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NATIONAL SCIENCE FOUNDATION ACT AMENDMENTS OF 1968

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HEARINGS

BEFORE THE

CIAL SUBCOMMITTEE ON SCIENCE

OF THE

COMMITTEE ON

BOR AND PUBLIC WELFARE

UNITED STATES SENATE

NINETIETH CONGRESS

FIRST SESSION

ON

S. 2598 and H.R. 5404

TO AMEND THE NATIONAL SCIENCE FOUNDATION ACT OF 1950 TO MAKE CHANGES AND IMPROVEMENTS IN THE ORGANIZATION AND OPERATION OF THE FOUNDATION, AND FOR OTHER PURPOSES

NOVEMBER 15 AND 16, 1967

Printed for the use of the
Committee on Labor and Public Welfare

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CONTENTS

	Page
S. 2598	2
Departmental reports:	
National Science Foundation	20
Department of Health, Education, and Welfare	23
H.R. 5404	26
Departmental reports:	
National Science Foundation	45
Department of Health, Education, and Welfare	49
Bureau of the Budget	52

CHRONOLOGICAL LIST OF WITNESSES

NOVEMBER 15, 1967

Kennedy, Hon. Edward M., a U.S. Senator from the State of Massachusetts	56
Hornig, Dr. Donald F., Director, Office of Science and Technology, Executive Office of the President	57
Haworth, Dr. Leland J., Director of the National Science Foundation	68
Handler, Dr. Philip, Chairman, National Science Board	81
Seitz, Dr. Frederick, President, National Academy of Sciences	98
Brooks, Dr. Harvey, Chairman, Committee on Science and Public Policy of the National Academy of Sciences, and dean of engineering and applied physics, Harvard University	102

NOVEMBER 16, 1967

Daddario, Hon. Emilio O., U.S. Representative from the State of Connecticut, accompanied by Philip Yeager, counsel; and Joseph Felton, counsel; both of the House Committee on Space and Astronautics	110
Harris, Hon. Fred R., a U.S. Senator from the State of Oklahoma	126
Pell, Hon. Claiborne, a U.S. Senator from the State of Rhode Island	145
Pollack, Herman, Director of International Scientific and Technological Affairs, U.S. Department of State	146

STATEMENTS

Brooks, Dr. Harvey, Chairman, Committee on Science and Public Policy of the National Academy of Sciences, and dean of engineering and applied physics, Harvard University	102
Prepared statement	103
Daddario, Hon. Emilio O., U.S. Representative from the State of Connecticut, accompanied by Philip Yeager, counsel; and Joseph Felton, counsel; both of the House Committee on Space and Astronautics	110
Prepared statement	121
Handler, Dr. Philip, Chairman, National Science Board	81
Prepared statement	89
Harris, Hon. Fred R., a U.S. Senator from the State of Oklahoma	126
Haworth, Dr. Leland J., Director of the National Science Foundation	68
Prepared statement	76
Hornig, Dr. Donald F., Director, Office of Science and Technology, Executive Office of the President	57
Kennedy, Hon. Edward M., a U.S. Senator from the State of Massachusetts	56
Pell, Hon. Claiborne, a U.S. Senator from the State of Rhode Island	145
Pollack, Herman, Director of International Scientific and Technological Affairs, U.S. Department of State	146
Seitz, Dr. Frederick, President, National Academy of Sciences	98
Prepared statement	98

ADDITIONAL INFORMATION

Page

Article:
"Case for a National Social Science Foundation, The," by Senator Fred R. Harris, from Science, August 4, 1967 ... 136
Commission on the Social Sciences, establishment of ... 162
Communications from:
Handler, Dr. Philip, Chairman, National Science Board of the National Science Foundation, to:
Prospective members of the Special Commission on the Social Sciences, August 4, 1967 ... 82
Senator Edward M. Kennedy, November 19, 1967 ... 93
Haworth, Leland J., Director, National Science Foundation, to Senator Edward M. Kennedy:
November 29, 1968 ... 71
November 30, 1968 ... 116
Hornig, Donald F., Director, Office of Science and Technology, to Senator Edward M. Kennedy, December 12, 1968 ... 67
Keeney, Barnaby C., Chairman, National Foundation on the Arts and Humanities, to Senator Pell, December 14, 1967 ... 159
Ohlke, C. C., Commission on the Social Sciences, to K. Dun Gifford, legislative assistant, Office of Senator Kennedy of Massachusetts, January 29, 1968, with attachment ... 162
Revelle, Roger, director, Center for Population Studies, Harvard University, Cambridge, Mass., to Senator Pell, November 15, 1967 ... 156
Wenk, Edward, Jr., executive secretary, National Council on Marine Resources and Engineering Development, to Senator Edward M. Kennedy, September 18, 1967 ... 67
National Science Foundation:
Grants, contracts, and fellowships awarded, by State, fiscal year 1966, a table ... 132
House Report No. 1236, "The National Science Foundation, Its Present and Future," February 1, 1966 ... 197
International activities summary ... 153
Obligations, by discipline, fiscal year 1966, a table ... 121
Responses to questions submitted to National Science Foundation by Senator Griffin ... 164
Supplemental ... 194

NATIONAL SCIENCE FOUNDATION ACT AMENDMENTS OF 1968

WEDNESDAY, NOVEMBER 15, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENCE
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met, pursuant to notice, at 9:30 a.m., in room 4232, New Senate Office Building, Senator Edward M. Kennedy (chairman of the special subcommittee) presiding.

Present: Senators Kennedy of Massachusetts (presiding) and Pell.

Senator KENNEDY of Massachusetts. The subcommittee will come to order.

We begin today the first Senate hearings since 1950 devoted to a broad review of the National Science Foundation Act. I hope that the hearings will give us the base of information we in the Senate need if we are to streamline and modify the act to assure its continued participation in the forward march of American science.

For two consecutive years the House of Representatives has passed legislation amending the National Science Foundation Act. We have before us H.R. 5404 which passed the House last April 12. We also have before us S. 2598, which I introduced last month. It is different from the House bill, and I hope that these differences provoke discussions by our witnesses on the resolution of them.

I want to acknowledge at this point the appointment of this subcommittee by Chairman Lister Hill. He has a deep personal interest in this specific legislation, as he does in the general subject we are considering this morning. The membership includes Senator Claiborne Pell of Rhode Island and Senator Robert Griffin of Michigan, both of whom have shown a significant interest in the National Science Foundation, as well as the scientific community generally.

I order the text of the bills referred to printed in the record at this point along with departmental reports we receive.

(The bills S. 2598 and H.R. 5404 and departmental reports follow:)

90TH CONGRESS
1ST SESSION

S. 2598

IN THE SENATE OF THE UNITED STATES

OCTOBER 30, 1967

Mr. KENNEDY of Massachusetts introduced the following bill; which was read twice and referred to the Committee on Labor and Public Welfare

A BILL

To amend the National Science Foundation Act of 1950, making changes and improvements in the organization and operation of the Foundation, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be known as the "National Science Foundation Act Amendments of 1967."

SEC. 2. Section 3 of the National Science Foundation Act of 1950 is amended to read as follows:

"FUNCTIONS OF THE FOUNDATION

"SEC. 3. (a) The Foundation is authorized and directed

"(1) to initiate and support basic scientific research and programs to strengthen scientific research

potential in the mathematical, physical, medical, biological, engineering, social, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) to support such scientific activities and to appraise the impact of research upon industrial development and upon the general welfare;

"(2) to award, as provided in section 10, scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, social, and other sciences;

"(3) to foster the interchange of scientific information among scientists in the United States and foreign countries;

"(4) to evaluate the status and needs of the various sciences as evidenced by programs, projects, and studies undertaken by agencies of the Federal Government, by individuals, and by public and private research groups, employing by grant or contract such consulting services as it may deem necessary for the purpose of such evaluations; and to take into consideration the results of such evaluations in correlating the research and educational programs undertaken or supported by the Foundation with programs, projects, and studies undertaken by agencies of the Federal Government, by individuals, and by public and private research groups;

"(5) to maintain a current register of scientific and technical personnel, and in other ways to provide a central clearinghouse for the collection, interpretation, and analysis of data on the availability of, and the current and projected need for, scientific and technical resources in the United States, and to provide a source of information for policy formulation by other agencies of the Federal Government; and

"(6) to initiate and maintain a program for the determination of the total amount of money for scientific research, including money allocated for the construction of the facilities wherein such research is conducted, received by each educational institution and appropriate nonprofit organization in the United States, by grant, contract, or other arrangement from agencies of the Federal Government, and to report annually thereon to the President and the Congress.

"(b) When requested by the Secretary of State or the Secretary of Defense, the Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation or national security by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific activities.

"(c) In addition to the authority contained in subsec-

tions (a) and (b), the Foundation is authorized to initiate and support scientific research, including applied research, at academic and other nonprofit institutions. When so directed by the President, the Foundation is further authorized to support, through other appropriate organizations, applied scientific research relevant to national problems involving the public interest. In exercising the authority contained in this subsection, the Foundation may employ by grant or contract such consulting services as it deems necessary, and shall coordinate and correlate its activities with respect to any such problem with other agencies of the Federal Government undertaking similar programs in that field.

"(d) The Board and the Director shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences.

"(e) In exercising the authority and discharging the functions referred to in the foregoing subsections, it shall be one of the objectives of the Foundation to strengthen research and education in the sciences, including independent research by individuals, throughout the United States, and to avoid undue concentration of such research and education.

"(f) The Foundation shall render an annual report to the President for submission on or before the 15th day of January of each year to the Congress, summarizing the activities of the Foundation and making such recommenda-

tions as it may deem appropriate. Such report shall include information as to the acquisition and disposition by the Foundation of any patents and patent rights."

SEC. 3. Section 4 of the National Science Foundation Act of 1950 is amended to read as follows:

"NATIONAL SCIENCE BOARD

"SEC. 4. (a) The Board shall consist of twenty-four members to be appointed by the President, by and with the advice and consent of the Senate, and of the Director ex officio. In addition to any powers and functions otherwise granted to it by this Act, the Board shall establish policies to guide the Foundation.

"(b) The Board shall have an Executive Committee as provided in section 6, and may delegate to it or to the Director or both such of the powers and functions granted to the Board by this Act as it deems appropriate.

"(c) The persons nominated for appointment as members of the Board (1) shall be eminent in the fields of the basic, medical, or social sciences, engineering, agriculture, education, or public affairs; (2) shall be selected solely on the basis of established records of distinguished service; and (3) shall be so selected as to provide representation of the views of scientific leaders in all areas of the Nation. The President is requested, in the making of nominations of persons for appointment as members, to give due considera-

tion to any recommendations for nomination which may be submitted to him by the National Academy of Sciences, the National Association of State Universities and Land Grant Colleges, the Association of American Universities, the Association of American Colleges, or by other scientific or educational organizations.

"(d) The term of office of each member of the Board shall be six years; except that any member appointed to fill a vacancy occurring prior to the expiration of the term for which his predecessor was appointed shall be appointed for the remainder of such term. Any person, other than the Director, who has been a member of the Board for twelve consecutive years shall thereafter be ineligible for appointment during the two-year period following the expiration of such twelfth year.

"(e) The Board shall meet annually on the third Monday in May unless, prior to May 10 in any year, the Chairman has set the annual meeting for a day in May other than the third Monday, and at such other times as the Chairman may determine, but he shall also call a meeting whenever one-third of the members so request in writing. A majority of the members of the Board shall constitute a quorum. Each member shall be given notice, by registered mail or certified mail mailed to his last known address of record not less than fifteen days prior to any meeting, of the call of such meeting.

"(f) The election of the Chairman and Vice Chairman of the Board shall take place at each annual meeting occurring in an even-numbered year. The Vice Chairman shall perform the duties of the Chairman in his absence. In case a vacancy occurs in the chairmanship or vice-chairmanship, the Board shall elect a member to fill such vacancy.

"(g) The Board shall render an annual report to the President, for submission on or before the 31st day of January of each year to the Congress, on the status and health of science and its various disciplines. Such report shall include an assessment of such matters as national scientific resources and trained manpower, progress in selected areas of basic scientific research, and an indication of those aspects of such progress which might be applied to the needs of American society. The report may include such recommendations as the Board may deem timely and appropriate.

"(h) The Board is authorized to establish such special commissions as it may from time to time deem necessary for the purposes of this Act.

"(i) The Board is also authorized to appoint from among its members such committees as it deems necessary, and to assign to committees so appointed such survey and advisory functions as the Board deems appropriate to assist it in exercising its powers and functions under this Act."

SEC. 4. Section 5 of the National Science Foundation Act of 1950 is amended to read as follows:

"DIRECTOR OF THE FOUNDATION

"SEC. 5. (a) The Director of the Foundation (referred to in this Act as the 'Director') shall be appointed by the President, by and with the advice and consent of the Senate. Before any person is appointed as Director, the President shall afford the Board an opportunity to make recommendations to him with respect to such appointment. The Director shall receive basic pay at the rate provided for level II of the Executive Schedule under section 5313 of title V, United States Code.

"(b) Except as otherwise specifically provided in this Act (1) the Director shall exercise all of the authority granted to the Foundation by this Act (including any powers and functions which may be delegated to him by the Board), and (2) all actions taken by the Director pursuant to the provisions of this Act (or pursuant to the terms of a delegation from the Board) shall be final and binding upon the Foundation.

"(c) The Director may from time to time make such provisions as he deems appropriate authorizing the performance by any other officer, agency, or employee of the Foundation of any of his functions under this Act, including functions delegated to him by the Board; except that the Director

may not redelegate policymaking functions delegated to him by the Board.

"(d) The formulation of programs in conformance with the policies of the Foundation shall be carried out by the Director in consultation with the Board.

"(e) The Director shall not make or revoke any contract, grant, or other arrangement pursuant to section 11(c) without the prior approval of the Board if, in his opinion, such action involves a policy determination of the nature reserved to the Board.

"(f) The Director, in his capacity as ex officio member of the Board, shall, except with respect to compensation and tenure, be coordinate with the other members of the Board. He shall be a voting member of the Board and shall be eligible for election by the Board as Chairman or Vice Chairman of the Board."

SEC. 5. The National Science Foundation Act of 1950 is further amended by striking out section 8, by redesignating sections 6 and 7 as sections 7 and 8, respectively, and by inserting after section 5 the following new section:

"DEPUTY DIRECTOR AND ASSISTANT DIRECTORS

"SEC. 6. (a) There shall be a Deputy Director of the Foundation (referred to in this Act as the 'Deputy Director'), who shall be appointed by the President, by and with

the advice and consent of the Senate. Before any person is appointed as Deputy Director, the President shall afford the Board and the Director an opportunity to make recommendations to him with respect to such appointment. The Deputy Director shall receive basic pay at the rate provided for level III of the Executive Schedule under section 5314 of title 5, United States Code, and shall perform such duties and exercise such powers as the Director may prescribe. The Deputy Director shall act for, and exercise the powers of, the Director during the absence or disability of the Director or in the event of a vacancy in the office of Director.

"(b) There shall be four Assistant Directors of the Foundation (each referred to in this Act as an 'Assistant Director'). Each Assistant Director shall receive basic pay at the rate provided for level V of the Executive Schedule under section 5316 of title 5, United States Code, and shall perform such duties and exercise such powers as the Director may prescribe."

SEC. 6. The section of the National Science Foundation Act of 1950 redesignated as section 7 by section 5 of this Act is amended to read as follows:

"EXECUTIVE COMMITTEE

"SEC. 7. (a) There shall be an Executive Committee of the Board (referred to in this Act as the 'Executive Committee'), which shall be composed of five members and shall

exercise such powers and functions as may be delegated to it by the Board. Four of the members shall be elected as provided in subsection (b), and the Director ex officio shall be the fifth member and the chairman of the Executive Committee.

"(b) At each of its annual meetings the Board shall elect two of its members as members of the Executive Committee, and the Executive Committee members so elected shall hold office for two years from date of their election. Any person, other than the Director, who has been a member of the Executive Committee for six consecutive years shall thereafter be ineligible for service as a member thereof during the two-year period following the expiration of such sixth year. For the purposes of this subsection, the period between any two consecutive annual meetings of the Board shall be deemed to be one year.

"(c) Any person elected as a member of the Executive Committee to fill a vacancy occurring prior to the expiration of the term for which his predecessor was elected shall be elected for the remainder of such term.

"(d) The Executive Committee shall render an annual report to the Board, and such other reports as it may deem necessary, summarizing its activities and making such recommendations as it may deem appropriate. Minority views

and recommendations, if any, of members of the Executive Committee shall be included in such reports."

SEC. 7. The section of the National Science Foundation Act of 1950 redesignated as section 8 by section 5 of this Act is amended to read as follows:

"DIVISIONS WITHIN THE FOUNDATION

"SEC. 8. There shall be within the Foundation such Divisions as the Director, in consultation with the Board, may from time to time determine."

SEC. 8. Section 9 (a) of the National Science Foundation Act of 1950 is amended by striking out "section 3 (a) (7)" and inserting in lieu thereof "section 4 (h)".

SEC. 9. Section 10 of the National Science Foundation Act of 1950 is amended—

(1) by striking out "section 17" and inserting in lieu thereof "section 16";

(2) by inserting "social," after "engineering,"; and

(3) by striking out "among the States, territories, possessions, and the District of Columbia" and inserting in lieu thereof "throughout the United States".

SEC. 10. (a) Section 11 (c) of the National Science Foundation Act of 1950 is amended—

(1) by striking out "basic";

(2) by striking out "research" each place it appears;

87-071 O - 68 - 2

(3) by inserting "Secretary of State or" before Secretary of Defense"; and

(4) by striking out "the national defense" and inserting in lieu thereof "international cooperation or national security".

(b) Section 11 (d) of such Act is amended by striking out "research" and inserting in lieu thereof "activities".

(c) Section 11 (h) of such Act is amended by striking out "section 5 of the Act of August 2, 1946 (5 U.S.C. 73b–2)" and inserting in lieu thereof "section 5703 of title 5, United States Code,".

(d) Section 11 of such Act is further amended by the addition of a new subsection (j) as follows:

"(j) to arrange with and reimburse the heads of other Federal agencies for the performance of any activity which the Foundation is authorized to conduct."

SEC. 11. Section 13 (a) of the National Science Foundation Act of 1950 is amended—

(1) by striking out ", with the approval of the Board,"; and

(2) by striking out "section 16 (d) (2)" and inserting in lieu thereof "section 15 (d) (2)".

SEC. 12. Section 14 of the National Science Foundation Act of 1950 is repealed.

SEC. 13. (a) Section 15 of the National Science Foundation Act of 1950 is redesignated as section 14 and is amended to read as follows:

"MISCELLANEOUS PROVISIONS

"SEC. 14. (a) The Director shall, in accordance with such policies as the Board shall from time to time prescribe, appoint and fix the compensation of such personnel as may be necessary to carry out the provisions of this Act. Except as provided in section 4(h), such appointments shall be made and such compensation shall be fixed in accordance with the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates: *Provided*, That the Director may, in accordance with such policies as the Board shall from time to time prescribe, employ such technical and professional personnel and fix their compensation, without regard to such provisions, as he may deem necessary for the discharge of the responsibilities of the Foundation under this Act. The members of the special commissions shall be appointed without regard to the provisions of title 5, United States Code, governing appointments in the competitive service.

"(b) Neither the Director, the Deputy Director, nor any Assistant Director shall engage in any other business,

vocation, or employment while serving in such position; nor shall the Director, the Deputy Director, or any Assistant Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Foundation makes any grant, contract, or other arrangement under this Act.

"(c) The Foundation shall not, itself, operate any laboratories or pilot plants.

"(d) The members of the Board and the members of each special commission shall receive compensation at the rate of $100 for each day engaged in the business of the Foundation pursuant to authorization of the Foundation and shall be allowed travel expenses as authorized by section 5703 of title 5, United States Code.

"(e) Persons holding other offices in the executive branch of the Federal Government may serve as members of special commissions, but they shall not receive remuneration for their services as such members during any period for which they receive compensation for their services in such other offices.

