes; and second, the operation of scientific and/or engineering laboratories or enterprises. I think experience has shown that when an agency has both operating and supporting functions, its operations must of necessity take precedence over its supporting activities. (DuBridge, p. 12.)

While we do not pretend to understand all the implications of centralization represented by the NIRAS prototype organization, we believe that consolidations of this nature will have to trade off *some expected gain in efficiency in pursuit of common objectives* against some expected loss in pursuit of unique objectives. (Ink, p. 124.)

See excerpt in pro column (Ink, p. 124.) [Note that the expected gain in efficiency because of pursuit of common objectives would have a trade-off of some expected loss in pursuit of unique objectives.]

What is suggested here and what I think is acceptable to everybody at this table is an agency which is much less hierarchical and less centrally administered than the standard Cabinet department. And I like the other terminology for that symbolism. But it is really just a symbolic point.

If the Federal Government is avowedly going to get into the business, as it has been actually now for a good many years, of supporting higher education along with research, you want to organize in a way which does not project Federal administrative controls on a hierarchical basis down into the laboratories. And I think that the scheme that is suggested here of a unified institution with each of its several parts representing the kind of balance that the Science Foundation has already exemplified—the balance between administrative responsibility on the one hand and a consensus in the scientific community on the other—you really need symbolism to signify that it is not being run like other departments. Just because it has broad concern for the whole range of science and higher education in the country, it doesn't mean it has to try to run the universities and the research laboratories of the country right out of Washington. (Price, p. 156.)

As to the first [of the three categories of motivation for reconsidering centralization given in the background report], organizational neatness, I will only comment generally that the desirability of this in Federal programs is, by no means, limited to science and technology. More specifically, I would associate myself with a statement made by Dr. James Fisk in 1961:

> "The diffusion of science and technology throughout the government is not a sign of untidy administrative housekeeping. Rather it reflects the very nature of science itself. Organizationally, science is not a definable jurisdiction. Like economics, it is a tool. It is an instrument for accomplishing things having nothing to do with science." (Bennett, p. 256.)

PRO

[With particular reference to a statutory Council of Advisers on Science and Education, but also applicable to any other proposal for centralization.]

* * * The point that I would like to emphasize is that brought out by Dr. Shannon, that the very reason that this [advisory council] should be created by legislation is that in the creation of this by legislation, Congress would have to give thought to what receptor mechanisms it would set up in the form of committees or subcommittees so as to take advantage of whatever came from this new organization in the executive branch. (Bennett, p. 302.)

CON

Why then do some university people think there should be a change in Government structure? As far as I can tell, there is but one principal reason: a more coherent or more centralized structure, some believe, will be able to speak more effectively for science in the administration and in the Congress and, hence, to secure adequate funding. This is an important matter, and—if true—would be a powerful argument for a more centralized structure—such as, say, a Department of Science. But would such a single agency be more effective in dealing with its two authorization and two appropriation subcommittees in the House and Senate than several agencies with their several committees? I must leave the answer to that to those of you who are more experienced in the behavior of congressional committees. My limited experience leads me to have some grave doubts. (DuBridge, p. 7.)

HUMANITIES

The new arrangement must take account of the humanities and social sciences as well as the physical and biological sciences. The fields conventionally outside the definition of science must be included, and must partake of the same rationale as makes Government support of any kind of science possible. The humanities and certain parts of the social sciences cannot effectively justify themselves by an argument of indirect practicality, and certain other parts of the social sciences cannot by any definition be separated from applications. Therefore the Government must come to see strong and effective intellectual activity regardless of field as a national necessity and a bulwark for free universities. The NIRAS model certainly recognizes this dimension. (Dupree, p. 146.)

My major criticism of the proposal * * * is that the reorganization would still leave a great deal to be accomplished, and very little with which to accomplish it. I do not say that centralization would injure the Government; neither do I say that it would be great advantage to the Government, or to the humanities. I do say that I doubt very much that any reorganizational steps are going to make much difference where the humanities are concerned, until the humanities—and their uses—become an important and daily part of American life. And I do think that Government activities in education, and possibly research, ought to be centralized, with particular attention to innovation in education. (Keeney, p. 353.)

Another major need, which DRHE* can help meet, is for a common framework for Federal support of science, social science, the arts, and the humanities. The Federal Government is now not just the patron of science, but the patron of *research*—in all disciplines. Although I would have some concern about the humanities and social sciences being swallowed up in a combined department (and have for that reason earlier supported Senator Fred Harris' proposed National Foundation for the Social Sciences as an entity separate from NSF). I think that under the DRHE concept the advantages outweigh the dangers. For if the Department is as broad in scope as I would like to see it, there is no reason in the world why the Secretary need always be a physical scientist. In fact, it would be a very healthy development—even an educational one—for scientists to have to make their case in an agency directed by someone who is not himself a physical scientist but who is conversant with basic research in some area.