"(f) In making contracts or other arrangements for scientific research, the Foundation shall utilize appropriations available therefor in such manner as will in its discretion best realize the objectives of (1) having the work performed by organizations, agencies, and institutions, or

individuals in the United States or foreign countries, including Government agencies of the United States and of foreign countries, qualified by training and experience to achieve the results desired, (2) strengthening the research staff of organizations, particularly nonprofit organizations, in the United States, (3) aiding institutions, agencies, or organizations which, if aided, will advance scientific research, and (4) encouraging independent scientific research by individuals.

"(g) Funds available to any department or agency of the Government for scientific or technical research, or the provision of facilities therefor, shall be available for transfer, with the approval of the head of the department or agency involved, in whole or in part, to the Foundation for such use as is consistent with the purposes for which such funds were provided, and funds so transferred shall be expendable by the Foundation for the purposes for which the transfer was made.

"(h) For purposes of this Act, the term 'United States' when used in a geographical sense means the States, the District of Columbia, the Commonwealth of Puerto Rico, and all territories and possessions of the United States."

SEC. 14. Sections 16 and 17 of the National Science Foundation Act of 1950 are redesignated as sections 15 and 16, respectively. Subsection (a) of the section redesignated

as section 15 is amended by striking out "1946" each place it appears and inserting in lieu thereof "1954". Subsection (b) of the section redesignated as section 15 is amended by striking out "section 15 (h)" in paragraph (1) and inserting in lieu thereof "section 14 (g)".

SEC. 15. (a) (1) Section 5313 of title 5, United States Code, is amended by adding at the end thereof the following new paragraph:

"(19) Director of the National Science Foundation."

(2) Section 5314 of such title is amended by striking out paragraph 40, and by inserting in lieu thereof the following new paragraph:

"(40) Deputy Director, National Science Foundation."

(3) Section 5316 of such title is amended by striking out paragraph (66), and by inserting in lieu thereof the following new paragraph:

"(66) Assistant Director, National Science Foundation (4)."

(4) The amendments made by this subsection (and the amendments made by sections 3 and 4 of this Act insofar as they relate to rates of basic pay) shall take effect on the first day of the first calendar month which begins on or after the date of the enactment of this Act.

(b) Section 902 (c) of the National Defense Education

Act of 1958 is amended by striking out "$50" and inserting in lieu thereof "$100".

SEC. 16. Except as otherwise specifically provided therein, the amendments made by this Act are intended to continue in effect under the National Science Foundation Act of 1950 the existing offices, procedures, and organization of the National Science Foundation as provided by such Act, part II of Reorganization Plan Numbered 2 of 1962, and Reorganization Plan Numbered 5 of 1965. From and after the date of the enactment of this Act, part II of Reorganization Plan Numbered 2 of 1962, and Reorganization Plan Numbered 5 of 1965, shall be of no force or effect; but nothing in this Act shall alter or affect any transfers of functions made by part I of such Reorganization Plan Numbered 2 of 1962.

NATIONAL SCIENCE FOUNDATION
OFFICE OF THE DIRECTOR
WASHINGTON 25, D.C.

November 29, 1967

Honorable Lister Hill
Chairman, Committee on Labor
and Public Welfare
United States Senate
Washington, D. C. 20510

Dear Mr. Chairman:

In reply to your letter of October 31, 1967, we are pleased to submit the following report from the National Science Foundation on S. 2598.

The National Science Foundation (The National Science Board and the Director) wishes heartily to endorse the general purposes of the bill and virtually all of its provisions. We are gratified that the changes proposed by the Foundation (in our report to you dated April 24, 1967) with respect to those Sections of H.R. 5404 which would become Sections 3(a)6, 3(d), 4(h), 5(e) and 6(b) of the National Science Foundation Act have been adopted in S. 2598.

With respect to the language of S. 2598 we have only a few suggested changes and comments. First, we note that there is a difference between the language proposed for Section 4(a) in S. 2598 and that proposed for Section 4(a) in H.R. 5404, with the Senate version providing that the National Science Board "shall establish policies to guide the Foundation", where the House version reads that the Board "shall establish and be responsible for the policies of the Foundation." We believe that the words "to guide" in this context appear to weaken the policy functions of the Board rather than to strengthen them. In our view, it would be preferable to delete these words entirely and amend the language of Section 4(a) to provide simply that the Board "shall establish the policies of the Foundation." This language has the endorsement of the National Science Board and was also recommended by the President's Science Advisor, Dr. Donald F. Hornig, in his recent testimony before Senator Kennedy's Subcommittee.

With respect to the general authority of the Foundation, we are pleased to note that both the Senate and House versions include social science as one of the disciplines to be specifically enumerated in Section 3(a)(1). We would also like to suggest that the list be further expanded by the addition of the word "environmental." As explained in the testimony of the Director of the National Science Foundation on November 15, 1967 before Senator Kennedy's Subcommittee, it would be advantageous to give express recognition in the National Science Foundation Act to that branch of the natural sciences which under the general heading of environmental science includes oceanography, geology and other earth sciences, atmospheric sciences, and related disciplines.

An additional comment relates to the provision contained in proposed Section 3(b) which provides that, "When requested by the Secretary of State or the Secretary of Defense, the Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation or national security..." (underscoring ours). As you know, this provision would enable the National Science Foundation to support certain international scientific activities in the interests of United States foreign policy objectives even though the advantages to United States science might be marginal. We are concerned that some of the testimony at the recent hearings may have inadvertently created the impression that this provision is in some way designed to circumvent existing Congressional limitations, monetary or otherwise, relating to the scope of United States foreign aid programs. This is emphatically not the case. The Foundation is in no way required to undertake the support of any activity specified in proposed Section 3(b). Its purpose,rather, is to remove an implied restriction on the Foundation's authority, dating from a period when its resources and goals were far more limited, so as to enable it to support foreign or international scientific projects principally in those countries which are not highly advanced in science and technology, when such scientific projects would be of value to the attainment of United States foreign policy objectives. With respect to the wording of proposed Section 3(b), we recommend that the term ",respectively," be inserted at page 3, line 22, between "security" and "by" in order to make the

legislative intent clear that requests from the Secretary of State would relate solely to international cooperation and those of the Secretary of Defense solely to national security.

The above constitutes our specific comments on S. 2598. We strongly urge its enactment, or that of its counterpart, H.R. 5404, when modified in accordance with the foregoing recommendations.

The Bureau of the Budget has advised us that it has no objections to the submission of this report from the standpoint of the Administration's program.

Sincerely yours,

Philip Handler

Philip Handler
Chairman
National Science Board

Leland J. Haworth

Leland J. Haworth
Director
National Science Foundation

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

DEC 11 1967

Dear Mr. Chairman:

This letter is in response to your request of October 31, 1967, for a report on S. 2598, a bill "To amend the National Science Foundation Act of 1950, making changes and improvements in the organization and operation of the Foundation, and for other purposes."

S. 2598 would amend the National Science Foundation Act of 1950 to strengthen the activities of the Foundation, as would H.R. 5404, a bill on which the Department expressed its views to the Committee in September 1967.

Both H.R. 5404 and S. 2598 would, among other things:

(1) emphasize the role of the National Science Foundation in evaluating the status and needs of the various sciences and in providing for their balanced support (taking into account the programs of the mission-oriented Federal agencies);

(2) provide for a clearer distinction between the respective policy-making functions of the National Science Board and the executive functions of the Director of the Foundation, and augment the staff supporting the Director (authorizing, to assist the Director, a Deputy Director and four Assistant Directors);

(3) provide new authority for the Foundation to initiate and support applied research;

(4) add the social sciences to the areas of sciences specifically identified in the basic law as within the scope of the Foundation's activities; and

(5) provide for greater flexibility in organization and operation by removing statutorily designated Divisions within the Foundation (enabling the Director, in consultation with the Board, to determine the divisional structure) and eliminating the provisions in existing law directing the Foundation to engage in certain activities with respect to weather modification.

Although the provisions of S. 2598 and H.R. 5404 are generally similar, there are certain major differences between the bills. Some of these differences are as follows:

(1) With respect to the section dealing with the "Functions of the Foundation," S. 2598 would provide that "The Board and the Director shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences." H.R. 5404 would reserve this authority solely for the Board.

(2) With respect to the section dealing with the "National Science Board," S. 2598 makes no provision for the appointment of five professional staff members and supporting clerical staff. Such a provision is contained in H.R. 5404.

(3) With respect to the section dealing with the "Director of the Foundation," S. 2598 would provide that the "Director shall not make or revoke any contract, grant, or other arrangement pursuant to Section 11(c) without prior approval of the Board, if, in his opinion, such action involves a policy determination of the nature reserved to the Board." H.R. 5404 would require the Director to secure the prior approval of the Board if such contract, grant, or other arrangement "involves a new type of program, or involves a total commitment of over $2 million, or over $500,000 in any one year, or a commitment of such other amount or amounts and subject to such other conditions as the Board in its discretion may determine and publish in the Federal Register."

(4) With respect to the section dealing with the "Deputy Director and Assistant Directors," although both bills would provide for the appointment of "four Assistant Directors of the Foundation," S. 2598 deletes the requirement contained in H.R. 5404 that such Assistant Directors shall be appointed by the President by and with the advice and consent of the Senate.

(5) With respect to the section dealing with "Divisions of the Foundation," S. 2598 would further amend Section 11 of the National Science Foundation Act to add a new subsection (j) calling for reimbursement of other Federal agencies for the performance of any activity which the Foundation is authorized to conduct. This subsection is not contained in H.R. 5404.

None of the above-mentioned changes between S. 2598 and H.R. 5404 touches issues that are of immediate concern to this Department. Accordingly, our original assessment of the merits of the legislation as contained in our earlier report on H.R. 5404 represents our views on S. 2598. For your convenience, a copy of that report is enclosed.

We are advised by the Bureau of the Budget that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

/s/ Wilbur J. Cohen

Under Secretary

Honorable Lister Hill
Chairman, Committee on
Labor and Public Welfare
United States Senate
Washington, D.C. 20510

90TH CONGRESS
1ST SESSION

H. R. 5404

IN THE SENATE OF THE UNITED STATES

APRIL 13, 1967

Read twice and referred to the Committee on Labor and Public Welfare

AN ACT

To amend the National Science Foundation Act of 1950 to make changes and improvements in the organization and operation of the Foundation, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 3 of the National Science Foundation Act of 1950 is amended to read as follows:

"FUNCTIONS OF THE FOUNDATION

"SEC. 3. (a) The Foundation is authorized and directed—

"(1) to initiate and support basic scientific research and programs to strengthen scientific research potential in the mathematical, physical, medical, biological, en-

gineering, social, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) to support such scientific activities and to appraise the impact of research upon industrial development and upon the general welfare;

"(2) to award, as provided in section 10, scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, social, and other sciences;

"(3) to foster the interchange of scientific information among scientists in the United States and foreign countries;

"(4) to evaluate the status and needs of the various sciences as evidenced by programs, projects, and studies undertaken by agencies of the Federal Government, by individuals, and by public and private research groups, employing by grant or contract such consulting services as it may deem necessary for the purpose of such evaluations; and to take into consideration the results of such evaluations in correlating the research and educational programs undertaken or supported by the Foundation with programs, projects, and studies undertaken by agencies of the Federal Government, by individuals, and by public and private research groups;

"(5) to maintain a current register of scientific and

technical personnel, and in other ways to provide a central clearinghouse for the collection, interpretation, and analysis of data on the availability of, and the current and projected need for, scientific and technical resources in the United States, and to provide a source of information for policy formulation by other agencies of the Federal Government; and

"(6) to initiate and maintain a program for the determination of the total amount of money for scientific research, including money allocated for the construction of the facilities wherein such research is conducted, received by each educational institution, nonprofit organization and private contractor in the United States, by grant, contract, or other arrangement from agencies of the Federal Government, and to report annually thereon to the President and the Congress.

"(b) When requested by the Secretary of State or the Secretary of Defense, the Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation or national security by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific activities.

"(c) In addition to the authority contained in subsections (a) and (b), the Foundation is authorized to initiate

and support scientific research, including applied research, at academic and other nonprofit institutions. When so directed by the President, the Foundation is further authorized to support, through other appropriate organizations, applied scientific research relevant to national problems involving the public interest. In exercising the authority contained in this subsection, the Foundation may employ by grant or contract such consulting services as it deems necessary, and shall coordinate and correlate its activities with respect to any such problem with other agencies of the Federal Government undertaking similar programs in that field.

"(d) The Board shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences.

"(e) In exercising the authority and discharging the functions referred to in the foregoing subsections, it shall be one of the objectives of the Foundation to strengthen research and education in the sciences, including independent research by individuals, throughout the United States, and to avoid undue concentration of such research and education.

"(f) The Foundation shall render an annual report to the President for submission on or before the 15th day of January of each year to the Congress, summarizing the activities of the Foundation and making such recommendations as it may deem appropriate. Such report shall include in-

87-071 O - 68 - 3

formation as to the acquisition and disposition by the Foundation of any patents and patent rights."

SEC. 2. Section 4 of the National Science Foundation Act of 1950 is amended to read as follows:

"NATIONAL SCIENCE BOARD

"SEC. 4. (a) The Board shall consist of twenty-four members to be appointed by the President, by and with the advice and consent of the Senate, and of the Director ex officio. In addition to any powers and functions otherwise granted to it by this Act, the Board shall establish and be responsible for the policies of the Foundation.

"(b) The Board shall have an Executive Committee as provided in section 7, and may delegate to it or to the Director or both such of the powers and functions granted to the Board by this Act as it deems appropriate.

"(c) The persons nominated for appointment as members of the Board (1) shall be eminent in the fields of the basic, medical, or social sciences, engineering, agriculture, education, or public affairs; (2) shall be selected solely on the basis of established records of distinguished service; and (3) shall be so selected as to provide representation of the views of scientific leaders in all areas of the Nation. The President is requested, in the making of nominations of persons for appointment as members, to give due consideration to any recommendations for nomination which may be

submitted to him by the National Academy of Sciences, the National Association of State Universities and Land Grant Colleges, the Association of American Universities, the Association of American Colleges, or by other scientific or educational organizations.

"(d) The term of office of each member of the Board shall be six years; except that any member appointed to fill a vacancy occurring prior to the expiration of the term for which his predecessor was appointed shall be appointed for the remainder of such term. Any person, other than the Director, who has been a member of the Board for twelve consecutive years shall thereafter be ineligible for appointment during the two-year period following the expiration of such twelfth year.

"(e) The Board shall meet annually on the third Monday in May unless, prior to May 10 in any year, the Chairman has set the annual meeting for a day in May other than the third Monday, and at such other times as the Chairman may determine, but he shall also call a meeting whenever one-third of the members so request in writing. A majority of the members of the Board shall constitute a quorum. Each member shall be given notice, by registered mail or certified mail mailed to his last known address of record not less than fifteen days prior to any meeting, of the call of such meeting.

"(f) The election of the Chairman and Vice Chairman

of the Board shall take place at each annual meeting occurring in an even-numbered year. The Vice Chairman shall perform the duties of the Chairman in his absence. In case a vacancy occurs in the chairmanship or vice chairmanship, the Board shall elect a member to fill such vacancy.

"(g) The Board shall render an annual report to the President, for submission on or before the 31st day of January of each year to the Congress, on the status and health of science and its various disciplines. Such report shall include an assessment of such matters as national scientific resources and trained manpower, progress in selected areas of basic scientific research, and an indication of those aspects of such progress which might be applied to the needs of American society. The report may include such recommendations as the Board may deem timely and appropriate.

"(h) The Board may, with the concurrence of a majority of its members, permit the appointment of a staff consisting of not more than five professional staff members and such clerical staff members as may be necessary. Such staff shall be appointed by the Director and assigned at the direction of the Board. The professional members of such staff may be appointed without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 of such title relating to classification, and compensated at a rate not

exceeding the appropriate rate provided for individuals in grade GS–15 of the General Schedule under section 5332 of such title, as may be necessary to provide for the performance of such duties as may be prescribed by the Board in connection with the exercise of its powers and functions under this Act. Each appointment under this subsection shall be subject to the same security requirements as those required for personnel of the Foundation appointed under section 14 (a).

"(i) The Board is authorized to establish such special commissions as it may from time to time deem necessary for the purposes of this Act.

"(j) The Board is also authorized to appoint from among its members such committees as it deems necessary, and to assign to committees so appointed such survey and advisory functions as the Board deems appropriate to assist it in exercising its powers and functions under this Act."

SEC. 3. Section 5 of the National Science Foundation Act of 1950 is amended to read as follows:

"DIRECTOR OF THE FOUNDATION

"SEC. 5. (a) The Director of the Foundation (referred to in this Act as the 'Director') shall be appointed by the President, by and with the advice and consent of the Senate. Before any person is appointed as Director, the President shall afford the Board an opportunity to make recommenda-

tions to him with respect to such appointment. The Director shall receive basic pay at the rate provided for level II of the Executive Schedule under section 5313 of title 5, United States Code, and shall serve for a term of six years unless sooner removed by the President.

"(b) Except as otherwise specifically provided in this Act (1) the Director shall exercise all of the authority granted to the Foundation by this Act (including any powers and functions which may be delegated to him by the Board), and (2) all actions taken by the Director pursuant to the provisions of this Act (or pursuant to the terms of a delegation from the Board) shall be final and binding upon the Foundation.

"(c) The Director may from time to time make such provisions as he deems appropriate authorizing the performance by any other officer, agency, or employee of the Foundation of any of his functions under this Act, including functions delegated to him by the Board; except that the Director may not redelegate policymaking functions delegated to him by the Board.

"(d) The formulation of programs in conformance with the policies of the Foundation shall be carried out by the Director in consultation with the Board.

"(e) The Director shall not make any contract, grant,

or other arrangement pursuant to section 11 (c) without the prior approval of the Board if such contract, grant, or other arrangement involves a new type of program, or involves a total commitment of over $2,000,000, or over $500,000 in any one year, or a commitment of such other amount or amounts and subject to such other conditions as the Board in its discretion may determine and publish in the Federal Register.

"(f) The Director, in his capacity as ex officio member of the Board, shall, except with respect to compensation and tenure, be coordinate with the other members of the Board. He shall be a voting member of the Board and shall be eligible for election by the Board as Chairman or Vice Chairman of the Board."

SEC. 4. The National Science Foundation Act of 1950 is further amended by striking out section 8, by redesignating sections 6 and 7 as sections 7 and 8, respectively, and by inserting after section 5 the following new section:

"DEPUTY DIRECTOR AND ASSISTANT DIRECTORS

"SEC. 6. (a) There shall be a Deputy Director of the Foundation (referred to in this Act as the 'Deputy Director'), who shall be appointed by the President, by and with the advice and consent of the Senate. Before any person is appointed as Deputy Director, the President shall

afford the Board and the Director an opportunity to make recommendations to him with respect to such appointment. The Deputy Director shall receive basic pay at the rate provided for level III of the Executive Schedule under section 5314 of title 5, United States Code, and shall perform such duties and exercise such powers as the Director may prescribe. The Deputy Director shall act for, and exercise the powers of, the Director during the absence or disability of the Director or in the event of a vacancy in the office of Director.

"(b) There shall be four Assistant Directors of the Foundation (each referred to in this Act as an 'Assistant Director'), who shall be appointed by the President, by and with the advice and consent of the Senate. Before any person is appointed as an Assistant Director, the President shall afford the Board and the Director an opportunity to make recommendations to him with respect to such appointment. Each Assistant Director shall receive basic pay at the rate provided for level V of the Executive Schedule under section 5316 of title 5, United States Code, and shall perform such duties and exercise such powers as the Director may prescribe."

SEC. 5. The section of the National Science Foundation

Act of 1950 redesignated as section 7 by section 4 of this Act is amended to read as follows:

"EXECUTIVE COMMITTEE

"SEC. 7. (a) There shall be an Executive Committee of the Board (referred to in this Act as the 'Executive Committee'), which shall be composed of five members and shall exercise such powers and functions as may be delegated to it by the Board. Four of the members shall be elected as provided in subsection (b), and the Director ex officio shall be the fifth member and the chairman of the Executive Committee.