As Federal support for social science and the arts and humanities burgeons—it is bound to do so in the next few years—common principles will have to be developed for equitable and rational allocation of resources among and between these major areas. A single agency would be able to avoid a narrow perspective on each. The effort at consolidation would be messy, perhaps, but it would be productive of a fruitful interfield dialog. In general, the public interest is always advanced when narrow interests have

I should like to direct some comments to the matter of Federal support of the social sciences and the organizational implications of such support. It is obvious that the Nation is faced with growing problems requiring decisions and actions based on sound social, political and economic data and on better knowledge about human attitudes and behavior. This has naturally led many to the belief that more research in the social sciences is needed, and sometimes to the further conclusion that a separate organization for general support of the social sciences is the best way to promote expansion of this field. Let me add, however, that much research on social problems is needed which goes well beyond the social sciences. I think, for example, of the engineering research related to housing. This indicates the need for a greater cooperative effort among social scientists and natural scientists working on social problems.

On the other hand, there are those who view the present Federal support of the social sciences—let alone any expansion—with suspicion. The seeming lack of relevance of many federally financed research projects and the sensitivity and controversial nature of the subjects dealt with make the social sciences an obvious target of attack. This suggests that a separate organization for the social sciences would be highly vulnerable to programmatic and budgetary constraints.

When the pros and cons of a separate organization for the support of the social sciences are weighed—together

* Dept. of Research and Higher Education, very similar to NIRAS.

to be weighed in a broader context than they provide in themselves—so that policy choices cannot be dictated by too narrow a perspective. (Reagan, pp. 148–49.)

with the general reluctance to proliferate executive branch organization—the bureau continues to conclude that the need or desirability of a separate organization has not been persuasively established as yet.

More and more mission agencies are exhibiting an interest in support of social science. Regardless of whether a separate organization is later found to be desirable, agencies with important social goals should be encouraged to utilize social science more effectively in support of those goals. (Ink, p. 126.)

* * * This report does a valuable negative service * * * by debunking the idea that all research ought to be put together. There were shadings of difference between the testimony of Mr. Reagan and Mr. Dupree here, and I might differ in minor degree with them but I think everybody here agrees with what this document says: "That the major principle should be that clearly identified mission-oriented research should remain with the operational agencies." This is what justifies the appropriations. And in any case, a measure of pluralism is good; in any case a certain amount of basic research unquestionably does something to keep the applied research programs alive. And the connection is important. (Price, p. 157.)

My conclusion from a study of history, and from my own involvement in scientific research, is that those who think they can centralize the control of research ought to forget it and for two good reasons:

(1) They cannot succeed.

(2) If they even meet with partial success the major result will be the choking off of creativity.

The things which can be done to enhance the probability of useful research are mostly in the categories of avoiding those things which hinder the process. Good scientific research requires a permissive atmosphere, reasonable financial support, and above all freedom. Freedom to try, freedom to publish, freedom to persuade, freedom to travel, freedom to make mistakes, and freedom to contribute.

To put it more bluntly, one should not try to centralize the control of research because it cannot be done without either serious detriment to the results or loss of necessary opportunity for the man with the new idea.

I have dwelt on the topic of research because I think it is important enough to justify a separate discussion of why we ought not to centralize it. On the other hand, I believe that engineering development can be managed and can be controlled much better than it is. (Tribus, p. 102.)

Research continues to be relatively unpredictable. It would be a mistake to have an arrangement whereby a single individual either at the top of, or buried somewhere in, a single agency could make the decision not to follow a certain line of research despite the opinions of a large body of researchers. The multiplicity of support which has existed in the past has prevented this from happening, and a number of vital pieces of basic research have thereby taken place which otherwise would probably have been cut off. (Brown, p. 417.)

The mission-oriented agencies have a great deal to gain by supporting basic research in terms of establishing relationships with researchers, so that those researchers may become interested in the applications and development which lie at the heart of the activities of the mission-oriented agencies. They then can act as consultants for, or have ideas on, these developments, thus providing an important input from highly intelligent and motivated people outside of the government. Researchers, faculty and students simply will not have the same attitude toward some of the applied problems if their work is entirely sup-

To say that we can see the advantages doesn't mean that we could immediately be sure we should take thus-and-such an agency away from a department and put it here. As one who has spent a fair part of his life working as a bureaucrat on administrative analysis I think that unless you really calculate what you are losing by taking a program away from another department, you can't really evaluate the net cost of the transfer. And this, of course, I haven't done. But as far as general approach goes, we have here, I think, a proposed package which makes a lot of sense in several ways. (Price, p. 157.)

ported by some pure research agency. Furthermore, I believe that the agencies which ultimately use the fruits of basic and applied research have a direct, even if not the primary, responsibility for the health of those activities. This means that these agencies should directly support such activities. (Brown, p. 417.)

Reporting Systems

And when we put the several things together in this model scheme, one thing I think comes out quite clearly * * *: The multiple grant-in-aid and contractual programs that we have been using to run all of this business, each of which was justified at the outset as a separate enterprise, involves so much redtape and so many reporting systems that you put a very considerable burden on the instittuions that you are endeavoring to help.

The danger here, I think, is not central policy control over universities and research laboratories; nobody, as far as I know, has ever wanted to exercise it. It is the piddling little control that comes at the 15th level down where the administrator is worried about reporting to his boss and his boss is worried about reporting to you gentlemen, and so they put on a lot of conditions that don't do anybody any good and add greatly to the burden of the work and complicate everything. This is not dissimilar to the model cities program and to the Health, Education, and Welfare grants to cities and States. The Federal Government, by getting deeper into grant-in-aid programs of all kinds has now, I think, got to think more carefully whether the de-

tailed supervisory system, and the detailed system for controlling the applications and the awards, have not been set up in much more pluralistic and restrictive detail than make any sense from the point of view of either the donor or the recipient. (Price, p. 157.)

Were such an amalgamation to occur, then it would become possible to simplify many procedures, rationally to manage a somewhat more desirable form of H.R. 35, and to arrange for Federal support of graduate research education along the lines proposed in the first annual report of the National Science Board. (Handler, pp. 198–199.)

Management Problems

In matters pertaining to organizational change, it is, obviously, seldom, if ever, the case that any given organizational pattern is ideal. There is, moreover, a widespread recognition that the management of resources and people is usually the major determinant of success, regardless of organizational pattern.

Finally, I would like to add the caveat that the creation of large government organizations often tends to reduce flexibility in program management and can tend to stifle creative science. Organizational layering, administrative complexity, and a new order of complication in decision-making, all seem to be frequent byproducts of large organizations. (Ink, p. 124.)

D. Strengthening the Present Federal Organization for Science, Technology, and Education

Major areas in need of improvement which both proponents and opponents of further centralization agreed on are (1) the organization for science, technology, and education in the Executive Office of the President, and (2) the continuation of relevant mission-oriented basic and applied research and development in the departments and agencies, and (3) a larger role for the National Science Foundation.

1. *Organization for science, technology, and education in the Executive Office of the President*

It is generally recognized that no matter what kind of centralized agency might be agreed on, its status vis-a-vis the other departments and agencies would only be coordinate. Therefore, the need still remains for a top-level coordinating body to ease interagency conflicts, to advise on priorities, and to integrate science with the other facets of public policy.

Science and technology of one kind or another are responsibilities of a majority of the advisory bodies within the Executive Office of the President. Among these bodies are: (1) the Office of Science and Technology, whose Director is also the (2) President's Science Adviser, and Chairman of the (3) President's Science Advisory Committee and of the (4) Federal Council for Science and Technology. (5) The National Aeronautics and Space Council and (6) the National Council on Marine Resources and Engineering Development [11] were established to coordinate space and oceanographic activities respectively. The chairman of each is the Vice President. In 1969, a Presidential Task Force on Oceanography was established to consider ways of accelerating the public and private development of this important area.

Dealing with problems related to the environment are (7) the Council on Environmental Quality, (8) the Cabinet Committee on the Environment, (9) the Citizens' Advisory Committee on Environmental Quality, and (10) the Task Force on Air Pollution. High-level matters involving science and technology in military or foreign affairs are decided in (11) the National Security Council. Finally, the place where all the scientific and technological concerns of the whole Government come together is (12) the Bureau of the Budget.

Questioning of Dr. DuBridge brought out these main points concerning the Executive Office science organization:

1. Reports of panels of the President's Science Advisory Committee on such problems as defense technology, space technology, environmental science, urban problems, academic science, et cetera, which bring to the attention of the cognizant agencies gaps or inadequacies or lack of coordination have proved to be "fairly influential" documents in helping those agencies (p. 15).

2. NSF assists OST through the provision of statistical studies, and other information-gathering and background studies (p. 15).

3. OST is responsible for the operation of the Federal Council for Science and Technology and is "trying earnestly to make it more effective." An OST staff member is designated to serve on each committee

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[11] The National Council on Marine Resources will go out of existence on June 30, 1970, unless its life is extended by further legislation for another year, as was recently requested by the administration.

of the Federal Council, either as chairman, chief executive officer, or member. He observed that "Many of the reports of the Federal Council suggesting remedies for inadequacies in our science and technology picture have had a very great influence in bringing attention to these problems and in encouraging agencies to take further action or revise their activities or policies" (pp. 15–16).