"(b) At each of its annual meetings the Board shall elect two of its members as members of the Executive Committee, and the Executive Committee members so elected shall hold office for two years from the date of their election. Any person, other than the Director, who has been a member of the Executive Committee for six consecutive years shall thereafter be ineligible for service as a member thereof during the two-year period following the expiration of such sixth year. For the purposes of this subsection, the period between any two consecutive annual meetings of the Board shall be deemed to be one year.

"(c) Any person elected as a member of the Executive Committee to fill a vacancy occurring prior to the expiration

of the term for which his predecessor was elected shall be elected for the remainder of such term.

"(d) The Executive Committee shall render an annual report to the Board, and such other reports as it may deem necessary, summarizing its activities and making such recommendations as it may deem appropriate. Minority views and recommendations, if any, of members of the Executive Committee shall be included in such reports."

SEC. 6. The section of the National Science Foundation Act of 1950 redesignated as section 8 by section 4 of this Act is amended to read as follows:

"DIVISIONS WITHIN THE FOUNDATION

"SEC. 8. There shall be within the Foundation such Divisions as the Director, in consultation with the Board, may from time to time determine."

SEC. 7. Section 9 (a) of the National Science Foundation Act of 1950 is amended by striking out "section 3 (a) (7)" and inserting in lieu thereof "section 4 (i)".

SEC. 8. Section 10 of the National Science Foundation Act of 1950 is amended—

(1) by striking out "section 17" and inserting in lieu thereof "section 16";

(2) by inserting "social," after "engineering,"; and

(3) by striking out "among the States, Territories, possessions, and the District of Columbia" and inserting in lieu thereof "throughout the United States".

SEC. 9. (a) Section 11 (c) of the National Science Foundation Act of 1950 is amended—

(1) by striking out "basic";

(2) by striking out "research" each place it appears;

(3) by inserting "Secretary of State or" before "Secretary of Defense"; and

(4) by striking out "the national defense" and inserting in lieu thereof "international cooperation or national security".

(b) Section 11 (d) of such Act is amended by striking out "research" and inserting in lieu thereof "activities".

(c) Section 11 (h) of such Act is amended by striking out "section 5 of the Act of August 2, 1946 (5 U.S.C. 73b-2)" and inserting in lieu thereof "section 5703 of title 5, United States Code,".

SEC. 10. Section 13 (a) of the National Science Foundation Act of 1950 is amended—

(1) by striking out ", with the approval of the Board,"; and

(2) by striking out "section 16 (d) (2)" and inserting in lieu thereof "section 15 (d) (2)".

SEC. 11. Section 14 of the National Science Foundation Act of 1950 is repealed.

SEC. 12. (a) Section 15 of the National Science Foundation Act of 1950 is redesignated as section 14 and is amended to read as follows:

"MISCELLANEOUS PROVISIONS

"SEC. 14. (a) The Director shall, in accordance with such policies as the Board shall from time to time prescribe, appoint and fix the compensation of such personnel as may be necessary to carry out the provisions of this Act. Except as provided in section 4(h), such appointments shall be made and such compensation shall be fixed in accordance with the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates: *Provided*, That the Director may, in accordance with such policies as the Board shall from time to time prescribe, employ such technical and professional personnel and fix their compensation, without regard to such provisions, as he may deem necessary for the discharge of the responsibilities of the Foundation under this Act. The members of the special commissions shall be appointed without regard to the provisions of title 5, United States Code, governing appointments in the competitive service.

"(b) Neither the Director, the Deputy Director, nor any Assistant Director shall engage in any other business, vocation, or employment while serving in such position; nor shall the Director, the Deputy Director, or any Assistant Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Foundation makes any grant, contract, or other arrangement under this Act.

"(c) The Foundation shall not, itself, operate any laboratories or pilot plants.

"(d) The members of the Board and the members of each special commission shall receive compensation at the rate of $100 for each day engaged in the business of the Foundation pursuant to authorization of the Foundation and shall be allowed travel expenses as authorized by section 5703 of title 5, United States Code.

"(e) Persons holding other offices in the executive branch of the Federal Government may serve as members of special commissions, but they shall not receive remuneration for their services as such members during any period for which they receive compensation for their services in such other offices.

"(f) In making contracts or other arrangements for scientific research, the Foundation shall utilize appropriations available therefor in such manner as will in its discre-

tion best realize the objectives of (1) having the work performed by organizations, agencies, and institutions, or individuals in the United States or foreign countries, including Government agencies of the United States and of foreign countries, qualified by training and experience to achieve the results desired, (2) strengthening the research staff of organizations, particularly nonprofit organizations, in the United States, (3) aiding institutions, agencies, or organizations which, if aided, will advance scientific research, and (4) encouraging independent scientific research by individuals.

"(g) Funds available to any department or agency of the Government for scientific or technical research, or the provision of facilities therefor, shall be available for transfer, with the approval of the head of the department or agency involved, in whole or in part, to the Foundation for such use as is consistent with the purposes for which such funds were provided, and funds so transferred shall be expendable by the Foundation for the purposes for which the transfer was made.

"(h) For purposes of this Act, the term 'United States' when used in a geographical sense means the States, the District of Columbia, the Commonwealth of Puerto Rico, and all territories and possessions of the United States."

SEC. 13. Sections 16 and 17 of the National Science

Foundation Act of 1950 are redesignated as sections 15 and 16, respectively. Subsection (a) of the section redesignated as section 15 is amended by striking out "1946" each place it appears and inserting in lieu thereof "1954". Subsection (b) of the section redesignated as section 15 is amended by striking out "section 15(h)" in paragraph (1) and inserting in lieu thereof "section 14(g)".

SEC. 14. (a) (1) Section 5313 of title 5, United States Code, is amended by adding at the end thereof the following new paragraph:

"(19) Director of the National Science Foundation."

(2) Section 5314 of such title is amended by striking out paragraph 40, and by inserting in lieu thereof the following new paragraph:

"(40) Deputy Director, National Science Foundation."

(3) Section 5316 of such title is amended by striking out paragraph (66), and by inserting in lieu thereof the following new paragraph:

"(66) Assistant Directors, National Science Foundation (4)."

(4) The amendments made by this subsection (and the amendments made by sections 3 and 4 of this Act insofar as they relate to rates of basic pay) shall take effect on the first day of the first calendar month which begins on or after the date of the enactment of this Act.

(b) Section 902 (c) of the National Defense Education Act of 1958 is amended by striking out "$50" and inserting in lieu thereof "$100".

SEC. 15. Except as otherwise specifically provided therein, the amendments made by this Act are intended to continue in effect under the National Science Foundation Act of 1950 the existing offices, procedures, and organization of the National Science Foundation as provided by such Act, part II of Reorganization Plan Numbered 2 of 1962, and Reorganization Plan Numbered 5 of 1965. From and after the date of the enactment of this Act, part II of Reorganization Plan Numbered 2 of 1962, and Reorganization Plan Numbered 5 of 1965, shall be of no force or effect; but nothing in this Act shall alter or affect any transfers of functions made by part I of such Reorganization Plan Numbered 2 of 1962.

Passed the House of Representatives April 12, 1967.

Attest: W. PAT JENNINGS,

Clerk.

NATIONAL SCIENCE FOUNDATION
OFFICE OF THE DIRECTOR
WASHINGTON, D.C. 20550

April 24, 1967

Honorable Lister Hill
Chairman, Committee on Labor
and Public Welfare
United States Senate
Washington, D. C. 20510

Dear Senator Hill:

In reply to your letter of April 14, 1967, we are pleased to submit the following report from the National Science Foundation on H.R. 5404.

The National Science Foundation (the National Science Board and the Director) wishes heartily to endorse the general purposes of the bill and most of its provisions. We do, however, believe that several changes are necessary in those provisions relating to proposed Sections 3(a)(6), 3(d), 4(h), 5(e) and 6(b) of the National Science Foundation Act.

1. While endorsing the general purpose of proposed Section 3(a)(6), we question the provision which would require the Foundation to maintain a program not only for the determination of the total amount of money spent for research by each educational institution in the United States, but also by each nonprofit organization and private contractor. We have no difficulty with this provision insofar as it relates to educational institutions. But we do have serious reservations about the feasibility of fulfilling this requirement, if strictly interpreted, for each nonprofit organization and private contractor. In particular, it would be very difficult to ascertain the costs of research conducted under contract provisions which do not break down the contract price in terms of its various elements. Furthermore, the identification of research expenditures made by subcontractors would in many instances offer insurmountable difficulties.

Therefore, we would anticipate that in the early years of this program, non-academic organizations would be included only to the extent feasible, and that, with respect to these organizations, the Foundation could gather only those statistics that are meaningful and could be obtained with a reasonable expenditure of effort. As time goes on, the Foundation would, of course, expand its statistical coverage to the extent feasible.

87-071 O - 68 - 4

In order to make this clear in the bill we recommend that Section 3(a)(6) be revised to indicate that non-academic organizations need be included only to the extent deemed feasible by the Foundation. The phrase "received by each educational institution, nonprofit organization, and private contractor in the United States," should be changed to read, "received by each educational institution and appropriate nonprofit organization in the United States."

2. The bill proposes that Section 3(d) of the National Science Foundation Act provide that "The Board shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences."

We note that the Director has authority to speak on policy matters as the Director of the National Science Foundation in addition to speaking in his capacity as a Board member.

It seems important to us, therefore, that the quoted statement of legislative intent not be restricted to the Board but specifically apply to the Director as well. Our concern is that this Section as now phrased could be interpreted as limiting one of the proper functions of an agency head, viz., to recommend policies and actions on matters in which the agency has a vital concern. The Director of the Foundation in his capacity as Director--as distinguished from his position as an ex-officio member of the Board--is involved in daily intercourse with other agencies of government and with the academic community and must, of necessity, "recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences." Therefore we recommend that proposed Section 3(d) be revised by adding the words "and the Director" after the word "Board."

3. Proposed Section 4(h) permits the appointment of a staff to the Board. The Board has carefully considered this provision and has concluded that it can be more effectively served by the regular staff of the Foundation. We are aware of no difficulties that have ever arisen with regard to the adequacy of staff services for the Board, and we believe that the provision of a separate staff would be divisive and undesirable. Accordingly, we recommend that this Section be deleted.

4. Proposed Section 5(e) would prohibit the Director from making any grant or contract "without the prior approval of the Board if such contract, grant or other arrangement involves a new type of program, or involves a total commitment of over $2,000,000 or over $500,000 in any one year or a commitment of such other amount or amounts and subject to such other conditions as the Board in its discretion may determine and publish in the Federal Register." The Board has determined that this limitation is both unnecessary and undesirable, notwithstanding the fact that the Board may broadly delegate this authority to the Director by virtue of proposed Sections 4(b) and 5(e).

We agree that the Board should bear responsibility for Foundation policies as provided for in proposed Section 4(a). It also seems clear that the Board should bear the primary responsibility for refining the general purposes of the Foundation, as expressed in the Act, into specific objectives and formulating broad policies to achieve those objectives. However, the approval of individual transactions within established policies is, we feel, a matter for the Chief Executive Officer of the Foundation--the Director.

As generally understood, the development of what we refer to as programs, which is the first step in the implementation of policy, bridges the functions of policy determination and policy implementation. Thus, we believe that while the Board should not be involved in the approval of individual transactions, regardless of amount, it should be intimately and continuously involved in the formulation and review of programs. It follows, therefore, that the general activities to be encompassed in a program developed pursuant to broad objectives established by the Board, and the magnitude of Foundation resources to be put into such a program, should be determined by the Director and the Board in consultation, as provided for in proposed Section 5(d). Specific transactions and implementing measures undertaken within each program approved by the Board should be the sole responsibility of the Director, regardless of dollar amount, unless such transaction or measure raises a policy question of the nature reserved to the Board.

For this reason, the Foundation recommends that Section 5(e) be amended to read as follows:

"(e) The Director shall not make or revoke any contract, grant, or other arrangement pursuant to Section 11(c) without the prior approval of the Board if, in his opinion, such action involves a policy determination of the nature reserved to the Board."

5. Proposed Section 6(b) would provide four Assistant Directors of the Foundation to be appointed by the President with the advice and consent of the Senate. The Foundation considers this provision to be undesirable in its present form for the reason that it would give the Foundation an excessive number of Presidential appointees for an agency of its size, and would remove virtually all the top positions of the Foundation from career status. We would favor retaining the present language of Section 6(b) provided the words, "who shall be appointed by the President, by and with the advice and consent of the Senate" were deleted from the first sentence, and the sentence immediately following were also deleted.

The above constitutes the specific comments which the National Science Foundation has on H.R. 5404. We strongly urge its enactment as modified in accordance with the foregoing recommendations.

The Bureau of the Budget has advised us that it has no objection to the submission of this Report from the standpoint of the Administration's program.

Sincerely yours,

Philip Handler

Philip Handler
Chairman, National Science Board

Leland J. Haworth

Leland J. Haworth
Director, National Science Foundation

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

SEP 19 1967

Dear Mr. Chairman:

This letter is in response to your request of April 14, 1967, for a report on H.R. 5404, a bill "To amend the National Science Foundation Act of 1950 to make changes and improvements in the organization and operation of the Foundation, and for other purposes."

H.R. 5404 would amend the National Science Foundation Act of 1950 to effect certain changes, which are a consequence of the extensive hearings held during the summer of 1965 by the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics. The results of these hearings were reported in a report of the Committee, in December 1965, entitled "The National Science Foundation--Its Present and Future." At these hearings, views of the Department of Health, Education, and Welfare were presented through testimony of the Commissioner of Education and the Director of the National Institutes of Health.

A number of legislative recommendations were made in the Subcommittee's report on these hearings, almost all of which are embodied in H.R. 5404. The proposed amendments would, among other things:

(1) emphasize the role of the National Science Foundation in evaluating the status and needs of the various sciences and in providing for their balanced support (taking into account the programs of the mission-oriented Federal agencies);

(2) provide for a clearer distinction between the respective policy-making functions of the National Science Board and the executive functions of the Director of the Foundation, and augment the staff supporting both the Board and the Director (authorizing, to assist the Director, a Deputy Director and four Assistant Directors);

(3) initiate new authority for the Foundation to initiate and support applied research;

(4) add the social sciences to the areas of sciences specifically identified in the basic law as within the scope of the Foundation's activities; and

(5) provide for greater flexibility in organization and operation by removing statutorily designated Divisions within the Foundation (enabling the Director, in consultation with the Board, to determine the divisional structure) and eliminating the provisions in existing law directing the Foundation to engage in certain activities with respect to weather modification.

With respect to the changes in the Foundation's organization and operations proposed by H.R. 5404: First, it is recognized that an increasingly strong and effective National Science Foundation will contribute much to the achievement of national goals, including those sought through the Department of Health, Education, and Welfare. Second, there is important and inevitable interaction between programs and activities of the Foundation and those of two parts of this Department--the Office of Education and the National Institutes of Health of the Public Health Service. This interaction is most pronounced in the case of science education, support of basic research (particularly in the biological and behavioral sciences), and development of capabilities of higher education institutions.

In general, and from the perspective of this Department, the changes proposed in the National Science Foundation Act of 1950 appear to be desirable and constructive. Taken together, they should be quite effective in giving new impetus and direction to the role of the Foundation in the development of the Nation's science capabilities. We are, however, concerned about certain aspects of the bill and the role of the Foundation with respect thereto.

First in importance is the basic intent of the bill with respect to the Foundation's role vis-a-vis that of mission-oriented agencies supporting science. The scope and magnitude of science in this country, its strength and rate of growth, are a consequence of a pattern of support which is unique to this Nation. This pattern has involved major dependence of large areas of science upon the programs of the mission-oriented agencies aimed at social goals in agriculture, national defense, health, atomic energy, and other areas--complemented by fundamental noncategorical support through the programs of the Foundation. While there is clear need to advance the capability and to emphasize the essential role of the Foundation in this pattern, the continued advancement of the mission programs as a part of the total Federal pattern is also of vital importance. Thus, for example, the vitality of the Nation's biological and medical sciences will be best maintained through the complementary efforts of this Department (through the Public Health Service) and the Foundation rather than through major dependence upon one or the other of these agencies. The Department assumes the bill intends no change in this basic pattern and that these mutually supportive arrangements are intended to continue.

In addition to interaction between the Foundation and the Department in the science area, the Foundation and the Department interact on education matters as well. The role of the Foundation in support of education for science under existing authority has been restated in the bill. Accordingly, the number of program points at which the activities of the Foundation and Department touch and support each other in this bill is also quite significant and indicates the importance of appropriate liaison between the two organizations.

Another reason for strengthened liaison between the Foundation and this Department is the inclusion of the social sciences among the areas of science statutorily identified as within the purview of the Foundation. In fact, the proposed change is but formal recognition of the actual involvement of the Foundation in this area. However, the change is proposed at a time when acquisition of new knowledge in these areas has become a critical need in many of the major programs of this Department dealing with social and behavioral problems.

Finally, of importance is the interaction which will occur as the result of the amendment to section 3 of the National Science Foundation Act of 1950, contained in section 1 of H.R. 5404. This amendment would provide authority for the Foundation to undertake programs in the applied research area. It will be important that the Foundation, under this amendment, channel its efforts into helping to solve problems through support of applied research only after the capability of the several mission-oriented agencies has been explored and determined to be unavailable or unsuitable for the purposes sought. Otherwise there will always be a risk that the Foundation will be diverted from its primary role in support of basic research.

In the light of this existing and potential interaction between and overlapping of the functions of the Foundation and this Department, the importance of high-level liaison between the Foundation and the National Science Board, on the one hand, and this Department, on the other, cannot be over-emphasized. It would be helpful if the legislative history made the expectation of such liaison between the two organizations clear.

The Department defers to agencies more directly concerned with respect to other changes in the National Science Foundation Act of 1950 which are provided for in H.R. 5404.

In summary, subject to reservations expressed above, we would not object to enactment of H.R. 5404.

We are advised by the Bureau of the Budget that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

[redacted]

Secretary

Honorable Lister Hill
Chairman, Committee on
Labor and Public Welfare
United States Senate
Washington, D. C. 20510

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

SEP 8 1967

Honorable Lister Hill
Chairman, Committee on Labor
and Public Welfare
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

This is in reply to your letter of April 14, 1967, requesting Bureau of the Budget views with respect to H.R. 5404, a bill "To amend the National Science Foundation Act of 1950 to make changes and improvements in the organization and operation of the Foundation, and for other purposes."

The Bureau of the Budget endorses the intent of H.R. 5404 to clarify the respective functions of the National Science Board and of the Director of the Foundation and to provide authority for the Foundation to initiate and support applied scientific research under specified circumstances. However, we believe that the amendments outlined below are needed if the bill is to fulfill the objective of making the Foundation a more effective instrument in carrying out national policies for strengthening science, particularly in academic institutions.

The Foundation is particularly well situated to provide assistance to the Executive Office of the President in the analysis of the effectiveness of scientific programs of national concern--especially when such programs involve a number of Federal agencies. The performance of this function by the Foundation would be greatly facilitated by a specific statutory authorization. We recommend, therefore, the addition of a new subsection 3(c)--renumbering succeeding subsections accordingly--, to read as follows:

> "(c) In addition to any other authority contained in this Act, the Foundation is authorized, when requested by the Director of the Office of Science and Technology, to conduct analytical studies of existing or prospective scientific programs of national concern, to assist the Office of Science and Technology in performing its function of evaluating Federal programs and identifying opportunities for increasing the effectiveness of such programs in achieving national goals. The Foundation shall include in its Annual Report an account of all such studies carried out in the preceding year."

Section 3(d) as proposed in H.R. 5404 provides that the Board shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences. The Board should consider and recommend such policies. However, the Director, in carrying out his functions, should also make recommendations in regard to national policies for the promotion of basic research and education in the sciences. We strongly recommend, therefore, that section 3(d) be amended by adding the words "and the Director," after the word "Board."

Proposed section 4(a) states that "the Board shall establish and be responsible for the policies of the Foundation." We believe that to make the Board "responsible" for the policies of the Foundation may unwisely imply responsibility for their execution--a function which must clearly remain with the Director. Moreover, the Foundation will be receiving policy guidance from other sources than the Board. Accordingly, we recommend that this section be revised to read that "the Board shall establish policies to guide the Foundation."

Proposed section 4(f) provides for the election of the Chairman and Vice Chairman by members of the Board. This provision is not consistent with general practice in regard to agencies of the executive branch. For example, in the cases of the National Endowment for the Arts and the National Endowment for the Humanities, the President designates the Chairmen. The President also designates the Chairman of virtually every other multi-member board or commission. We are aware of no reason why the National Science Board should be treated differently. Accordingly, we believe that section 4(f) should now be amended to provide that the President designate the Chairman and Vice Chairman from among the Board's members.

Section 4(h) of H.R. 5404 would provide authority for the appointment of a staff for the National Science Board, consisting of not more than five professional staff members and necessary clerical staff. While it is clear that the Board should have adequate staff assistance to carry out its functions, we are sure that such assistance can and will be made available by the Director from the regular professional staff of the Foundation. We note that the Chairman of the Board and the Director of the National Science Foundation expressed the same view in their letter to you of April 24. The creation of a separate Board staff could lead to duplication of effort and might tend to create an atmosphere of divergence between the Board, on the one hand, and the Director and his staff, on the other. We recommend, therefore, that section 4(h) be removed from the bill.

We believe that the provisions of proposed sections 5(a) and 6(a) which would place the Director and Deputy Director in Levels II and III of

the Federal Executive Salary Schedule should be considered only in the context of a general review of section 5313 of Title V, United States Code. Therefore, we strongly recommend that these provisions be deleted from this bill with the assurance that they will be carefully considered in a general review of executive salaries.

Proposed section 5(a) continues the present arrangement under which the Director is appointed for a six-year term. While provision is made for removal by the President, it would be preferable to conform to the well-established practice under which terms of office (except for members of boards and commissions) are not specified. Therefore, we recommend the deletion of the words "and shall serve for a term of six years unless sooner removed by the President."

Proposed section 5(e) would prohibit the Director from making any grant or contract "without the prior approval of the Board if such contract, grant or other arrangement involves a new type of program, or involves a total commitment of over $2,000,000 or over $500,000 in any one year or a commitment of such other amount or amounts and subject to such other conditions as the Board in its discretion may determine and publish in the Federal Register." We believe that this limitation is inconsistent with the Director's function as the chief executive of the Foundation. The Director is a senior Federal official, directly responsible to the President and to the Congress for the propriety of his acts. We do not believe it is appropriate or necessary to set a dollar limitation on the actions he may take in carrying out established policies. We recommend, therefore, that section 5(e) be deleted from the bill. Alternatively, we would have no objection to the recommendation of the Foundation that this section be changed to read as follows:

> "(e) The Director shall not make or revoke any contract, grant, or other arrangement pursuant to Section 11(c) without the prior approval of the Board if, in his opinion, such action involves a policy determination of the nature reserved to the Board."

We believe it would be desirable to provide specific authorization for the Foundation to delegate to another Federal agency the authority to carry out scientific activities which the Foundation is authorized to support. For example, section 3(c) proposed in H.R. 5404 would authorize the Foundation, at the direction of the President, to undertake support of applied research programs relevant to national problems involving the public interest. After such a program has been initiated by the Foundation it might be most effective, at some later time, to place the program under the management of a Federal agency charged with mission responsibilities to which the particular research program was particularly relevant. We recommend, therefore, the addition of a new subsection (d) in section 9 of H.R. 5404, to read as follows:

"(d) Section 11 of such Act is further amended by the addition of a new subsection (j) as follows:

> "(j) to arrange with and reimburse the heads of other Federal agencies for the performance of any activity which the Foundation is authorized to conduct."

We consider it undesirable to establish four positions of Assistant Director, to be appointed by the President with confirmation by the Senate, as provided in proposed section 6(b). This provision would, with other provisions of H.R. 5404, result in a total of six Presidentially-appointed officials in the Foundation. We believe that this would be excessive for an agency of the Foundation's size and scope of responsibilities, and would place an unnecessary burden on the President. We recommend, therefore, that the words "who shall be appointed by the President, by and with the advice and consent of the Senate" be deleted from the first sentence of the section, and that the sentence immediately following also be deleted.

We strongly urge the enactment of H.R. 5404 provided the bill is amended in accordance with the foregoing recommendations.

Sincerely,

Wilfred H. Rommel

Wilfred H. Rommel
Assistant Director for
Legislative Reference

STATEMENT OF HON. EDWARD M. KENNEDY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator KENNEDY of Massachusetts. The National Science Foundation is charged with supporting the development of American scientific expertise. This is a very broad charge. It is also a very great challenge. The record of the National Science Foundation in carrying out the charge and meeting the challenge is a proud one—but one which I think is too little known.

Let me cite a few examples of the extent of the National Science Foundation activity:

From 1952 to 1966, the NSF invested more than $210 million in graduate fellowships, representing 42,850 fellowship awards and 8,197 traineeships for award by 193 institutions.

From 1958 to 1966, the NSF has provided more than 43,000 undergraduate research opportunities.

In 1966, the NSF awarded 358 separate grants which permitted 3,721 college science teachers to take refresher courses.

By the end of 1966, more than 275 definitive editions of textbooks had been developed by NSF-supported groups.

Since 1960, the NSF has made 833 grants for construction or renovation of graduate science facilities.

In 1966, the NSF has made 833 grants for construction or renovation of graduate science facilities.

In 1966, the NSF made grants to 401 colleges and universities in all the 50 States for support in modernizing science curriculums.

The NSF continued to support national research programs and centers, such as the Indian Ocean expedition and the Kitt Peak National Observatory.

I want to emphasize that these examples are only a few from among many. The full catalog of NSF assistance defies summary.

A very good answer to the question of the need for continued pressure for more and better basic research was given by J. Robert Oppenheimer, wartime director of the Los Alamos Scientific Laboratory:

> We learned a lot during the war. But the things we learned (were) not very important. The real things were learned in 1890 and 1905 and 1920, in every year leading up to the war, and we took this tree with a lot of ripe fruit on it and shook it hard and out came radar and atomic bombs . . . The whole spirit was one of frantic and rather ruthless exploitation of the known; it was not that of the sober, modest attempt to penetrate the unknown.

That is, I think a superb justification of our need to keep up the pressure on science development. There is simply no way to develop basic knowledge on a crash basis. It must develop slowly, through painstaking efforts at piecing together seemingly unrelated bits of evidence. When the picture is completed, it is useful, whether it be in medicine, metals technology, radio astronomy, or any of the hundreds of other fields. But the picture cannot be rushed to completion.

Massachusetts has long been a leader in science research. Of the nearly $17 billion of Federal funds going for scientific research, well over $1 billion goes to Massachusetts. There are 9,540 scientists living in Massachusetts according to the NSF. This is 4.25 percent of all American scientists, while Massachusetts has only 2.75 percent of the U.S. population. This is some indication of the interest in science matters in Massachusetts.

The hearings we begin today can lead to a greater understanding of the need for continued growth of basic science research. They will also lead to a streamlining of the NSF machinery.

Both results will help advance the march of American science, and with it, the quality of life for all Americans.

We want to welcome as our first witness today Dr. Donald F. Hornig, the Director of the Office of Science and Technology in the White House and the man in charge of day-to-day direction of science research for the President.

Doctor, we welcome you, and appreciate your appearance here today.

I see you have a statement here. I will ask you to proceed in your own manner, reading it if you wish or excerpting it.

Dr. HORNIG. Thank you, Senator.

STATEMENT OF DR. DONALD F. HORNIG, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. HORNIG. Mr. Chairman and members of the subcommittee, I appreciate the opportunity to testify on this bill because of my deep conviction that the National Science Foundation plays a critically important and unique function for the Nation. Any steps that will strengthen the structure of the Foundation are in the national interest. The bill under consideration would help the Foundation to function more effectively, and for this reason I heartily support it.

Apart from the proposed statutory changes themselves, consideration by the Congress provides an opportunity—for the first time since the National Science Foundation Act was passed in 1950—to review the accomplishments of the Foundation, and to consider the problems and opportunities which lie ahead.

The most critical problem that has faced the National Science Foundation in fulfilling its full promise for the Nation has been a chronic shortage of funds. The Congress has not, in my judgment, fully grasped the stake which the Nation has in a strong and well-financed National Science Foundation.

This is not a problem confined to the last year or so, but rather a condition that has afflicted the Foundation from its earliest days. It may be that the scientific community has not been articulate or persuasive enough on this point, for until recently Congress has certainly shown no reluctance to support science when the relevance of science to the national needs and aspirations has been adequately demonstrated.

Whatever the causes might be, it is my conviction that the role intended for the National Science Foundation is not being played with full effectiveness because it has not been given the necessary resources. The elevation of NSF to its proper relative and absolute position is a task that will require several years. However, part of that task—securing a more effective charter for the organization—can be undertaken immediately. The bill under consideration is directed to this end.

I should like to comment briefly on why an effective National Science Foundation is so important.

First, it is the only agency of Government which has a direct congressional mandate to strengthen science, and education in science,

without regard to the applicability of the findings to immediate problems. It is responsible for giving this country a sound scientific foundation which will provide us with a pool of knowledge and understanding of which applied science and engineering can draw, as well as a pool of educated men and women who can staff the enterprises of the future. To do this it obviously has a responsibility to help develop healthy academic institutions to carry out these tasks. It is the core of our basic science strength—although until now it has never had more than one-seventh of the total resources, even in the support of academic science.

Many other Federal agencies also support basic and academic science, and quite properly so. The NIH supports development of those scientific areas which can contribute to the improvements of the Nation's health—a broad spectrum centered around the life sciences. The Department of Defense has a responsibility to support basic and applied research as well as manpower development in areas which may be vital to the security and the country—again a broad spectrum centered on the physical sciences and engineering.

The Department of Agriculture covers everything related to farming. Similarly, the other two principal agencies in the support of academic science, the AEC and NASA, support research and training related to atomic energy and space, respectively. We should clearly encourage the expansion of such efforts in the future in the Department of Commerce (civilian technology), Interior (natural resources), Transportation and HUD.

This pluralistic approach to science does not produce a single, simple administrative structure, but it has been a basic strength of our system for the support of science and technology. It makes the system responsive to national needs as reflected through the missions of the Federal agencies.

It is far from perfect, though. Some areas of science may not be stimulated as they ought to be. A system focused on the search for answers to current problems could suffer from the absence of revolutionary new ideas not tightly linked to a recognized, stated goal. A system which lacked the stimulus of basically new ideas might degenerate into one designed to refine existing methods, lacking the ability to cope with completely new opportunities.

We have thus far avoided that difficulty. The Federal agencies have wisely interpreted their missions broadly, and Congress has concurred. As a result, the various agencies of Government other than NSF now provide a great deal of support for basic research. Indeed, they provide well over four-fifths of all Federal funds for basic research.

However, the very fact that basic research of this nature is related—however generally—to agency missions generates the need to insure that new opportunities do not slip through the cracks, that the full spectrum of basic research is covered, and to insure that no important areas of science are left uncovered. By providing the glue that ties all of the parts together, the research supported by the National Science Foundation not only assures a well-rounded total approach to support of science, but insures a continuing expansion of the fund of the basic knowledge required for fields such as health, defense, space, environmental quality, agriculture and civilian technology. This is a major role of the National Science Foundation. The role is particu-

larly important since there are continuing and increasing pressures on most agencies of government to confine their support to work that is directly and clearly related to their statutory tasks.

Research is important, not only because it produces findings of great value over both the short and the long run, but also it is an essential part of advanced education in the sciences and engineering. Without research, advanced education is sterile, pedantic and rigid. Research that is carried on apart from advanced education can be and often is highly productive, but it does not contribute to creating the next generation of scientists and engineers.

As is true of support for research, the mission-oriented agencies contribute heavily, directly and indirectly, to the production of scientists and engineers. However, the Nation needs support for the advanced education of scientists which is not linked to or derived from the activities of mission-oriented agencies.

This is another important task for the National Science Foundation; it is particularly significant when, as is now the case, many universities are having difficulties in sustaining advanced education in the sciences for rapidly growing numbers of students at the level of quality required to meet national needs which continue to expand and change.

Science and technology as such, together with the training of scientists and engineers, are so significant for this country that we need a strong governmental agency concerned with the health, vigor, and growth of these enterprises in themselves, and not as means to other ends. The National Science Foundation has performed these important functions for the Nation.

The National Science Foundation has recognized that the rate of growth and change in science has made imperative a revision in the methods of teaching science. The Foundation has played a central role in bringing about educational innovation and reform of curriculums in science.

A central element of this task has been to bring to bear the talents of the best scientists upon the extremely difficult questions involved in teaching science. The result has been that a startling proportion of the most successful innovations in high school curriculums has come from work under the auspices of the Foundation.

The revolutionary changes in science curriculums have sparked other inquiries into the ways in which creativity and independent thought can be stimulated in students of history, music, art, English, et cetera.

An even stronger and wide-ranging effort by the Foundation in this field would certainly contribute substantially to the quality of education in the Nation, particularly in elementary and secondary teaching.

Finally, the National Science Foundation provides an important focus for assessing periodically the state of science and technology in the Nation, for evaluating our strengths and weaknesses, for determining the adequacy of our stock of scientists and engineers to meet the demands of the future, and for providing the data for decisions concerning the balance of our total national effort.

One of the elements of strength in science and technology is the continuing attention paid to such questions by a large number of individuals and groups. We have no blueprint for science and no central planning body. Instead, we have a pluralistic system of involve-

ment, criticism, and interacting forces. In this complex system, the National Science Foundation provides a focus and a source of advice.

Let me now turn to the provisions of the bill.

With regard to the Board and Director (sec. 4(a)), the bill provides that the National Science Board "shall establish and be responsible for the policies of the Foundation." Either wording, combined with the powers assigned to the Director, describes a pragmatic working relationship which has proved in practice to be effective. Nevertheless, I believe that the wording of the Senate bill is preferable because it is simpler. However, I believe the word "guide" carries too much of the implication of an advisory function so I would prefer the still simpler statement, "shall establish the policies of the Foundation."

With respect to removal of unwise limitation on grantmaking authority of the Director (sec. 5(e)), in reviewing the bill, I noted that two significant provisions of H.R. 5404 were altered. One of these provided that the Director could not provide support "without the prior approval of the Board if such contract, grant, or other arrangement involves a new type of program, or involves a total commitment of over $2 million, or over $500,000 in any one year, or a commitment of such other amount or amounts and subject to such other conditions as the Board in its discretion may determine and publish in the Federal Register."

This limitation would unduly restrict the Director, and would not focus appropriately on the policy role of the Board.

I agree with the Director of the Foundation and the Chairman of the National Science Board that the wording of S. 2598 is definitely preferable. Section 5(e) now requires the Director to secure the prior approval of the Board if, in his opinion, any action involves a policy determination of the nature reserved to the Board. This formulation appropriately combines the need for exercise of strong executive authority with the need for policy review by the Board.

With respect to removal of provision of separate staff for the Board, H.R. 5404 provided that a separate staff might be assigned to help the Board, and the Director should be responsible for insuring that this help is available to the Board. A separate staff for the Board would tend to generate and foster a separatist attitude which might well result in less rather than more effective staff work for the Board.

I share the view of the Director of the Foundation and of the Chairman of the National Science Board that this provision should not be a part of the bill.

With regard to science and technology on the international scene, both the Senate and the House bill contain a clause (sec. 3(b)) stating that "when requested by the Secretary of State or the Secretary of Defense, the Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation or national security * * *" The portion of the section relating to the Secretary of State and international cooperation is new.

This authority is potentially of great significance. As the President said recently, "I believe the language of science offers us new and still largely unused opportunities for international understanding and cooperation." The National Science Foundation is a natural focus for these activities.

We have thus far not exploited adequately the full potential of science as a force leading toward a greater degree of unity among

nations. Nor has the State Department had a fully adequate link to the scientific community so that it could take full advantage of the impact of science on the foreign relations of the United States. The National Science Foundation is a natural focus for many aspects of international cooperation in scientific matters.

We have made agreements for scientific cooperation with many of our friends abroad—notably with Western Germany, Japan, and Italy. We are searching for new ways to assist South and Central American science in accordance with the President's pledge at Punta del Este. Much remains to be done in this area where science contributes to objectives which we hold in common with other countries.

The National Science Foundation has carried on a limited program of scientific activities connected with international cooperation, but these would be strengthened and the role of the Foundation made more explicit if the proposed amendment were adopted.

I see no danger that this clause would involve the Foundation inappropriately in matters relating to foreign affairs. Our problem to date has been the underinvolvement of the Foundation in proper, constructive use of science and technology to promote international cooperation, and the proposed amendment would help to rectify this situation.

With respect to applied research (sec. 3(c)), the existing restrictions to basic research has limited the Foundation because the boundary between basic and applied research is often indistinct, particularly when the distinction rests on the motivation of the investigator rather than on the nature of the research itself.

The limitation to basic research has produced problems in dealing with engineering research and the training of engineers. It has also caused NSF to draw back from research which might be designated "exploratory but practical." Finally, the existing limitation tends to place an artificial restriction on the evolution of what starts as basic research. Surely if a project intitiated as basic research turns out to present practical possibilities, it should not have to be dropped as if it were contaminated.

The bill contains a further provision authorizing the Foundation to support applied research relevant to national problems involving the public interest when so directed by the President. I favor this authority because it makes the resources of the Foundation available to resolve urgent problems that may not fall within the province of any other Federal agency.

On the other hand, I believe that this authority should be invoked only when other resources are clearly inadequate or inappropriate, and that the President will rarely have to invoke this provision. Our array of Federal departments and agencies, particularly since HUD and DOT have been created, now provides logical sources of support for research on virtually all such problems.

As to the social sciences, the bill makes clear the duty of the Foundation to support research in the social as well as the physical and biological sciences. In my view this is sound because the social sciences are important and need support. It is appropriate to provide it through NSF because it would be undesirable to introduce arbitrary barriers between the natural and social sciences.

Moreover, just as the biological sciences have benefited by close association with physics, chemistry, and mathematics, it can be ex-

pected that the social sciences will develop more productively through close interaction with the physical and biological sciences.

With regard to personnel provisions, I note that S. 2598 deletes the 6-year statutory term for the Director which was included in H.R. 5405. In view of the significance of this position in relation to the science policy of the Nation and in relation to the policies of the executive branch, it seems to me quite proper that the Director should serve at the pleasure of the President as do other major officials in the executive branch. On the other hand, S. 2598 proposes that four statutory Assistant Directors not be President appointees. I agree with this deletion.

With respect to compensation, both S. 2598 and H.R. 5405 place the Director in level II and the Deputy Director in level III of the Federal executive salary schedule. They are now at levels III and V, respectively. While I recognize that executive compensation is best considered in the context of an overall review of the executive salary structure, I do believe that more adequate compensation and status for these positions is indicated.

Finally, on a technical matter, I note that the requirement that the NSF statistical program include research funds received by private contractors (sec. 3(a)(6)) has been deleted from S. 2598. While it would be useful to have such data, and while NSF should work toward this goal, I believe that a statutory requirement to this effect would impose an impossible task on NSF at this time because of the elaborate net of contractors, subcontractors, et cetera, that is to say that the fact these research funds are frequently indistinguishable in private contracts from other funds and so on—but principally it is a very elaborate structure from whom information would have to be gathered, and then correlated at great expense.

In conclusion, these comments in no way modify my view that the bill is sound. I have not commented on every aspect of the bill, but I shall be glad to answer any questions which the committee may have. For the reasons which I have indicated, I believe that the Nation has an important stake in a National Science Foundation which can operate smoothly and flexibly. This bill will contribute to this end, and I therefore hope that it will be enacted.

I will be very glad to answer your questions.

Senator KENNEDY of Massachusetts. Thank you very much, Doctor, for a very comprehensive and helpful commentary on the legislation which is before us.