4. OST is working with the White House congressional liaison officers "to see how more effectively we can get the proper information to the congressional committees as to the total science and technology needs of the country and how the needs of the various departments fit into this picture" (p. 16).

5. OST is attempting to establish a closer relation with the staffs of the Marine Council and the Space Council.

6. Regarding OST-Bureau of the Budget relationships, Dr. DuBridge said, "We also work closely with the Bureau of the Budget in looking at the whole science and technology budget of the Nation. We are now conducting a very intense study in collaboration with BOB to see where our total science and technology budget is adequate or inadequate" (p. 16).[12]

It would appear that no matter what the scientific or technological problem, an organizational unit exists at the Presidential level to which it can be referred. Whether that organization is adequate to meet competing demands put on it is the real question.

On the other hand, matters relating to education which must be settled at the Executive Office level must be dealt with largely on an ad hoc basis. In 1965, a Committee on Academic Science and Engineering (CASE) was established as an interagency coordinating committee of the Federal Council for Science and Technology. Its task was to implement the President's policy directive regarding strengthening the academic capability of science throughout the Nation and to deal with other matters involving Federal Government-university relationships.

From the beginning CASE has maintained a close relationship with the Federal Interagency Committee on Education (FICE), established in 1964. However, both units are interagency committees, neither of which has authority or means to attain anything more than voluntary compliance.

There is now one additional ad hoc group at the Executive Office level dealing with education. This is the Task Force on Priorities in Higher Education, which was established in October 1969 "to study problems such as imbalance in the present development of higher education in the United States, the assurance of adequate support for colleges and universities, campus conditions, and larger opportunities for students from minority and low income backgrounds."

Two observations appear to be valid criticisms of the Executive Office organizational structure for education, and higher education in particular: (1) the interagency coordination of educational policy is weak, and (2) inadequate structures exist to reconcile the goals for the Federal support of academic science with the broader question of the Federal role in support of higher education.

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[12] Recent press stories about Dr. DuBridge state that OST was excluded from the final round of Bureau of the Budget deliberations on the fiscal 1971 budget. (Jonathan Spivak: "Nixon's science advisor shines quitely," Christian Science Monitor, Feb. 11, 1970: 18; and James M. Naughton: "DuBridge, a quiet man at White House, stirs worry among scientists that his views are not heard," New York Times, Mar. 1, 1970:70).

Dr. Bennett summarized the problem in this excerpt from a staff study which he submitted for inclusion in the hearing record.[13]

> *New means of reconciling goals for academic science and higher education.*—The existing arrangements for evolving strategies for academic science or for appraising the interaction of the natural sciences with the humanities and social sciences are inadequate. The present arrangement displays only ad hoc organization for communication and consultation within the Federal components of the system and externally with academic institutions and their intermedians. Under the theory that has prevailed until now, advance consultation among agencies to adjust proposed actions that will affect higher education and academic science should be effective. *It is quite evident, however, that consultation of this sort will be less and less effective in producing significant alterations in the prospective situation, and particularly in coping with the large-scale problem of securing a good fit between Federal programs for academic science and other programs affecting universities, particularly at the graduate level.* There has been much interagency consultation on major actions affecting academic science, but even in this area, effective action is limited. Timely results are hard to derive from interagency consultation because the power of decision is dispersed among many points and levels in the large agencies. Finally, the mission agencies have statutory authority to modify their programs in the interest of strengthening academic science only within very narrow limits.
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> When the broader question of *reconciling goals, emphasis, purpose, and relations* between various programs for academic science and for more general support of higher education is considered, it becomes evident that the machinery is even rudimentary. Two weak interagency committees, *the Federal Interagency Committee on Education and the Committee on Academic Science and Engineering of the Federal Council for Science and Technology*, provide the only institutionalized means of dealing with these questions.
>
> The *climate has changed rapidly* and now includes budgeting constraints; rising costs of performing research; multiplying problems at the interface of academic science and higher education in general; pressures for equalization in distribution of limited funds for academic science and institutional support; increasing institutional needs for assurance in long-term planning; and frustration and friction arising from inadequate government-university communications.
>
> It is time to strengthen the Federal organization for planning, balancing, and communication between the function of supporting academic science and the emerging Federal function of general support for higher education. Therefore, *any structural remedy must go beyond a concern for academic science alone and place research and education in a unified perspective.*

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[13] Some suggestions for improving the administration of Federal programs of support for academic science (pp. 264–282, at pp. 275–276).