In your testimony you discuss the pluralistic aspect of our research programs, within the different agencies of the Federal Government. And you make the comment that this is a strength of our research programs. You also suggested that these various research programs of the respective organizations are extremely important and make significant contributions.

I wonder about the area of overlap, of duplication, which must, by the nature of the institution itself, exist. I wonder if you could comment on this point—what is being done, what can usefully be done, in order to keep duplication at an absolute minimum.

Dr. HORNIG. Well, this is naturally a problem with which we have been concerned. It is a problem which I have some responsibilities for.

The ways in which we try to eliminate duplication are these:

In the first place, at the working level there is a sense of interchange between the program directors in common areas among the various

agencies. Through my Office we try to keep in touch with the programs of all of the agencies, and to help them coordinate their programs, and to eliminate overlapping programs.

Another mechanism—the Federal Council of Science and Technology, in which the principal technological officers of all of the agencies are members, and one of whose most important functions is to coordinate the programs of the various agencies in science. It has, for example, committees, subcommittees in various efforts to do this in some detail.

There is a Committee on Atmospheric Sciences, for example, there is a Committee on Environmental Quality which is trying to coordinate the research being done with relation to the environment in many agencies, there is a Committee on Water Resources Research, which recently published a 10-year plan, and has done a very careful job of coordinating water resources research—and so on.

We have recently been able to initiate on a far broader scale than the past comprehensive reporting recorded on computers of all of the research projects supported by the Federal Government.

This is done both through the Science Information Exchange, supported by the National Science Foundation, and on the computerized systems of NASA and the Department of Defense, and it is being broadened now to include the entire Federal Government. So we work on it.

But I do want to emphasize that overlapping and duplication we do not want. But on the other hand, like all other vital human activities, science is and should be competitive. When two people work at solving a jigsaw puzzle, they may be duplicating activities, but it gets the puzzle solved faster.

Senator KENNEDY of Massachusetts. Could you elaborate, to some degree, on how the decisions are made as to what priorities are going to be placed upon the directions of research? How do you decide whether you are going ahead to develop new curriculums in the primary and secondary schools, versus providing funds for graduate centers in the study of science?

How are these decisions made?

Dr. HORNIG. I think I would have to say that there is no simple, monolithic decisionmaking process on these things. Like many things in American life, what one tries to do is to bring to bear all of the significant forces, and then to resolve the conflicts.

Let me be more specific.

In making such decisions, the question is what we want to achieve, and there are two basic reasons in science why one wants to achieve things. One is what is needed by the society—health, environmental control, and so on. And this is achieved by having the influence of mission-oriented agencies whose job it is to make progress in these various fields. So this reflects in our decisionmaking—our needs.

On the other hand, needs for which there are no solutions cannot be met in a given time, and so there is another criterion, and this is what the National Science Foundation largely brings in, which is the opportunities which are provided by new ideas, which have the right place in the intellectual structure of things and which we are confident will some day be used.

Now, in resolving these things, I am afraid what I would say is that by and large there is a continuing process of debate and discussion

in the executive branch, through various advisory mechanisms with the external community, and it is eventually resolved in connection with the Bureau of the Budget, the entire programs, and finally with the Congress.

Senator KENNEDY of Massachusetts. You speak in your testimony of the importance of an expansion of the social sciences within the NSF. Would you elaborate on your reasons for this belief?

Dr. HORNIG. Yes. I think that it is plain that so many of our problems resolve around social problems—that all of the sciences which can shed light on the basic principles involved in human and social behavior need developing.

Now, there is a fair investment in them now. I think the Federal Government altogether spends about $300 million on the social sciences. But in my view the social sciences have not yet evolved the kind of basic laws and principles that the national sciences have. They are only learning to become quantitative and predicative. And I think that they are making great progress in these directions. But I think that the interaction of the social sciences with the more experimental, more quantitative approaches of the national sciences gives strength to them.

I think that more and more there are inputs from biology and experimental psychology into the softer branches of the social sciences. And they should all be treated as a broad spectrum.

But I guess basically I would simply say that the social sciences are just plainly important, and that the country needs a sound foundation in them, in the same way that it needs the natural sciences.

Senator KENNEDY of Massachusetts. You also comment, to some extent, on the international science efforts, and the kinds of imaginative cooperation that could take place among the different nations.

Could you be more specific as to the types of programs which would be useful and helpful in developing research for our national interest, as well as for the interest of the world community?

Dr. HORNIG. Yes. The National Science Foundation does participate in a number of international activities now. It funds, for example, the participation of American scientists in international meetings. It does fund cooperative endeavors between the United States and Italy, in such fields as molecular biology, and the United States and Japan through the United States-Japan Cooperation Committee.

But I think the point I would make is simply that science is an international activity, with or without support from the National Science Foundation. Scientists everywhere are linked through scientific journals, through personal correspondence, through comparing notes at international meetings. Nevertheless, in the course of carrying on cooperative research on both sides of the ocean, or across the world, it might be advantageous at times to transfer American funds, not in the sense of assistance, but in expediting cooperation from which we expect to get gains. And I think this comes up whenever there are groups of scientists working on common problems in two countries, where it might be expeditious, for instance, to have people travel back and forth between each other's laboratories—when American work might profit by the presence of foreign scientists in the American laboratory, or when the American scientist might be able to carry on his work better by traveling to a laboratory abroad which is

particularly equipped to do the kind of work he wants to do. You might come up with an exchange of students.

I think a particular point which comes up from time to time is that in connection with other programs in the developing nations particularly we would like to make available the experience we have had, the skills which have been acquired in the American scientific community in helping them to develop scientific and educational systems.

Now, this is not the kind of assistance which requires, as AID gives it, a great amount of capital assistance. It is mainly a question of American intellectual assistance, and in such cases the National Science Foundation, which has deep roots in the American scientific community, is I think peculiarly adapted to do it.

It has in the past assisted AID occasionally in some of these ventures.

For example, in the Indian program to assist secondary education in the sciences, AID has gone to NSF itself to help get backup and roots in American experience.

So that this can be done, but it is cumbersome. I think the power of NSF to on occasion be able to provide the small amounts of funds which would enable American intellectual investment to be made abroad, could be very important.

Senator KENNEDY of Massachusetts. As I understand it, you make decisions as the Director of the OST on the research to be undertaken by the various departments in the Government on, say, water pollution, air pollution, mass transportation, or education for the disadvantaged.

What is the attitude of your office toward these research programs, as far as looking into social problems such as the problems of the cities? Has there been any change in attitude or increased efforts in view of what has happened during the course of the last summer?

Dr. HORNIG. I think I can say simply that we have stressed as much as we know how the necessity for our expanding our efforts in all of these areas as fast as we can develop good programs and good ideas. I think they are not limited just by money—but that we have yet to learn exactly how to go about, for instance, a program in urban research, most effectively.

We have worked with the Department of HUD on this score, and sponsored in Woods Hole, in your State, the summer before last a summer-long study on the problem of science and technology in relation to the city and urban problems.

But I think that in all of these areas it is plain that we can benefit from research, just as we have learned to do in defense and in health and in space—we are on a learning curve, and we are going to have to push. But we are working hard on learning how to do it.

Senator KENNEDY of Massachusetts. I am very glad to hear that, and I hope you will redouble your efforts, perhaps again at Woods Hole.

I notice that the Science Foundation's obligations, by discipline, in fiscal year 1966, listed in millions of dollars, listed oceanography at 29, biology at 79, chemistry 40, physics 50, and mathematics 45.

These represent, of course, balances which must be struck. But I would like to know how you relate oceanography at 29 million to biology at 80 million. How are these priorities established?

Dr. HORNIG. I hope you also give the Director a chance to answer this question.

Senator KENNEDY of Massachusetts. Yes, I shall.

Dr. HORNIG. I would note several factors in the comparisons you have made.

One, of course, is that biology is also supported and very strongly by the National Institutes of Health, which is the strongest single supporter of biology. So that when we looked at it, we would look in terms of the total support, and strike a national balance.

But quite aside from that, the ways one has of judging are by the number of good proposals that are available. I know the Director of the National Science Foundation uses this as a very important guide—the number and quality of proposals for scientific work that he receives.

A second criterion that is important is that some fields are intrinsically more expensive than others. And there is a high entry fee. The most extreme example is space. One either buys big rockets, or one does not do space research. And similarly oceanography is an intrinsically expensive but important field.

Nevertheless, you have to buy ships and operate crews and keep them on the ocean for a long time. So this has to be taken into account.

But I think in the end the main criterion for balance in the basic sciences is the extent to which we can carry out the good proposals which have been received, the good ideas which are available.

Senator KENNEDY of Massachusetts. To pursue a specific example for a moment, I know there are a number of different ways of producing fish protein concentrate—chemical, biological, mechanical and so forth. Some have been approved by the Food and Drug Administration, others have not.

Could you give us a status report on this program, and what you see in the future?

Dr. HORNIG. Well, I think the present status is that the Food and Drug Administration has approved the distribution for human use of fish protein concentrate produced by the Bureau of Commercial Fisheries process, that is extraction with isopropinol, in packages not bigger than 1 pound, appropriately labeled.

I am afraid—I am not aware of any other processes that have been licensed at the present time.

The problem with production of all food products, though, is that in order to license new processss, the product has to be reproducible, pure, it must not be subject to spoilage, it must not contain too much fat. But these problems are now rapidly being beaten, because there are a number of other processes which surely will become commercialized in the near future.

Now, you ask about the prospects.

I think that the fish protein concentrate offers an economical and a compact and convenient way of distributing fish products in a way that does not spoil if properly handled, which can overcome certain marketing problems in places which are not accustomed to eating fish, by incorporation in other food products. I think it offers enormous possibilities for contributing to protein—the problem of protein malnutrition in some of the developing countries. Of course, fish meal, which is like FPC but less refined, is already one of the most important sources of animal foods. Unhappily, animals are in some respects better fed than humans on this score.

Senator KENNEDY of Massachusetts. I would agree with you, Doctor, and point out that this is one reason I introduced an amendment to the foreign aid bill to encourage its production and use. I would like to request that your office file with us a memorandum giving us a picture of the research programs being carried out now, at the present time, in FPC, and the prospects for greater utilization of it.

Mr. HORNIG. I would be very happy to do that.

(The information requested and subsequently supplied follows:)

OFFICE OF SCIENCE AND TECHNOLOGY,
Washington, December 12, 1967.

Hon. EDWARD M. KENNEDY,
U.S. Senate, Washington, D.C.

DEAR SENATOR KENNEDY: This is a brief progress report on the development of fish protein concentrate (FPC).

Two fish protein concentrate products have now been developed and approved by the Food and Drug Administration as a food additive for human consumption. One product, developed by the Bureau of Commercial Fisheries (BCF) in the Department of the Interior, extracts fish protein concentrate from whole hake by a solvent process using isopropyl alcohol. The second, developed by the Viobin Corporation, gives a fish protein concentrate through extraction with ethylene dichloride followed by an isopropyl alcohol rinse.

A third chemical process is under development in Sweden, but it has not yet been approved by the Food and Drug Administration for human consumption in this country.

The Bureau of Commercial Fisheries is continuing to expand its program of reseach and pilot production of FPC. Chemical processes to utilize fatty fish such as menhaden, anchovies, and herring are now under development. These fatty fish are more important resources to the less developed world than are the lean, hake-like fish found in waters near the U.S. In addition, preliminary studies of biological processes for FPC are under way. Enzymatic digestion of whole fish to produce FPC may eventually be cheaper, simpler, and more easily exportable than chemical processes; however, the successful development of biological processes is still several years away.

Last year Congress authorized BCF to build a pilot demonstration plant to work out the engineering and design problems associated with commercial production of FPC. In May, 1967, BCF distributed a request for proposals to all interested firms. Seven proposals have been received. BCF is now in the final stages of negotiations and expects to execute a contract early in 1968.

In conjunction with the BCF efforts, AID is engaged in a demonstration program to utilize FPC as a protein supplement in developing countries. AID has led teams to Asia and Latin America (a trip to Africa is planned shortly) to determine suitable sites for FPC projects on the basis of the country's need for protein, its nearby fishery resources, and its ability to absorb the necessary technology. An extensive market analysis and market development also will be emphasized in these projects. As demonstrations of FPC's potential proceed, we expect that private industry will participate on an increasing scale in production and distribution worldwide.

The Office of Science and Technology, working with the National Council on Marine Resources and Engineering Development, the Bureau of the Budget, BCF, AID and other concerned agencies, has a continuing interest in the development of fish protein concentrate as an important component of the President's war on hunger.

Sincerely,

DONALD F. HORNIG, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
NATIONAL COUNCIL ON MARINE RESOURCES AND
ENGINEERING DEVELOPMENT,
Washington, September 18, 1967.

Hon. EDWARD M. KENNEDY,
Old Senate Office Building,
Washington, D.C.

DEAR SENATOR KENNEDY: On behalf of the Vice President and the Marine Sciences Council I wish to express appreciation for your action and efforts in

presenting the amendment to the Foreign Aid Bill authorizing an expanded program for Fish Protein Concentrate.

May I express my personal feeling about the strong need and desirability of this valuable amendment and its provisions for very substantial increment to the program implementation.

Sincerely,

EDWARD WENK, Jr.

Senator KENNEDY of Massachusetts. As I understand it, one chemical process has been approved, but the biological and mechanical have not.

I wonder if we are continuing to try and find ways—through research—of bringing the costs down, improving the techniques which would make this economical which would obviously benefit and help the hungry millions of the world. As the President has stated so often, we have a deep interest in providing protein for a very reasonable cost to people who suffer malnutrition.

Dr. HORNIG. I will be glad to provide a statement. I am not aware of any purely mechanical process. There are, as you say, biological processes. But I would be glad to put together a summary.

Senator KENNEDY of Massachusetts. Thank you very much, Dr. Hornig. We will print that summary in the appendix to these hearings.

We appreciate your appearance here and your helpful commentary. And we look forward to workship with you in the future.

Dr. HORNIG. Thank you, Mr. Chairman.

Senator KENNEDY of Massachusetts. Our next witnesses are Dr. Philip Handler, Chairman of the National Science Board, and Dr. Leland Haworth, Director of the National Science Foundation.

STATEMENT OF DR. LELAND J. HAWORTH, DIRECTOR OF THE NATIONAL SCIENCE FOUNDATION

Dr. HAWORTH. Thank you, Mr. Chairman.

I have a statement here, Mr. Chairman, that will take, I think, a little overlong to read, in view of the urgencies of your schedule. It would require between 20 and 25 minutes.

So if it is appropriate, I will try merely to summarize it, and then submit it for the record.

Is that satisfactory?

Senator KENNEDY of Massachusetts. Your statement will be included in its entirety in the record, and I would be pleased to have you summarize it.

Dr. HAWORTH. It is a pleasure for me to review with you and your subcommittee the provisions of S. 2598.

I would also like, Mr. Chairman, to thank you for the remarks that you made, at the time you introduced this bill on the floor of the Senate and again this morning, regarding the Foundation and its comprehensive role and activities which I felt you described very well.

We are also grateful, of course, to Mr. Daddario and his subcommittee in the House for the review they made that led up to H.R. 5404, which is also before us.

I do not believe, in view of your well-expressed description and that of Dr. Hornig of the role of the Foundation that I need to repeat that. I agree with everything that both of you have said. Perhaps I should be a little more definite than that. I thought especially

apt your own phrase, when you pointed out on the floor of the Senate that the functions that have been assigned to the Foundation under its present act can be described by a single phrase, "a national program for enhancing the health of basic American science and science education." I thought that telescoped the whole thing as succinctly as could possibly have done.

I think that the Foundation could do more and better things with the types of changes that are proposed in H.R. 5404, and in your own bill, S. 2598, so I basically support both of these bills. But I feel that, because of the changes that you have introduced in the Senate version, I definitely prefer it, and would like to see the Senate bill enacted in substantially its present form.

With these preliminary remarks, then, I will turn to the two bills, and discuss some of the provisions in both of them. They really fall into two groups. One group relates to the substance of the Foundation's scientific, educational and related programs, and the other to organizational and procedural matters, including the role of the National Science Board in the sphere of national policymaking for science, as well as in respect to its role within the Foundation itself.

I think that, if enacted, both bills will make the Board more truly the National Science Board as distinguished from what one might call the Board of the National Science Foundation. I believe that this broadening is a very appropriate thing.

Turning to the first group of provisions, the ones that relate to the substance of our programs, one provision that I consider of outstanding importance has been mentioned by Dr. Hornig, and that is the support of applied research, particularly in academic and other nonprofit institutions.

As Dr. Hornig has pointed out, the limitation placed on the Foundation by its present act is, I believe, definitely a handicap, especially with respect to academic institutions, for a number of reasons. I think there are three of major importance. One is that the fact that in general the Foundation can support only basic research, though there are a couple of exceptions to this limitation. Because it can support only basic research, a member of the faculty of an academic institution cannot, of course, apply to the Foundation for support for applied research. Not only does this prevent support of such research by the Foundation, but it also may tend—and I believe definitely in some instances has—to make people choose research projects somewhat different than they would choose were they free to seek support for applied research, and therefore tends to skew the programs or research projects that these people endeavor to plan and carry out.

I think that whatever direction an artificial skewing of this sort might take would be bad, but I think it is especially bad when it prevents them—or at least discourages them—from working in fields that might have beneficial effects to society.

A second reason is one that Dr. Hornig did not specifically mention, and that is that it seems inappropriate for us to fail to continue supporting a man who, in the course of doing some definite basic research, suddenly sees a golden opportunity to pursue it in applied directions, because our funds are not available for that purpose.

I think the anomaly of this sort of thing is pretty well pointed up by the fact that under the present act, we can, for example, give a fellowship to a man who, while supported by the fellowship, may

definitely take part in applied research, but we would not be able to support the same research, under a research grant that he is working on. This seems an anomalous situation that I believe should be corrected. All of this applies particularly to engineering. The engineering departments of the country, which right after the war swung pretty far in the direction of working on basic engineering science, now believe they perhaps overshot the mark, and are swinging back more toward engineering practice. And it will be more difficult for us to support them under the present provisions of the act.

The second feature common to both bills that I would like to make a special point of is the identification of the social sciences as a group of sciences that we are explicitly and specifically expected to support.

As you know, we have been supporting them at a growing rate, in fact probably the most graphically growing rate of any of the sciences over the last 10 years. But we have done it under the anonymity of the phrase "other sciences" in the act. And as Dr. Horning has said, and many people have said, the social sciences must be supported more vigorously—they must play a greater role not only intellectually, but in a practical sense, in the affairs of society. I believe that it would be very helpful for this to be recognized by the Congress by making the suggested change listing them in the act along with the physical, biological, engineering, and other sciences.

Senator KENNEDY of Massachusetts. In your prepared testimony, though you say that 8 percent of the total of $196 million in research support provided by the Foundation was awarded in the social sciences. I would think that is a rather small percentage—even with the increases of the last few years.

Dr. HAWORTH. Yes, it is not as large as we would like to see it. Although it is true that, as also pointed out on that same page, Mr. Chairman—that we have been able to support a slightly larger fraction of the social science proposals that we have received than is true for the sciences as a whole.

Now, to some extent I think this is due to the fact that until fairly recently, social scientists have not felt—in a kind of psychological sense—that they were quite a part of the scientific family in the same sense as the natural scientists, because there has not been this recognition—which goes back, of course, to the discussions in the late forties that led up to the National Science Foundation Act, when there was some reservation in the public mind and in the Congress on the question of the Federal Government supporting the social sciences.

Senator KENNEDY of Massachusetts. Of the funds actually being expended in research on the social sciences, what are some examples of things being done?

Dr. HAWORTH. Well, we now cover all the fields of social science, but with a tendency to emphasize the sorts of things that can be studied in quantitative, objective way—in the same sense that one can do in the natural sciences. We support economics, sociology, social psychology, and anthropology, among others.

Senator KENNEDY of Massachusetts. Could you give us some idea, in the social sciences, of the kinds of things you would see down the road, with your changed priorities?