Suggestions for Changes in the Executive Office Organization

Significant reorganization of the Executive Office of the President was proposed with the transmittal to the Congress on March 12, 1970, of Reorganization Plan No. 2 of 1970.[14] Seeking improvements in two major areas—policy determination and executive management—the plan would establish a Domestic Council, a counterpart to the National Security Council, to coordinate domestic policy formulation, and would reorganize the Bureau of the Budget into an Office of Management and Budget, to be the President's principal arm for the exercise of his managerial functions. Consolidated at once under the Domestic Council would be the interagency Council for Urban Affairs, the Cabinet Committee on the Environment and the Council for Rural Affairs. With the President as Chairman, the Council's membership will include the Vice President, and the Secretaries of the Treasury, Interior, Agriculture, Commerce, Labor, Health, Education and Welfare, Housing and Urban Development, and Transportation, and the Attorney General. Other members will be the Director of the Office of Economic Opportunity and the Postmaster General so long as the Post Office remains a Cabinet department. The President may add other executive branch officials at his discretion.

It is understood that statutory units in the Executive Office will not be affected by the reorganization. Neither the President's message nor the plan itself mentions any of the science-based units within the Executive Office. But a quick review of the specific policy functions for which the President intends the Domestic Council to assume a lead position makes it apparent that science, technology, and educational needs, policy choices, priorities allocation and review will have to be taken into consideration because they are important parts of the total needs, policy choices, priorities allocation and review questions.

Proposed changes in the Executive Office organization for dealing with science, technology, and education suggested by the witnesses during the hearings had several main themes:

1. Most frequently heard was the view that the OST was understaffed in relation to the size of its task. The present staff of about 50 is certainly too small. To double it immediately might make it unwieldy. Perhaps an increase somewhat in between would be advisable. (Seaborg, p. 74.)

2. OST should be more involved in the budget process for science (Seaborg, p. 60; Long, p. 313; Bennett and Shannon, p. 259). A suggestion was made that OST might be placed within the Bureau of the Budget. (Piore, p. 354.)

3. The policy planning capabilities of OST should be expanded. (Wenk, p. 184.)

4. OST should be given added authority for higher education, especially graduate education, so that academic science and graduate education can be considered as a unified package. (Bennett, Shannon.)

5. The Science Adviser and the Director of an enlarged OST should not be the same person. Each job is important. To the query whether the Science Adviser would lose some of his effectiveness, it was agreed that "the answer really * * * depends upon how the President uses the office and the man" (Long, pp. 321–322).

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[14] 91st Cong., 2d Sess. H. Doc. 91–275. 9 pp. Referred to House Committee on Government Operations.

6. Two or three presidentially appointed Deputy Directors for an enlarged OST should be authorized. (Long, p. 321.) Or the OST might be reconstituted with several advisers in a Council of Advisers on Education and Science, analogous to the Council of Economic Advisers. (Bennett, Shannon, p. 298.)

7. The coordination role of OST must be strengthened. The influence of interagency coordinating committees is directly related to the level at which the mechanism operates. Presidentially chaired committees are most effective of all. The Federal Council for Science and Technology has neither time nor capability to do in-depth coordination. It has no leverage. It can only act in consensus or through persuasion. It lacks authority. As one witness put it—

> Coordination will produce a lot of paper and a lot of reports. Two years from now they will be reproduced again with different signatures on them. But we will not get a big dish built for astronomy, for example (Piore, p. 346).

8. The final decisions are made in the Bureau of the Budget and in the Appropriations Committees by nonscientists. The Bureau of the Budget should acquire some science competence in its own right (Shannon, p. 286).

As a consequence of the President's reorganization plan, the witnesses' recommendations of almost a year ago must now be evaluated in terms of their current validity. If congressional hearings are held on the reorganization plan, this would be an important avenue to explore in order to gain further insight as to what the position of already existing statutory bodies will be vis-a-vis the Domestic Council and the Office of Management and Budget.

2. *Role of mission agencies*

Need to continue applied research and development activities.—Despite the fact that the subject has never been at issue so far as the subcommittee and most other critics of the present organization are concerned, the need for mission agencies to continue to support research and development related to their assigned tasks was emphasized constantly throughout the hearings. This attitude implied that (1) research effort needed to fulfill the agencies' missions would be removed to a centralized agency; and (2) every activity now under the jurisdiction of a particular agency did in fact relate to its present-day mission and should remain there.

Almost all the proponents of including certain applied science establishments within a centralized agency mean only those facilities which could be removed without affecting the mission agency's primary duties. Dean Price, referring to the subcommittee's background centralization report, said it did a valuable negative service by "debunking the idea that all research ought to be put together." While he said there were shadings of difference between individual witnesses, "* * * I think everybody here agrees with what this document says: *that the major principle should be that clearly identified mission-oriented research should remain with the operational agencies*" (p. 157, emphasis supplied).