Dr. HAWORTH. Most of the projects now are projects in support of individual scientists in universities. There are anthropological investi-

gations, for example studies of customs of various civilizations in all sorts of situations. There are also studies of economic theories.

We tend to support those projects that result in broad general conclusions rather than in the solution of specific problems at specific places or specific times. We do not tend to support work that, say, would help to solve the problem of some particular community if that project were not applicable to other communities.

But the trend that I think is very important is that there is more and more recognition of the fact that the social scientists in many areas—economics is certainly one—need to move toward larger, broader, more comprehensive programs in which they make use of extensive facilities such as data banks and computers and things of that sort, to attack problems on a broad front and in an interdisciplinary way, rather than one small project at a time. And it is this type of thing that is, of course, especially useful, or will be especially useful in attacking the types of things that will hopefully help solve some of the problems with which the country is faced.

There are also types of projects in which the scientific method, if I can use that phrase, are applicable. And they are also, of course, the types of projects that cost more because of the facilities, such as data banks and computers, which will be needed.

I don't know whether that is responsive to your question or not.

Senator KENNEDY of Massachusetts. Perhaps we could get some elaboration of that point later on.

Dr. HAWORTH. In a specific project sense?

Senator KENNEDY of Massachusetts. Yes, perhaps that could be submitted at a later time.

(The information requested and subsequently supplied for the record follows:)

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., November 29, 1967.

Re social science research projects.

Hon. EDWARD M. KENNEDY,
U.S. Senate,
Washington, D.C.

DEAR SENATOR KENNEDY: In the hearings held on November 15, 1967, before the Special Subcommittee on Science, Senate Committee on Labor and Public Welfare, to consider S. 2598 and H.R. 5404, you asked that I provide you with some indication of specific projects in Social Sciences support by the National Science Foundation. I will do this by listing immediately below brief narrative descriptions of a number of projects in various social science fields. In addition, I am providing you with a complete listing of all social science research projects for which grants or awards were made by the National Science Foundation in fiscal years 1966 and 1967.

NSF-assisted projects include efforts to improve social science theory and to discover or refine methodology, and many substantive investigations into human social behavior, including the study of institutions and organizations. Much recent social science research has been quantitative or statistical in nature, and the NSF supports a considerable number of projects of this kind. In addition, the Foundation also supports projects employing qualitative, experimental, historical, archeological, comparative, and other approaches.

To illustrate the variety and scope of present NSF-supported projects, some examples from different disciplines follow:

ANTHROPOLOGY

As a consequence of their early and sustained interest in the study of non-Western societies, anthropologists have accumulated a considerable body of knowledge relevant to economic, social and political problems that confront

people in developing areas and significantly affect not only the welfare of these people but international relations as well.

Joseph Casagrande of the University of Illinois is studying ways in which four predominately Indian communities with varying economics adapt to the larger society in Ecuador; Ralph Beals, UCLA, is studying the impact of modern economic developments on traditional market systems in Oaxaca, Mexico, and there is a study by Harold Scheffler, Yale University, of revitalization movements in the Solomon Islands as responses to influences emanating from the West.

In their general concern with processes of cultural development, anthropologists rely on archaeology for the study of prehistoric societies. To illustrate, research under the direction of Rene Millon, University of Rochester, combines aerial mapping and excavation of the ancient pre-Hispanic city of Teotihuacan near Mexico City. Already this project is clearly showing how Teotihuacan grew from a small town to a great city which was confronted with such difficulties as overcrowding and apparently even underwent a kind of "urban renewal" as one response to the problem of heavy concentration of population within a relatively limited space.

ECONOMICS

Of all the social sciences none has been more successful in developing a body of useful formal theory than economics. The National Science Foundation assists a number of different types of research in economics.

In international trade research, both theory and quantitative studies are supported. Robert E. Baldwin of the University of Wisconsin is studying the structure of international trade; that is, the factors that determine which products are exchanged internationally. Irving Kravis of the University of Pennsylvania, and Robert Lipsey of the National Bureau of Economic Research in New York have been examining the degree to which trade patterns are influenced by price and by non-price factors. The findings are relevant to understanding the competitive position of the United States and therefore to the understanding of balance of payments problems.

Studies of money and credit functioning are numerous, including collaborative work of Karl Brunner of Ohio State University and Allan Multzer of Carnegie-Mellon University and research by a grant at the Cowles Foundation at Yale University, directed by James Tobin. Herbert Mohring of the University of Minnesota is studying the economics of urban transportation.

Among the historical studies in economics supported by the NSF are those of the economic development of Russia by Arcadius Kahan of the University of Chicago and of the United States by Robert Gallman of the University of North Carolina, who collaborates with William Parker of Yale University on historical changes in agriculture and industry.

POLITICAL SCIENCE

The Inter-University Consortium for Political Research is a group involving over 100 universities and colleges, administratively housed at the University of Michigan. NSF support has enabled the consortium to collect such information as voting statistics in a form suitable for research analysis by both historians and political scientists, to conduct special training and research conferences, and to disseminate research materials and analysis to scholars in both member and non-member institutions.

Some individual studies include a comparative study of political socialization (that is, the process by which people learn the norms and practices of citizenship) and of party worker recruitment in the U.S. and Canada by Allan Kornberg and Joel Smith of Duke University. They are studying political party workers in four cities trying to link the process by which as individual acquires political values and interests to entry into active political work and pursuit of a party career.

ECONOMIC AND SOCIAL GEOGRAPHY

Geographers study the interaction of man with his environment. Among the projects under way in geography are a number concerned with contemporary U.S. problems such as work by Harold McCarty of the University of Iowa on the location of American industries. He is attempting to construct indices which will permit relating various kinds of production activities to the local economic environment as a tool for regional analysis.

SOCIOLOGY AND SOCIAL PSYCHOLOGY

Research on a variety of topics and by a variety of methods is being supported.

In demography, James Beshers of the Massachusetts Institute of Technology is attempting to develop a mathematical model which will help to explain and predict streams of population migration.

Daniel O. Price of the University of Texas is being supported in a study of the changing educational level of Negro migrants from the South and its effects on the educational levels of the remaining Negro population in this region.

Robert W. Hodge, of the University of Chicago, is analyzing U.S. census data in an effort to discern trends in the occupational integration of ethnic and racial minorities in the United States.

A great deal of research in conflict and cooperation, from conflict between two people to that between nations, is being supported. Charles Tilly of Harvard University has examined historical records of urbanization and social change in France in the period from 1830 to 1960, and of political disturbances during the same period. The data are coded and transformed into quantitative terms so that several hypotheses about the relations between social change and political upheaval can be tested. In very different fashion, conflict processes between persons are being studied in experimental games which simulate international conflicts in the work of Anatol Rapoport and Marc Pilisuk of the University of Michigan, as well as by others. In another instance, Joseph and Dina Zinnes, one a psychologist and the other a political scientist, of Indiana University are analyzing the content of hostile messages between nations which preceded the outbreak of World War I to test a psychological theory and develop a mathematical model of decision making.

Values and attitudes and how they form, how attempts to alter them are resisted, and how they relate to behavior is a central concern of much of the research being supported by the NSF sociology program. Stuart Cook of the University of California is engaged in a series of laboratory studies aimed at the problem of techniques of measuring attitudes and comparisons of various techniques designed to change them. Muzafer Sherif of Pennsylvania State University, is conducting a field study of the values and attitudes of adolescents and the relative influences of peers, the family, schools and other social institutions upon their formation and maintenance. William McGuire of Columbia University is involved in a program of experiments on techniques of resisting persuasion.

These illustrate some of the types of research in the social sciences that the Foundation has supported and is supporting. I will, of course, be pleased to provide you with additional information on these or any other activities supported by Foundation programs.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

Dr. HAWORTH. I might say at this point, Mr. Chairman, that I believe the interrelationship of the two things that I have mentioned so far; namely, applied research and social science, is an important one. I believe that the extension of the Foundation's authority to applied research will have an importance in social science—though not relatively as great importance as in engineering—and that these two things are closely related.

Moving along, then, the authority to support activities in the international field which you discussed with Dr. Hornig is also, I believe, important. Here I would like to try to clarify what I mean.

At the present time the Foundation, of course, can, within limits, support, with its own funds, activities that have an international aspect to them. We must, however, satisfy the criterion that this support be helpful to American science, and a given proposal must compete on equal terms with support of science in this country, without any weight being given to questions of foreign policy or the general national interest, or things of that sort.

So that in such programs as the United States-Japan program, the United States-Italian program, that Dr. Hornig mentioned, we support

Americans who are doing the American part of a project, and the other country supports their own scientists, and we do this in terms of the research results that we believe will be forthcoming. We try to take advantage, of course, of situations that can also help our international relations. But we cannot give very much weight in the decisionmaking process to the latter. And it is in this sense that the proposed change would be helpful, because it would enable us, using our own funds, to bring in the general criterion of what is best for the welfare of the country, not merely what is best to advance science in this country.

So this again is the removal of a restriction—just as in the case of applied science—that will enable us to be more things, taking into account the broader criterion of total helpfulness to the country.

For example, the sort of thing that Dr. Hornig mentioned, the assistance that we are giving to AID in India, in their science education program is fine in that case. The funds come from AID's appropriation and we administer the program for them. But even this mechanism will not be available in instances where AID has no program in a given country or a given group of countries.

So I am strongly for this provision.

Turning to another programatic aspect, both of the bills would remove from the present act the directive to the Foundation to conduct a broad program in weather modification. I fully concur in this change. I believe that such a broad program in the developmental and operational aspects could be more appropriately done by other agencies. There is a bill, S. 2916, passed by the 89th Congress——

Senator KENNEDY of Massachusetts. Excuse me, Dr. Haworth, but we will have to recess for just a minute.

(Whereupon, a short recess was taken.)

Senator KENNEDY of Massachusetts. The subcommittee will come to order.

Dr. HAWORTH. I had just started to talk about the deletion of the weather modification provision which I heartily support. There is a bill, S. 2916, passed by the Senate, which would assign responsibilities to a number of other agencies, and would leave the Foundation with only limited responsibility in this field.

This bill provides that the words "atmospheric sciences" be added to the list in our act.

I would like to suggest to this committee that in addition to adding the social sciences, you add the environmental sciences. That includes oceanography, earth sciences, atmospheric sciences and so on. This would make it more explicit, even though these sciences are covered by the "biological" and the "physical science" provisions.

In this connection I would like to point out one thing that I have not said in the text that I have provided you, and that is that the deletion of the weather modification provision would leave, for the moment, one function with no agency responsible for it; namely, the reporting requirements that we now place under the terms of our act on the practitioners of weather modification. Although we would continue during any hiatus to try to fulfill this function, there would be no enforceable authority for our activities in this respect. You might consider leaving the present section 14 of the National Science Foundation Act in force, with the understanding, provided for in whatever way you desire, that this provision would no longer be operative after the function is assigned to some other agency. Of course, if S. 2916

became law before the present bill does, there would be no need for this.

Let me turn to the second group of provisions, those that relate to the procedural and policy formulation aspects and so forth. Let me first say that I consider the provision in both bills that the National Science Board prepare an annual report for submission to the President and the Congress on the status of science in the country to be a very important provision, because it will enable the Science Board to bring its wisdom and experience to bear in a formal way on the problems relating to science in the country, especially, of course, as it relates to Government support of science.

I join with Dr. Hornig in preferring the Senate version of the bill with respect to a separate staff for the Board. I believe we succeed in assisting the Board with staff in appropriate ways.

I would be afraid if there were a permanent separate staff that it might lead to a sort of a separateness and divisiveness that might be unhealthy, and I would certainly prefer to see it as it is now—that the staff of the Foundation serves both the Director and the Board.

Then I come to the provisions of which there are several that I will not try to enumerate, that relate to the respective authority of the National Science Board on the one hand and the Director on the other, and here I would like to read one paragraph from my testimony:

> I am especially pleased that the interrelation of several Sections proposed in S. 2598 succeeds in clarifying the relation of authorities and functions of the National Science Board and the Director. Thus the Board would be the policy-making body of the Foundation, while the Director would be authorized to conduct the affairs of the Foundation under policies established by the Congress, the President, and the Board. As a common provision of S. 2598 and H.R. 5404, the formulation of programs in confirmance with these policies would be made by the Director in consultation with the Board. On the other hand, in contrast to H.R. 5404, S. 2598 specifies that the Director would have the authority to make or revoke grants and contracts, without arbitrary limitation, unless he believes that a policy matter is involved that requires consideration by the Board. In both bills all actions taken by the Director would be final and binding upon the Foundation. I think that this full clarification is one of the most important features of S. 2598, for it places in proper perspective the two roles. The result would be to strengthen both: the National Science Board as the policy-making body, the Director as the duly appointed executive head of a Federal agency.

A corollary to this in a sense is the provision that S. 2598 has made in section 3(d), that the Director as well as the National Science Board shall recommend and encourage the pursuit of national policies in matters of research and education in the sciences. The Director, of course, does this in his capacity as a member of the executive family, but the introduction of this section as in H.R. 5404, without mentioning the Director, might be an implication that he was not supposed to do this. And so I believe that both the Board and the Director should be included as is done in S. 2598.

I concur with Dr. Hornig—and you find this on page 13 of my testimony—in the simplification that S. 2598 gives as compared to the House bill to the reporting requirements on support given to the various institutions, educational, nonprofit, and industrial, for reasons that I have stated there. I believe that to report individually on individual industries would be an almost impossible task, for two reasons—one, because of the tiering of subcontracts, and, two, because many procurement activities in various agencies provide in

the overhead allowance funds for the conduct of general research in the company in question, and it is almost impossible to trace the ultimate disposition of those funds. So although we will do what we can in any case, we believe that a requirement that we do this for industry would be, as I say, almost impossible. So I prefer S. 2598 in that respect.

And finally, with respect to the organization of the Foundation staff itself, I would like to endorse strongly the provisions of both bills—that the Deputy Director become a presidential appointee.

I also endorse the change that S. 2598 introduces compared to H.R. 5404 with respect to the proposed four new assistant directors, in that although I believe the provision for such assistant directors—not necessarily four, but some—is a good provision. I do not believe it appropriate that they be Presidential appointees. So I prefer the Senate version, your own version, of that requirement.

That completes the subjects that I wished to cover, Mr. Chairman. I would like to again say that I believe that this subcommittee and you personally have performed a very valuable service in preparing S. 2598, and particularly in bringing this whole bill, in whatever form, forward for what I hope will be speedy enactment.

Thank you very much, Mr. Chairman.

Senator KENNEDY of Massachusetts. Well, thank you very much, Dr. Haworth, for your comprehensive testimony and statement. It is extremely helpful to us. There is a great deal of food for thought in it. It will be of great help to the members of the subcommittee.

(The prepared statement of Dr. Haworth follows:)

PREPARED STATEMENT OF LELAND J. HAWORTH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Mr. Chairman and members of the committee, it is a special pleasure for me to be here today and to have this opportunity, as Director of the National Science Foundation, to review with you and your Subcommittee the provisions of S. 2598, the proposed National Science Foundation Act Amendments of 1967, as well as those of H.R. 5404, which have already received favorable action in the House of Representatives. I am glad to have this opportunity to discuss several of the proposed changes to the National Science Foundation Act that are common to these two bills, as well as several on which they differ.

First, Mr. Chairman, speaking for the Foundation and its staff, I would like to thank you for your remarks made at the time you introduced S. 2598 two weeks ago. Your comprehensive statement of the role and activities of the Foundation and the relationship of its work to the technological future of the United States is deeply appreciated. We are also grateful for the insight and for the patient and painstaking efforts of Mr. Daddario and his Subcommittee in conducting their extensive review of the Foundation, its problems, and its needs over a period of several years, an undertaking that has resulted in H.R. 5404, also under consideration here today.

As you so aptly stated, Mr. Chairman, in your remarks two weeks ago, the functions assigned to the Foundation by its present Act can be described by the single phrase "a national program for enhancing the health of basic American science and science education." This role is exercised across the whole spectrum of science, with care that no promising areas be neglected. While many Federal agencies provide support for scientific research, the areas they cover must of necessity be determined by their missions. In contrast, the Foundation aims to insure the continuation and strengthening of all American science and thus supports all basic areas. Similarly, the Foundation feels responsible for the support of graduate education in all fields of science and engineering and for the improvement of science education at all levels. The fundamental importance of the mission of the Foundation becomes especially clear in its relation to graduate education in the sciences and engineering. In the last two decades such education has come to depend heavily on financial support provided by the various Federal agencies through the mechanism

of research grants and contracts awarded to colleges and universities for specific research projects. Again, the choice of research to be supported by most agencies is dictated by their own needs as defined in their statutory missions without particular regard to the needs of the graduate education process as such. Yet there is no logical relationship between the needs of graduate education, on the one hand, and the research funded by these agencies to help solve current problems of society and of the Nation. Thus, the number of graduate students in science and engineering is growing rapidly and their education is directly and inseparably related to the adequacy of support for academic research. With many Federal agencies, notably the Department of Defense, not increasing their support for academic science, and perhaps actually decreasing it, the responsibility for maintaining and promoting the health of academic research, with its impact upon the development of future scientists and engineers, falls heavily upon the National Science Foundation. These considerations become even more acute during times of budgetary stringency, when other agencies must seek the most rapid pay-off possible and reduce their efforts in support of long-range needs. These are among the reasons that the Foundation must play a central role, and one of increasing importance, in maintaining and improving the quality and health of academic science. It is in this context, therefore, that I welcome the amendments proposed to the National Science Foundation Act of 1950 which would place the Foundation in a stronger position to help meet these essential needs.

After more than two decades of dramatic growth of scientific activity in the United States, of increasing recognition of the role of science in achieving national goals, and of rising expectations both in this Nation and abroad requiring the contributions of science and its applications, it is clearly in the public interest to make appropriate changes in the National Science Foundation Act. Such changes will enable the Foundation to conduct its operations more effectively in the future and in better relation both to other activities of the Federal Government and to changing needs of science and technology generally. Both of these bills achieve this purpose. Because, however, of the changes from H.R. 5404 that have been made, I prefer and wholeheartedly urge the enactment of S. 2598.

Before discussing the differences between these two bills, I would like to emphasize the importance of several common features that would modify the present legislation. They fall into two groups, one relating to the substance of the Foundation's scientific and educational programs, the other to organizational and procedural matters, including the role of the Board in the sphere of national policy for science.

Considering first the program-related provisions, one that I consider to be of outstanding importance to the future effectiveness of the Foundation, is the authority in the proposed Sec. 3(c) [1] for the support of applied research at academic and other nonprofit institutions. The limitation placed on the Foundation in the present Act to support of basic research has an unrealistic aspect, since it is often by no means clear just where the dividing line should be placed between basic and applied research. There are, however, more fundamental reasons why this limitation may not be in the public interest. In the first place, insofar as the support of research projects in academic institutions forms the basis for graduate education, a restriction to basic research can be very harmful. This limitation can have a distorting effect on academic science in limiting the choice of research which the principal investigator, faculty or graduate student, might normally choose to follow. Moreover, at the present time, the Foundation may support the work of an investigator in a basic science, but may not continue to support him if he wishes to pursue this work into applied areas to take advantage of opportunities uncovered in the basic research. The anomaly of this situation may be seen in the fact that under its present authority the Foundation may award a graduate fellowship to a student engaged in applied research, but it may not support a research project covering the same ground under which a graduate student may be supported as a research assistant. At the present time there is a trend in engineering schools away from an emphasis on engineering *science* and towards broader and more balanced programs having a greater relationship to the solution of problems of society and the adaptation of knowledge to engineering *practice*. This is also true of programs that require the joint contributions of several fields, notably engineering and the social sciences. Thus, if the Foundation is to continue to assist graduate schools while at the same time avoiding undue and unwanted influence on the development of academic programs and curricula, then it is essential that the authority of the

[1] Section numbers in this statement refer to proposed sections in the amended National Science Foundation Act. Where not specified these proposed section numbers are common to S. 2598 and H.R. 5404.

Foundation be broadened to include applied research, especially at academic and related institutions.