Mission agencies' responsibilities for supporting academic research and higher education.—It is much easier to relate applied research and development to the mission of a department or agency than

in the case of basic research. To go a step further, it in turn is easier to relate basic research to the mission of an agency than it is to justify support for the higher educational system. It is in these areas that difficulties arise, and yet the strength of the institutions depends on the production of research results and trained scientists.

In 1965, President Johnson in a memorandum to the heads of all departments and agencies stated that "a strong and vital educational system is an essential part of the Great Society." Directing attention to the Nation's colleges and universities, he termed them the "apex" of the educational pyramid where education and research become inseparable. He related the strength of the research and development programs of the major agencies to the total strength of our university system and said, "Research supported to further agency missions should be administered not only with a view to producing specific results, but also with a view to strengthening academic institutions and increasing the number of institutions capable of performing research of high quality." To this end—

> Departments and agencies should carefully assess the degree to which and the manner in which their existing programs support this policy and, when indicated, should use a larger proportion of their research funds in accordance with the intent of the policy. The means for attaining this objective will be determined by each department and agency. In carrying out the policy, the various Federal agencies supporting research at a university should act in concert to a greater degree in making decisions, so as to make the university better able to meet the collective needs of the agencies and to make the Federal support most effective in strengthening the university.[15]

Project Themis of the Department of Defense is the only new program which was undertaken in specific response to this directive. Implementation of this directive required additional research funding availability but since 1965, the exact opposite situation has prevailed.

In a statement of February 5, 1969, increasing the expenditure ceiling of the National Science Foundation, President Nixon endorsed the continued support of the education and research programs of the Nation's colleges and universities but the statement was ambiguous in that it did not indicate who, in addition to the National Science Foundation, should be doing this.

> The colleges and universities of this Nation provide a critical resource which needs to be fostered and strengthened. Our higher educational system provides the advanced training needed for tomorrow's leaders in science and technology, industry and government, and also conducts the basic research which uncovers the new knowledge so essential to the future welfare of the country. It is essential that these programs of education and research be sustained at a level of high excellence.[16]

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[15] Strengthening academic capability for science. Memorandum from the President to the heads of departments and agencies, Sept. 14, 1965. Weekly compilation of Presidential documents, Sept. 20, 1965, pp. 268–269.

[16] Statement by the President upon increasing the expenditure ceiling of the [National Science] Foundation, Feb. 5, 1969. Weekly Compilation of Presidential Documents, v. 5, Feb. 10, 1969, p. 225.

In recent years, however, revenue and expenditure ceilings imposed on agency spending by the Congress, a move to curb current inflationary trends by budget reductions, and the issue of relevancy in connection with research supported by the Department of Defense resulting in section 203 in the fiscal year 1970 Military Procurement Authorization Act have had the combined effect of reducing the total level of Federal support of academic science. Furthermore, there is a very real threat that agencies, confronted with budgetary restrictions, will assign their own internal priorities, which will result in additional reductions of longer range research support. This course of action can be rationalized as a logical one because—

> You in the Congress would look to that director to see that he accomplished his goals for society, and those programs which relate to the agency's mission at the turn of the century or in 1985 are the ones which could subside for a year or two—is certainly the decision he must take. Again, the urgent drives out the important. (Handler, p. 201.)

Both witnesses and the subcommittee members believe that the mission-oriented agencies should and must continue to support academic research to the extent consistent with their missions and whenever this can be done without interfering with their primary responsibilities. Secretary of Defense Laird supported this principle in his recent appearance before a joint session of the Senate Armed Services and Appropriations Committees in connection with the fiscal year 1971 defense program and budget:

> * * * We are concerned, too, about the broader implications of actions such as section 203 on the overall level of research in the United States. We accept the principle that research programs which are not relevant to military programs should be eliminated. * * * The important principle is that each major mission-agency in the Government maintain the necessary level of excellent, imaginative research in those fields related to its long-range mission needs. If we reduce our support of research projects on the theory that they do not seem to be related directly to military programs, I believe it is essential that the support of high-quality basic research projects of broad national interest be provided immediately by some other agency of the Government.

The case for continued multiagency support of advanced training is less clear, although at least two witnesses favored it. (Bennett, Shannon.)

Inadequate Utilization of Research and Development by the Newer Agencies

The hearings brought out that getting started on the right kind of research and development program for a newly established department or agency is also a problem. General Shriever observed that the formulation of meaningful basic and applied research programs can come about only through better and more advanced planning on the part of the agency "wherein the technologies, the state of the art, assumes an important factor with respect to what the objectives and

mission of that agency or those agencies are" (p. 323). He said this planning has been an evolutionary process within the Department of Defense, NASA and AEC. He mentioned both the Department of Transportation and the Department of Housing and Urban Development as examples of newly established agencies who are working on this problem.