A second feature common to both bills, that is particularly gratifying, is the specific identification of the social sciences as one of the major groups of sciences for which the Foundation has responsibility rather than including this responsibility under the phrase "other sciences" in Sec. 3(a)(1) and (3a)(2). Partly as the result of far-reaching changes in the mechanisms of defense during and following World War II, partly in response to expanding opportunities for improving public health, much of the support of scientific activities by Federal agencies has been directed to the natural sciences: mathematical, physical, and biological. As early as 1954, however, the Foundation undertook the support of research in the social sciences, initially on a necessarily limited and selective basis, under the authority contained in the Act, as interpreted in terms of the legislative history. The amount and scope of this support have gradually but steadily increased. In fiscal year 1967, for example, nearly 8 percent of the total of $196 million in research support provided by the Foundation (omitting the National Research Centers) was awarded in the social sciences. Basic research projects awarded support in the social sciences represented a larger fraction of proposals received—58 percent of the number and 35 percent of the dollar amount—than that for the basic research project support of the Foundation as a whole. We hope to stimulate more high-quality proposals in the social sciences in the future. Not only are there rapidly growing opportunities for research of high quality in all fields of the social sciences and an increasing number of competent scientists engaged in this research, but of even greater importance are the needs of society for far more understanding of man and of the nature and behavior of social institutions, that are available to us today. More and more, solutions to the problems of society are becoming dependent on science as a whole, and, more and more, the social and the natural sciences are becoming interdependent. The Foundation's involvement in all the sciences enables it to exploit opportunities for the types of interdisciplinary programs that are of ever growing importance. Thus, it seems to me to be both timely and desirable that this support of research in the social sciences be relieved of the anonymity conferred by the phrase "other sciences", and the intention of the Congress be specifically shown by giving to the Foundation a clear directive to continue with the development of a strong, balanced, and growing program.

An additional common provision of these two bills that I would like to mention is the proposed authority for the Foundation to support scientific activities in the international field at the request of the Secretary of State. The Foundation, under its present authority and, on occasion, by specific appropriation or executive direction, has for a number of years given support to international or foreign activities in scientific research and education where such support would advance science in the United States. Examples of these activities include the leading role of the Foundation in the participation of the United States in the International Geophysical Year, the Antarctic Research Program, the subsequent International Years of the Quiet Sun, the International Indian Ocean Expedition, and the United States-Japan Cooperative Science Program. There seems to be little question, however, that the National Science Foundation could assist American science in making greater contributions to total national interests, if the proposed Section 3(b) were enacted, thereby allowing the criteria of support to encompass all national interests and not only those of American science.

I would suggest one further clarification of Foundation authority, resulting from the proposed deletion in both bills of the authority contained in Sec. 3(a)(9) and 14 of the present Act to conduct a broad program in weather modification. I fully concur in this proposal, for the important developmental and operational aspects of this complex field imply major participation by other Federal agencies. This need has been recognized in two bills—S. 2916, passed by the Senate in the 89th Congress, and a similar bill currently under consideration in the House of Representatives. Both of these bills reserve to the Foundation the authority to support research that is basic to weather and climate modification, and both would insert the term "atmospheric" in Section 3(a)(2) of the present Act. While I believe that these proposed changes are constructive, I would suggest for your consideration a more general treatment of the matter. Specifically I refer to the complex, multidisciplinary fields of the environmental sciences: oceanography and the earth sciences, as well as the atmospheric sciences. The Foundation supports research in all of these fields. The authority for such support is found in the basic disciplines enumerated in the Act, as it would be enhanced by the authority to support applied research pursuant to the proposed Section 3(c).

Because of the growing importance and potential of these broad areas, however, I would suggest inclusion of the term "environmental" in the listing set forth in the proposed Sections 3(a)(1) and 3(a)(2) by the two bills under consideration here today.

Turning now to the second group of provisions, one that is common to these two bills, and one of special significance in the area of policy formulation, is the proposed Section 4(g) which would direct the National Science Board to prepare and transmit to the President, for submission to the Congress, a report each year on the status and health of science in America and elsewhere, national scientific resources, progress in selected areas of research, and opportunities for application to social needs. This report would constitute a major vehicle for recommendations in the broad area of science policy, thus affording the National Science Board a communicational device commensurate with the broad experience and insight of its distinguished members. Through this means the Board would assume an identity within the broad advisory structure of Government as one of the leading groups available both to the President and to the Congress for assistance during the complex decades ahead.

To assist the National Science Board, both in the preparation of this annual report and in other policy studies in which it may be engaged, the availability of professional staff is certainly necessary. However, I believe that the creation of a separate staff, as proposed in Sec. 4(h) of H.R. 5404, is undesirable. The Foundation is defined in Sec. 2 of the Act as consisting of a National Science Board and a Director. The staff of the Foundation has been properly interpreted, therefore, as being available to serve the needs of both and indeed does so. Specific assignments of staff to assist the Board are regularly made, and I believe it is preferable to retain this arrangement, thereby avoiding the problems, the possible divisiveness, and the possible duplication that would be inherent in separate staffs. I specifically support the omission of this Section, as is done in S. 2598.

I am especially pleased that the interrelation of several Sections proposed in S. 2598 succeeds in clarifying the relation of authorities and functions of the National Science Board and the Director. Thus the Board would be the policymaking body of the Foundation, while the Director would be authorized to conduct the affairs of the Foundation under policies established by the Congress, the President, and the Board. As a common provision of S. 2598 and H.R. 5404, the formulation of programs in conformance with these policies would be made by the Director in consultation with the Board. On the other hand, in contrast to H.R. 5404, S. 2598 specifies that the Director would have the authority to make or revoke grants and contracts, without arbitrary limitation, unless he believes that a policy matter is involved that requires consideration by the Board. In both bills all actions taken by the Director would be final and binding upon the Foundation. I think that this full clarification is one of the most important features of S. 2598, for it places in proper perspective the two roles. The result would be to strengthen both: the National Science Board as the policy-making body, the Director as the duly appointed executive head of a Federal agency.

In this same connection I am very glad to note that Section 3(d) proposed by S. 2598 provides that the Director, as well as the National Science Board, shall recommend and encourage the pursuit of national policies in matters of research and education in the sciences. This new Section is in contrast with the parallel Section of H.R. 5404 which may be interpreted as implying that the Director shall not make such recommendations. The language of S. 2598 is important for it describes the way in which this relationship actually operates in practice and must operate. The Board, as an essential part of its activities, is concerned with the study and recommendation of broad national policies, and the Director, as a voting member of the Board, participates in making these determinations. In a totally different sphere, however, in his day-to-day involvement in the affairs of the Executive Branch, the Director must and does make recommendations on matters of science policy. Neither in practice nor in principle does this dual role of executive head of a Federal agency, and *ex officio* member of the Board, result in a conflict, although it does imply frequent and constructive communication between the Director and the Board for the strengthening of policy positions that must be reached.

A further point on which I believe that S. 2598 marks a distinct improvement over H.R. 5404 is contained in the proposed Sec. 3(a)(6), under which the Foundation would for the first time be required to report annually to the President and to Congress on the total financial support for research, including facilities, received by each educational institution, nonprofit organization, and in H.R. 5404, private contractor in the United States from grants, contracts, and other arrangements

of Federal agencies. I believe that it would be wholly impractical, if not impossible, for the Foundation, or any other Federal agency, to meet this requirement as it relates to industry. There are two reasons. Through a cascading series of subcontractor arrangements throughout the United States, tens of thousands of private contractors receive support, in one form or another, for research activities conducted especially in support of major technical systems. Secondly, through procurement regulations that vary from agency to agency, private contractors receive, through various types of overhead allowances, significant Federal support of research and development related to general company activities. In the case of many competitive, fixed-price contracts, the amount of such research that is included in the contract price may never be known. Through its periodic industry surveys the Foundation has attempted to provide an indication of the amount of research supported by the Federal Government and by the companies themselves. These surveys, however, do not meet the requirements of the proposed directive. While the Foundation will endeavor to broaden and improve this coverage to the extent practicable, I am very glad to see that S. 2598 limits the reporting requirement to educational institutions and appropriate nonprofit organizations, a manageable undertaking.

The final point on which I would like to comment concerns the appointment of the Deputy Director and four Assistant Directors of the Foundation. I enthusiastically support the provision of both bills that the Deputy Director be appointed by the President and confirmed by the Senate. The nature of the assignments of the Assistant Directors, however, has not yet been fully resolved, although they would probably have staff, rather than operating, assignments. As such they would be of immeasurable help to the Director in the discharge of his responsibilities. I fully agree with the omission in the proposed Section 6(b) in S. 2598 of a requirement for Presidential appointment and Senate confirmation of the incumbents of these new positions in the Section 6(b) proposed by H.R. 5404.

In conclusion, I would like to say that I believe the Subcommittee has performed a valuable service in preparing and considering S. 2598, and thereby building on the excellent foundation represented by the careful efforts that have led to H.R. 5404. Thank you, Mr. Chairman, for this opportunity to appear here today in its support.

Senator KENNEDY of Massachusetts. I would like at this time to call on Dr. Philip Handler, Chairman of the National Science Board. I want to welcome you here. I notice that you have here with you some of the distinguished medbers of the Board. Would you like to introduce them?

Dr. HANDLER. Thank you very much, Senator Kennedy.

The importance which the Board places on the activities of the morning is attested to by the presence of this large group of representatives of the National Science Board. If they will rise as I call their names, I should like to introduce them.

Dr. Mina Rees, of New York. Dr. Thomas Jones, of South Carolina. Dr. William Hagerty, of Pennsylvania. Dr. Fred Thieme, of Washington. Joseph Reynolds, of Louisiana. Julian Goldsmith, of Illinois. Robert Morrison, New York. Roger Heyns, California. Ralph Tyler, who is the Vice Chairman of the Board, and was from California, but now resides in Illinois. Dr. Richard Sullivan, who was from Oregon at the time he was appointed but now resides here in Washington. Mr. Harvey Picker, of New York. Dr. Harvey Brooks, of Massachusetts.

Senator KENNEDY of Massachusetts. I understand that you will be meeting here in Washington for the next 3 days.

Dr. HANDLER. That is correct, sir.

Senator KENNEDY of Massachusetts. Well, we want to extend a special word of welcome to you gentlemen and ladies, and to say that we welcome any comments that you as individuals might have on the legislation. It would be very warmly received by the members of this committee.

We have witnesses who can present in a most able and articulate way the positions of the Board and the Foundation. But any individual comments or ideas which you think would be of help, we would be more than delighted to receive, and to make them a part of the record.

As Dr. Handler mentioned, your presence here indicates your very great interest and concern, and we want to welcome all of you.

Dr. Handler, would you like to begin?

STATEMENT OF DR. PHILIP HANDLER, CHAIRMAN, NATIONAL SCIENCE BOARD

Dr. HANDLER. It is a great privilege to be with you here this morning. My prime purpose in being here is to endorse the major provisions of S. 2598.

I do so largely out of conviction that vigorous prosecution of scientific research will continue to yield new and important insights into the nature of the universe, of life, of man, and of the societies which he has created. That application of the insight and understanding so obtained will stimulate and strengthen our economy, improve our agriculture and our health, as well as secure our national defense; that the conduct of scientific research in and of itself enriches our culture and our national life; that the best of science education should be an integral aspect of the education of all citizens, and that the National Science Foundation is the most appropriate single agent of the American people for the attainment and furtherance of these aims.

Since, however, it is abundantly evident in your own statements, Senator Kennedy, made before the Senate on September 20 and October 30 of this year, that you share these sentiments, I shall not pursue them further.

Accordingly, I should like to proceed directly to the provisions of the bill which is before us.

In general, this bill, like H.R. 5404, embodies two classes of changes in the original charter of the Foundation—those which define the scope and the sphere of the Foundation programs, and those which describe the structure, organization, and functioning of the agency itself. And I shall address myself to several, but not all of these changes.

First, the matter of the inclusion of the term "social sciences" as an explicit charge for the Foundation.

As was indicated in a commentary submitted on April 21, 1966, to the House subcommittee, chaired by Mr. Daddario, the National Science Board strongly approves specific identification of the social sciences among the broad fields of science which the Foundation is authorized to support. We recognize that expanded efforts in this area may be undertaken with clear awareness of the many difficulties inherent in such studies. But man has been much more successful at understanding his own biology and the universe in which he finds himself, than he has been in understanding himself as a social being. Since that understanding may well be imperative to man's very survival, as well as to his success in utilizing the truths of science and technology so as to improve the human condition, the Board welcomes this affirmation by the Congress.

The importance which the Board attaches to this matter is reflected in the fact that we have been in the process of appointing a Commission

on the Social Sciences. The authority to create such Commissions is already present in the act. This Commission has been asked to address itself to the following charge: It is asked to provide, first, a statement and analysis of the mechanisms and institutions, societal and governmental, that are needed to that the understanding and knowledge gained by the social sciences may be drawn upon and used effectively when they are relevant to understanding and dealing with significant problems in our society.

Second, an analysis of what forms of collaboration may be necessary among the social and natural sciences and engineering and among their practitioners in addressing these problems, and recommendations concerning how such collaboration might be brought about.

Third, a statement of what measures and programs to be administered by Federal agencies, including the National Science Foundation, are required so that the social sciences may be more effective, both in generating new knowledge and in its utilization, and so that our society can gain maximum benefit from the growing knowledge derived from fundamental research in the social sciences.

A copy of the full text of our letters of invitation to members of this Commission, including this charge, is available for the record, and if it seems desirable, I shall be pleased to place that letter in the record.

Senator KENNEDY of Massachusetts. It will be made a part of the record at this point, as I think it appropriate to our deliberations.

(The document referred to follows:)

NATIONAL SCIENCE FOUNDATION,
NATIONAL SCIENCE BOARD,
Washington, D.C., August 4, 1967.

DEAR _____: On Behalf of the National Science Board, it is my pleasure to invite you to serve as a Member of the Special Commission on the Social Sciences.

The National Science Foundation Act of 1950 includes the following provisions:

"SEC. 3(a)(7). The Foundation is authorized and directed to establish such special commissions as the Board may from time to time deem necessary for the purposes of this Act.

"SEC. 9(a). Each special commission established pursuant to section 3(a)(7) shall consist of eleven members appointed by the Board, six of whom shall be eminent scientists and five of whom shall be persons other than scientists. Each special commission shall choose its own chairman and vice chairman.

With increasing frequency, our Nation turns to the physical, biological and social sciences for help in dealing with public problems of all kinds. Scientific knowledge and understanding have become increasingly vital ingredients in our important decisions, private and public. Examples of this trend can be seen on every side. When we wish to improve the quality of our water supplies, we turn to chemistry and biology to understand the nature of stream pollution and the processes of purification. We turn to engineering for waste disposal and purification plans, to economics to analyze the costs and benefits of improvement, to political science to investigate the structure of local government organization that maintains water supplies and disposal systems. When we try to anticipate the consequences that may flow from the growing automation of production, we call on psychology and sociology to determine how people are affected by increasing amounts of leisure; on economics to analyze effects of automation on employment and living standards; on biology and psychology to assess whether the highly automated factory will increase or decrease the mental and physical stress on those who work in it.

Diverse institutions and channels in our society serve to bring scientific knowledge to bear on social problems and upon practical affairs generally. Many scientists trained in the basic natural science disciplines work directly with applied problems. In other cases, special professions, such as engineering and medicine,

facilitate the application and transmission of scientific knowledge. In general, these institutions are more highly developed in the physical and life sciences than in the social sciences. There are relatively few professionals in our society specifically trained to apply to practical affairs the knowledge that is gained by research in economics, political science, sociology, anthropology and psychology.

The National Science Foundation has supported education and research in fundamental aspects of the social sciences almost since its inception and has devoted an increasing fraction of its resources to these ends as the annual appropriation to the Foundation has grown. A Congressional Report concerning the Foundation and its programs, as well as a Bill to amend the charter of the Foundation which has been passed by the House and is currently under consideration by the Senate, have, for the first time, made explicit the charge to the Foundation to support research and education in the social sciences. This Bill would also authorize the Foundation, for the first time, to support investigations in applied science, including the social sciences.

Basic research in the social and behavioral sciences is now enjoying a period of vigorous growth. There is every reason to believe that these sciences will have broadening support from the National Science Foundation as well as other Federal agencies that provide funds for research in relevant areas. Parallel to this growth in basic research, we must increase our Nation's capacity to use the knowledge that is gained.

To understand better the requirements for effective utilization of the social sciences, by themselves and in conjunction with the other sciences, and to offer broad direction to the relevant programs of the Federal Government, including those of the Foundation, the National Science Board has authorized appointment of a Commission which is asked to address itself to the following:

(1) A statement and analysis of the mechanisms and institutions, societal and governmental, that are needed so that the understanding and knowledge gained by the social sciences may be drawn upon and used effectively when they are relevant to understanding and dealing with significant problems in our society.

(2) An analysis of what forms of collaboration may be necessary among the social and natural sciences, and engineering, and among their practitioners in addressing these problems; and recommendations concerning how such collaboration might be brought about.

(3) A statement of what measures and programs, to be administered by Federal agencies including the National Science Foundation, are required so that the social sciences may be more effective both in generating new knowledge and in its utilization, and so that our society can gain maximum benefit from the growing knowledge derived from fundamental research in the social sciences.

A parallel effort is under way under the aegis of the Committee on Science and Public Policy of the National Academy of Sciences. Since the forward look of that study is particularly focused on projected requirements for strengthening research in fundamental aspects of the social sciences, these two endeavors should prove to be mutually complementary. It is hoped that this Commission will submit a single report approximately one year hence. Unless it recommends otherwise, the Commission will automatically be terminated at that time. After the composition of the Commission has been established, an organizational meeting will be convened as soon as practicable.

The Board and Director of the National Science Foundation join me in hoping that you will find it possible to accept this invitation to serve on the Commission on the Social Sciences.

Sincerely yours,

PHILIP HANDLER, *Chairman.*

Dr. HANDLER. Let me turn now to the charge to the Foundation to extend its authorization to include support of applied research.

It is only appropriate and fair to indicate that when this matter first came before the Board it engendered considerable debate. It was argued that basic research is among the most significant of human activities, and since it seems perennially necessary to reconvince nonscientists that "nothing is more practical than basic research," there should be one agency in Government devoted exclusively to the support of basic science, which is among the most exciting adventures of our time, and the applications of which have remolded the world in which we live.

There was also concern that if the Foundation were to embark upon a visible program of applied research, with the passage of time the generally favorable disposition of nonscientists including, perhaps, many in Congress, toward applied research would be likely to result in a relative diminution in the basic science portion of the budget in favor of support of applied problems. Those are genuine problems and these apprehensions were shared by essentially all members of the Board at the time.

Nevertheless, the Board agreed that a legislative mandate to support applied research is desirable on several grounds, and I should like to list these.

First—limitation of the programs of the Foundation to basic research is a rather unclear mandate, since the line which divides basic and applied research is rather unclear. It certainly is arbitary, and it often reflects the attitude of the investigator or of his organization, or the agency which supplies supporting funds rather than any intrinsic attribute of the research itself.

In any case, the Foundation is already supporting some research which might readily be declared to be applied by some in-programs which previously were certified by the Board.

Secondly, by restricting its programs to basic research, the National Science Foundation may be causing some scientists, and particularly some engineers, to direct their research activities and hence their educational impact also away from their legitimate applied interests, Dr. Haworth also spoke to this point.

Third—there is a genuine need for support at academic institutions of applied work which will help to bridge the gap between fundamental findings and socially useful systems or concepts.

Fourth—the line separating basic from applied research is even more vague in the social sciences than it is in the natural sciences.

Fifth—the programs of applied research of the so-called mission-oriented agencies of the Government are so broad and relatively so well supported that applied research which shades over into development will always find more natural homes among these programs than at the National Science Foundation.

And finally, the Board, the Director, and his staff will certainly remain acutely aware of the fact that fundamental research is the paramount concern of the Foundation in its research programs.