Problems Not the Responsibility of Any Department or Agency

Still another task of Government is to step into areas of public concern where problems arise that are not part of the missions of any one agency and which private interests are unable to deal with. The danger is that nothing will be done until the situation reaches the point where it can no longer be ignored. By that time a crash program is necessary. The present organization dealing with environmental pollution is a case in point. The treatment of acid mine water and dealing with the cement dust problem were identified as examples of problems now currently not being given adequate consideration. (Walker, p. 332.)

In the past, when new problems have arisen, they have either been assigned to an already existing department or agency which appeared best able to cope with them, or a new single-purpose organization has been established for this specific purpose.

This is an area where a centralized agency might be useful. Referring to the acid mine water problem, for example, Dr. Walker speculated:

> If it were under the aegis of a Department of Science and Technology, they could say what needs to be done and what the goals are. Hopefully, they would find the money, and might well use industry and universities to solve some of the problems. Or, some of the national laboratories could be brought in very effectively here to provide a sort of in-house capability for a Department of Science (p. 332).

If later, a problem justified the establishment of a separate organization it could be transferred out of the centralized agency.

3. *A larger role for the National Science Foundation*

The hearings record only confirmed what people have been saying for years about the National Science Foundation. It must assume a larger role in the total support of academic science. How it can surmount its difficulties of previous years and sell itself to the American people and to the Congress was discussed by many witnesses.

The Foundation does not need additional authority. Its enabling act of 1950 and subsequent amendments, including those of 1968 are broad enough. What it does need, in the view of Dr. DuBridge, are additional leverage, prestige, and more money.

> * * * We have got a mechanism there, we don't need to change it, we just need to recognize its functions, its importance, and give it support. It is precisely the agency which can fill in gaps, which can do things other agencies won't or can't do and can move us forward in the science field (p. 21).

The present funding level of the Foundation is inadequate from many viewpoints. After 20 years, it is still under the half-billion-dollar amount, despite several unsuccessful attempts to attain this level. A number of witnesses spoke in terms of an annual billion-dollar budget as a goal for the Foundation. (DuBridge, p. 21; Handler, p. 200; Bennett, p. 293.) This amount would enable the Foundation to increase its support of academic research from about 15 percent of the total, as at present, to approximately one-third. (Bennett, p. 260.) More than $1 billion annually would be required if the Foundation were to take over support of one-third of academic science.

Dr. Bennett expressed the opinion that the increased funds for the Foundation should be dispensed through institutional grants that give the colleges and universities greater flexibility in meeting their individual needs. (p. 260.)

The Foundation's support for engineering is inadequate to finance the needs in this area. When individual projects run into millions of dollars, a total engineering budget of some $20 million cannot provide much support. (Walker, p. 329.)

The Foundation has never received the necessary funding to enable it to perform the balance-wheel function which was envisioned for it. The $19 million in research which the Department of Defense dropped from its support since 1965 was trivial by Defense standards. It loomed like a mountain and was an enormous source of confusion and difficulty for NSF. (Handler, p. 203.)

Academic research and graduate education activities should be more closely linked. Dean Price expressed the opinion that it was "high time that we no longer pretend that when we make grants at the graduate level for research we are doing something apart from supporting higher education" (p. 158). In his view, the issues raised in the past in opposition to the Federal support of higher education are now largely "irrelevant." He made this further observation, "The Federal Government may not be very deeply interested in supporting basic research for its own sake, but it is interested in supporting basic research as a most important part of a system of postgraduate education, which is a Government mission of long and respectable standing" (p. 159). Combining the two would also do away with the criticism that separates teaching from research, setting up in effect two classes of professors.

A number of thoughtful replies were made to the question what the Foundation might do to sell itself to the Congress and the American people and thereby improve its funding position:

1. The Foundation must improve its congressional relations.
2. It must emphasize that the support of scientific education and research is in the Nation's welfare rather than simply in the welfare of the scientists and the universities themselves.
3. Informed citizens must also spread the word that the activities of the Foundation and similar agencies are not "charity" but rather "an essential investment in the Nation's future welfare and its industrial and economic progress." (DuBridge, p. 31.)
4. It should make a greater effort to publicize its most successful projects in terms understandable to the layman and to generate public information materials which will help science writers and editors bridge the technology gap between scientists/engineers and the layman. (Tribus, p. 121.)

5. It should better illustrate how its programs benefit all areas of the country and help advance science while at the same time support a growing number of institutions. (Ink, p. 133.)

6. It must increase its contacts with officials of mission agencies to improve the understanding of the interrelationship of Foundation activities with the programs and interests of mission agencies. (Ink, p. 133.)

7. It should take advantage of its new authorization for policy level staff to strengthen its internal planning capabilities and its contacts with other Federal agencies and with interest groups outside science, too. (Wenk, p. 189.)

A final important point made concerning the Foundation's role was that its entire orientation should be toward future needs. As Dr. Handler put it—

> * * * there ought to be one agency to which the Congress can look and understand that its goals are always about tomorrow, and it is always building a platform with which all other agencies and American society in an unforeseeable future will be strengthened (p. 201).

This should be the Foundation's role or the role of a new agency which might be established in this area.

E. Legislative Reorganization

Since the executive branch is responsible to the legislative branch, a reorganization of any part of the former cannot be considered independently of its relationship to the latter. Equally important is the reciprocal influence each has on the other. Several witnesses discussed various aspects of the executive-legislative relationship. They are summarized for the record.

The subcommittee recognizes that the restructuring of the committee system, even with respect to matters dealing with "scientific research and development" is outside of its jurisdiction. It appreciates that legislative committee jurisdictions are firmly established and are not easily or lightly altered. The following summary of the hearing record on this subject may be useful in aiding in the broader study of the organization of the Congress which has been under consideration both in the House and in the Senate for the past several years.

1. *Role of Congress in decision making for science and technology*

Because every Member of Congress and every legislative and appropriations committee must deal constantly with subjects relating to science and technology, the question arises as to how this can be done. Dr. Wenk spoke to this question (pp. 177–181). In his view Members of Congress do not need a scientific or engineering background because the issues with which they must deal are political. The real need of Congress is to have access to staff and advisory services who can analyze the scientific and technical aspects of current issues and present them in the language understandable to persons with a nonscientific background.

Dr. Wenk spoke to the need for strengthening science policy research for the legislative branch, with particular reference to extending the capabilities of the Legislative Reference Service of the Library of Congress by (*a*) additions to professional staff, (*b*) utilization of ad hoc

consultation with individual experts, panels, or professional organizations, and (*c*) providing funds for policy research on contract with universities or nonprofit organizations (p. 180). He expressed the view that the concept of technology assessment should be made a much more important part of "science policy research" to an extent which would permit the staff organization to undertake studies on its own initiative "whenever the issues appear sufficiently compelling but where time and circumstances have not made it possible for immediate inquiry by congressional committees" (p. 181).

Another witness supported the utilization by the Congress of independent sources of advice, as for example, its requests to the National Academy of Sciences and the National Academy of Engineering. (Tribus, p. 112.)

It was suggested that Congress should be involved to a greater extent in formulation of goals and priorities to provide an overall statutory rationale to guide all Federal agencies involved in science (Reagan, p. 154) and to set goals for developmental projects. (Tribus, p. 114.)

More effective liaison should be provided by the public officials who present the programs of their agencies to the concerned committees and to other Congressmen as well. The few hours before a committee that a senior public official has in which to present the whole program of his agency in terms of public purposes are "crucial" in the communications process. In addition to explaining the technical aspects of the program, the official must also relate them to the political process. (Wenk, p. 179.)

2. *Need for committee realinements to accompany executive reorganization*

Because so many committees of the Congress have authority to make changes in Federal science programs, the formulation of a balanced program is very difficult. Dr. DuBridge spoke to this problem—

> * * * No matter how carefully a budget proposal for the R. & D. funding of the country is presented by the President to the Congress, the individual congressional committees each have their authority to make changes which may spoil these plans for a rounded and well-balanced whole.
>
> And that is why I suggested that the congressional problems here are very serious. Even if one had a very well-considered, rounded, balanced program for our national science effort which were presented by the President in his budget, it is not at all sure that it would come out of Congress still adequate or well rounded or adequately balanced (p. 29).

In another witness's opinion, "To centralize in the executive branch without accomplishing something along the same lines in the Congress seems to me would be to do only half the job." (Reagan, p. 153.) Moreover, to lodge authority for a centralized agency in already existing committees of the Congress would not be enough, for the Senate does not now have a single committee with a broad jurisdiction for science (p. 153).

Dr. Harris expressed the opinion that an important part of any reorganization plan was the designation of a few committees in the

Congress with authority to "maintain continuing surveillance over the health of R. & D. in the United States" (p. 238).

Dr. Handler speculated that a further executive centralization of science accompanied by the designation of centralized responsibility in one set of legislative committees of the Congress might provide an opportunity for that set of committees to become knowledgeable with respect to the federally supported scientific endeavor and so better inform the public (p. 204). Whether science would also lose because fewer committees and Members of the Congress would be personally involved must also be taken into consideration.

A final consideration is *how* to assure that the necessary legislative reorganization accompanies any executive reorganization. Drs. Bennett and Shannon believe that an important argument for effecting any executive reorganization by legislation is that this process would force Congress to give thought to what "receptor mechanisms" it would have to set up in the form of committees or subcommittees in order to assure legislative oversight of a new executive organization (p. 304).

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