However, it is precisely because the Board would prevent the long-range dangers which we noted, that the Board welcomes limiting this mandate to support of applied research at universities and other nonprofit organizations.

Presumably, the President would only direct the Foundation to support applied research relevant to the national interest at other appropriate organizations under rather unusual circumstances.

There is a section of the act which has been discussed both by the Director and by Dr. Hornig this morning. This is the section which deals with the relationship between the Foundation and the Secretaries of Defense and State.

My only point at this moment is to indicate that I would hope that it remains understood that the Foundation can continue to exercise its own initiative in the formulation of such programs, particularly in the field which Dr. Hornig described as being the underdeveloped role of the National Science Foundation with respect to international cooperation.

For example, I have just returned from Chile where I attended the dedication of the new observatory. This is the observatory where the new 150-inch telescope is to be located, which President Johnson announced at the Punta Del Este Conference. At this meeting in Chile, Dr. Wilson, who is the Deputy Director of the Foundation, and I were privileged to spend quite a few hours with President Frei. And there is one statement which President Frei made to us which I would like to direct to your attention. He said that certainly money as such, is of great importance, as aid to an underdeveloped nation, and without such funds, the road will be hard. But more important than money to an underdeveloped nation are trained people. Anything that the United States can do to help an underdeveloped nation in training its own people so that the nation can rise to its own potential would be the most important thing we could contribute. The National Science Foundation is particularly capable in this area, and I trust that under the terms of the act as it would be amended it will be clear that we could exercise this kind of initiative, upon consultation with the State Department and, in fact, would have a mandate to do so.

Senator KENNEDY of Massachusetts. What will happen when the people, after they are trained, and they emigrate to the United States?

Dr. HANDLER. Well, sir, in a sense that is not our national problem—it is theirs. I mean that quite seriously. It would be foolish for our Nation to close its doors to highly trained people who want to come and are useful to our society. A nation which is losing the best of its own education by exporting its trained people, is doing so because it has failed to generate opportuntiy at home. I know of no nation which is consistently losing trained scientists, engineers, and physicians to us simply because these people don't like life at home. Most of those whom I have encountered would have prefered to stay and work at home and use their training in the benefit of their own nation. But the opportunities to do so simply have not been created for them. To the extent to which, nevertheless, underdeveloped nations increase the numbers of people trained, those nations will be benefited. If some surplus spills over toward our country, we benefit. And, quite possibly, they must begin by training greater numbers than they can suitably employ.

May I turn, then, to some sections in the bill concerning the Director of the National Science Foundation and his staff?

It may well be inappropriate for the National Science Board or for its Chairman to speak to the specific position on the executive scale appropriate to the Director or the Deputy Director. However, we do believe that these officials bear exceedingly heavy responsibilities as the chief officers of a large agency whose programs must have enormous impact on the future of our country.

To assure success in recruiting of future Directors and Deputy Directors, to provide them with effective voices in the councils of government, and as symbols of the significance of the National Science Foundation in our national life, my colleagues of the Board and I suggest to the Congress and to the administration that both of these posts be assigned the highest possible ranks on the executive pay scale commensurate with their responsibilities and their importance to our Nation. We must leave to the Congress and to the President decision concerning exactly what that should be.

I have had no opportunity to consult with my colleagues of the Board, including those present, with respect to the deletion from section 5(a) of a fixed term of office for the Director. This proposed change in the act would make no real change in practice. It is patently clear that even today the Director may be removed from office by the President at his discretion. But this would become even more obvious if no term of office whatever is stipulated.

In the absence of such a stipulated term, I can only assume that the actual term of office would normally coincide with that of the President as do those with members of the Cabinet. In contrast, a 6-year term as at present, but subject to the continuing acquiescence of the President, is indicative of the essentially nonpolitical nature of this appointment. Thus, deletion from the act of a stipulated term would not change the realities but could arouse deep concern in the scientific and academic communities and occasion some loss of confidence in this respected and trusted agency.

We strongly urge restoration of the provision of a fixed 6-year term subject to the continuing acquiescence of the President.

The Board has considered the matter of the appointment of Assistant Directors and concurs entirely with the statements which have been made to you this morning by the Director and by Dr. Hornig.

Finally, in this regard, we particularly welcome the clear assignment to the Director of all responsibility for decisions concerning individual grants and contracts. Historically we have been moving toward this position in any case. At time zero in the life of the Foundation, the Board concerned itself with every transaction. As the activities of the Foundation burgeoned, the Board could consider fewer and fewer of these. And as a working mechanism, the Board chose to use the dollar figure of a given transaction as an indication of whether the Board should or should not be concerned with it.

In a general way, however, the larger the transaction, the greater the sum involved, the more carefully it has been examined by the Director and his staff anyway, and the advice which really counts has been given by skilled, appropriately competent, highly technical groups of individuals, rather than by the Board.

In contrast, matters of policy do not arise in a way proportional to the amount of money involved. And the Board should be concerned with matters of policy rather than with individual transactions.

At the same time, we think it is quite important that it be made explicitly clear that the Director is indeed the chief executive officer of the Foundation, and will bear all responsibility and authority for the award of grants, contracts, fellowships, and the like.

I am sure that all of the members of the Board acquiesce in this position.

Finally, let me turn to some matters concerning the Board itself.

We welcome the directive to prepare an annual report to be submitted to the President for transmission to the Congress. This is the most important means by which the Board will be enabled to express itself with respect to matters of National and Federal policy broadly rather than with matters which concern the Foundation alone. Indeed, we have already acted upon this proposal and are even now in the process of preparing the first such report on the subject of "A National Policy for Graduate Education in Science and Engineering." We are very pleased to have this opportunity.

In this regard, also, I might note that S. 2598 does not include the provision of a staff for the Board as was described in H.R. 5404. Dr. Haworth and I have previously indicated that we understood that this was sympathetically offered, so as to be helpful. A permanent Board staff, apart from the Foundation staff itself, and on permanent rather than on temporary assignment to be Board would in the long run be divisive, and mischief might come of it. And accordingly my colleagues and I are pleased to note the deletion of this provision. The Board will require staff on temporary assignment as, for example, to service the Board committees and preparation of the annual report. But this should be done by temporary rotating assignment.

We hope that in the future, as in the past, the entire staff of the Foundation will be available to the Board.

We are particularly pleased to note also the provision that both the Board and the Director shall recommend and encourage the pursuance of national policies for the promotion of basic research in education in the sciences. This is in accord with previous recommendations made by the Board, and we are delighted this has been taken into consideration in the framing of S. 2598.

I come finally to the role and the function of the Board with respect to policy. A question concerning this matter was raised by you, Senator Kennedy, in introducing this bill before the Senate.

As we have indicated in the past, in the general councils of government the Board is one among many voices, including that of the Director, in recommending broad National or Federal policies. As we have noted, in the future it is quite likely that the annual report of the Board will be the mechanism by which this can be accomplished.

It was clearly the intent of the House bill to strengthen the position of the Board with respect to specific matters of policy in the conduct of Foundation affairs, while transferring to the Director full authority for the implementation of policy by the award of grants and contracts.

In commenting upon the provisions of a much earlier version of the House bill, in April 1966, the Board stated that—

> In order to assure the efficacy of the National Science Board as a policy-making body, it is recommended that the statutory responsibility of the National Science Board for the programs as well as the policies of the Foundation, be continued and be made explicit in this Act.

And accordingly at that time it was recommended that the role of the Board be described in the following sentence:

> The Board shall establish and be responsible for the policies and programs of the Foundation.

However, it is important to note what that sentence was intended to mean. The Board interpreted it in four statements.

First, that the Board is to establish the purpose and the general nature of the various individual programs of awards conducted by the Foundation. Second, the Board is to exercise a continuing general surveillance of the awards made under such programs. Third, the Board can modify or terminate such programs when in its judgment they no longer appear to serve the national interest adequately. And finally, that the Director would bring to the Board those applications for grant or contract funds which raise matters of policy or their interpretation. We said that, "Under these circumstances it will be

apparent that the Director will exercise the authority of the Foundation and, with his staff, will render the many judgments required in the award of research grants, construction grants, training grants, fellowships and the like, and in the management of the national centers and programs. Ultimate responsibility for the nature and for the national purpose of these programs, and the manner in which their operation reflects their goals would continue to reside in the Board."

As I have indicated, the phrase "be responsible for" was interpreted in the limited sense which I indicated.

There can be no thought that a part-time Board can daily or weekly exercise such responsibility. But it can effectively operate as we have suggested.

The bill before you, however, indicates that the Board shall establish policies to guide the Foundation.

Now, I have had no opportunity to review this phrase with the Board, or with those of my colleagues in the room. Hence, I can only offer my own personal opinion. Whereas H.R. 5404 states that the Board shall establish and be responsible for the policies of the Foundation as the Board has recommended, the present bill provides that the Board shall establish policies to guide the Foundation. And in view of this history, I can only conclude that this latter provision would weaken rather than strengthen the position of the Board as policymaking body of the Foundation.

The net effect of the present bill which transfers, from the Board, authority to the Director for the award of grants and contracts, an action which we deem to be entirely sound, quite proper, and highly desirable, also seems to remove authoritative responsibility for formulation of policy. Thus, in my view, this might well transform the Board into a relatively ineffectual advisory body. And it scarcely seems appropriate to have the members of such an organization appointed by the President with the advice and consent of the Senate.

It is entirely possible, however, that the new language was actually intended to convey the fact that the policies of the Foundation must be in keeping with and conform to the larger policies set forth by the Congress and by the administration.

Throughout its history, the Board has been fully conscious of this reality. It has been well aware of the fact that the National Science Foundation is an agency of the Federal Government, and like all other agencies of government must and should conduct itself in accord with the provisions of relevant legislation, of relevant Executive orders, and of general administration policy.

If the intent of the present language is specifically to make this situation more explicit, then this section should be so worded as clearly to do so.

The present phrase, however, strongly implies that the Director and his staff are free to accept or reject policies formulated by the Board. If the act were thus amended, and that were its intent, the academic and scientific communities would surely protest that the Foundation had become an instrument which in the future might be much more subject to purely political manipulation rather than concerned entirely with the national scientific interest. The Board would seriously suffer in stature and in its usefulness—in contrast to your own statement, in placing this bill before the Senate, when you said that, "Second, it would strengthen the National Science Board, the governing body of the Foundation, and add several functions to it."

As I read this—I hope that I am incorrect—insertion of the unqualified phrase "to guide" in section 4(a) actually appears to strip the Board of its functions as that "governing body of the Foundation." If less than this is intended, and this phrase is retained, I would hope that the report accompanying this bill will one day render completely clear what meaning the phrase "to guide" is intended to convey.

The historical success of the Foundation affords no basis known to me for this marked diminution in the Board's responsibilities. Moreover, we should note that recommendations concerning national or Federal policy from a Board which had been divested of responsibility for the very agency with which it is most closely concerned, would ring hollow and have little impact. Accordingly, I am certain that the academic and scientific constituencies of the Foundation and my colleagues of the Board would ask that I recommend to you that this section be eighter retained in the form offered by H.R. 5404, or perhaps stated simply, as Dr. Hornig did earlier, as "The Board shall establish the policies of the Foundation," or, perhaps, either of these, so qualified as to make explicit that such policies established by the Board must be in conformance with the policies established by the Congress and/or the President.

Finally, Mr. Chairman, let me express, on behalf of my colleagues of the Board, our sincere thanks to you for the attention which you have paid to the problems of the Foundation in recent times, and for the careful effort which has gone into the framing of S. 2598.

Thank you very much, sir.

Senator KENNEDY of Massachusetts. Thank you very much for a very comprehensive statement. I know you have a prepared statement with you, and we will include it in the record at this point.

(The prepared statement of Dr. Handler follows:)

PREPARED STATEMENT OF PHILIP HANDLER, CHAIRMAN, NATIONAL SCIENCE BOARD

Mr. Chairman, members of the committee, it is a great privilege to be here this morning and to endorse the major provisions of S. 2598. I do so out of the convictions that (a) vigorous prosecution of scientific research will continue to yield new and important insights into the nature of the universe, of life, of man and of the societies he has created, (b) that application of the insight and understanding so obtained will stimulate and strengthen our economy, improve our agriculture and our health as well as secure our national defense, (c) that the conduct of scientific research, in and of itself, enriches our culture and our national life, (d) that science education should be an integral aspect of the education of all citizens and that (e) the National Science Foundation is the most appropriate single agent of the American people for the attainment and furtherance of these aims. Since it is abundantly evident, from statements made before the Senate on September 20 and October 30 of this year, that the Chairman shares these sentiments, I shall not belabor them further. May I then, proceed directly to the provisions of the Bill before you.

In general, this Bill, like H.R. 5404, embodies two classes of changes in the original charter of the Foundation: those which define the scope and sphere of the Foundation's programs and those which describe the structure, organization and functioning of the Agency itself. I shall address myself to several, but not all, of these changes.

Social Sciences.—As indicated in a commentary submitted on April 21, 1966, to the House Subcommittee chaired by Mr. Daddario the National Science Board strongly approves specific identification of the *social sciences* among the broad fields of science which the Foundation is authorized to support.

We recognize that expanded efforts in this area must be undertaken with clear awareness of the many difficulties inherent in such studies. But man has been much more successful at understanding his own biology and the universe in which

he finds himself than he has been in understanding himself as a social being. Since that understanding may well be imperative to man's very survival as well as to his success in utilizing the fruits of science and technology so as to improve the human condition, the Board welcomes this affirmation by the Congress.

The importance which the Board attaches to this matter is reflected in the fact that we have been in the process of appointing a Commission on the Social Sciences to which has been addressed the following charge: To provide—

(1) a statement and analysis of the mechanisms and institutions, societal and governmental, that are needed so that the understanding and knowledge gained by the social sciences may be drawn upon and used effectively when they are relevant to understanding and dealing with significant problems in our society;

(2) an analysis of what forms of collaboration may be necessary among the social and natural sciences, and engineering, and among their practitioners in addressing these problems; and recommendations concerning how such collaboration might be brought about; and

(3) a statement of what measures and programs, to be administered by Federal agencies including the National Science Foundation, are required so that the social sciences may be more effective both in generating new knowledge and in its utilization, and so that our society can gain maximum benefit from the growing knowledge derived from fundamental research in the social sciences.

A copy of the full text of our letters of invitation to the members of this Commission, including this charge and the reasoning of the Board in establishing this Commission, is available for the Record if this seems desirable.

Applied Science.—Extension of the authorization of the Foundation to include support of *applied research* engendered considerable debate among the Board. It was argued that basic research is among the most significant of human activities. Since it seems perennially necessary to reconvince non-scientists that "Nothing is more practical than basic research," there should be one agency in Government devoted exclusively to the support of basic science which is among the most exciting adventures of our time and the applications of which have remolded the world in which we live. And there was concern that if the Foundadation were to embark upon a visible program of applied research, with the passage of time the generally favorable disposition of nonscientists, including many in the Congress, toward applied research would probably result in a relative diminution in the basic science portion of the budget in favor of support of applied programs.

These apprehensions are shared by essentially all members of the Board. But the Board, nevertheless, agreed that a legislative mandate to support applied research is desirable on the following grounds:

1. Limitation of the programs of the Foundation to "basic research" is an unclear mandate since the line which divides basic and applied research is frequently unclear, is certainly arbitrary, and often reflects the attitude of the investigator, his organization, or the agency which supplies supporting funds, rather than the intrinsic attributes of the research. In any case, the Foundation is already supporting some research which might readily be declared to be "applied," in programs which have already been certified by the Board.

2. By restricting its programs to "basic" research, the National Science Foundation may be causing some scientists, and particularly some engineers, to direct their research activities and, hence, their educational impact also, away from their legitimate applied interests.

3. There is a genuine need for support, at academic institutions, of applied work which will help to bridge the gap between fundamental findings and socially useful systems or concepts.

4. The line separating "basic" from "applied" research is even more vague in the social sciences than in the natural sciences.

5. The programs of applied research of the so-called mission oriented agencies are so broad and, relatively, so well supported that applied research which shades over into development will always find more natural homes among these programs.

6. The Board, the Director and his staff will remain acutely aware that fundamental research is the paramount concern of the Foundation.

However, it is precisely because it would prevent the long-range dangers we have noted that the Board welcomes limitation of this mandate to support of applied research at universities and other nonprofit organizations. Presumably, the President would only direct the Foundation to support "applied research relevant to the national interest" at "other appropriate organizations" under unusual circumstances.

With respect to Sec. 3b, we have no problem with the stated relationship to the Secretary of Defense. I am pleased that the Subcommittee looks favorably upon an expanded role for the Foundation in international affairs. It is to be hoped that this Section will permit and encourage an increasing involvement of the Foundation in science activities overseas which are designed not so much to strengthen American science as to strengthen the potential of underdeveloped nations and thus help them to help themselves. This would involve the educational programs, materials and talents of the Foundation much more than the research programs and personnel. In so doing the National Science Foundation, which is singularly competent in in this area, could serve our nation in yet another way. Such activities are ongoing on a modest scale today but could become much more significant and a very important aspect of our foreign relations.

The Director of the National Science Foundation and His Staff.—It may be inappropriate for the Board or its Chairman to speak to the specific position on the Executive Scale appropriate to the Director or Deputy Director. However, we do believe that these officials bear exceedingly heavy responsibility as the chief officers of a large agency whose programs must have enourmous impact on the future of our country. To assure success in recruting of future Directors and Deputy Directors, to provide them with effective voices in the councils of government, and as symbols of the significance of the National Science Foundation in our national life, my colleagues of the Board and I suggest to the Congress and to the Administration that both of these posts be assigned the highest possible ranks on the Executive Pay Scale commensurate with their responsibilities and importance to our nation. But we must leave to the Congress and the President decision concerning exactly what those ranks shall be.

I have had no opportunity to consult with my colleagues concerning the deletion from Sec. 5(a) (page 8, lines 4–12) of a fixed term of office for the Director. This proposed change in the Act would make no real change in practice. It is patently clear that, even now, the Director may be removed from office by the President, at his discretion. This would become even more obvious if no term of office is stipulated. But in the absence of such a stipulated term, I can only assume that the actual term of office would normally coincide with that of the President, as do those of members of the Cabinet. In contrast, a six-year term, but subject to the continuing acquiescence of the President, is indicative of the essentially nonpolitical nature of this appointment. Thus, deletion from the Act of a stipulated term would not change the realities but could arouse deep concern in the scientific and academic communities and occasion a loss of confidence in this respected and trusted agency.

The Board supports the position of the Director concerning the manner of appointment of Assistant Directors (Sec. 6(b), page 10, lines 12–18).

Particularly do we welcome the clear assignment to the Director of all authority for decisions concerning individual grants, contracts, etc. The Foundation has been moving in this direction as the number of annual transactions has grown. The dollar limitation proposed in H.R. 5404 reflects the current delegation of authority from the Board to the Director. But policy problems do not arise as a function of the size of a grant and there is no compelling logic to such an arrangement. And we are indeed unanimous that the Director, as chief executive of the National Science Foundation, should indeed exercise the full authority granted to the Foundation in the law.

The National Science Board.—The Board welcomes the directive to prepare an annual report to be submitted to the President for transmission to the Congress (Sec. 4(g), page 7, lines 7–16). Indeed, we have already acted upon this proposal and are in the process of preparing the first such report on the subject of a National Policy for Graduate Education in Science and Engineering.

In this regard, we may note also that S. 2598 does not include the provision of a Board staff as described in H.R. 5404. The Director and I have previously indicated that, whereas we understood that this was sympathetically offered so as to be helpful, a *permanent* Board staff, apart from the Foundation staff rather than on temporary assignment, for instance, for preparation of a Board report on a specific technical subject, would in the long run be divisive and, hence, fail to accomplish its intended purpose. Accordingly, I am pleased to note deletion of this provision.

I am pleased to note also the provision that both the Board and the Director shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences (Sec. 3(d), page 4, lines 13–15), in accord with previous recommendations in this regard by both the Board and the Director.

I come, finally, to the role and function of the Board with respect to policy, a question raised by the Chairman in introducing this Bill before the Senate. As we have already indicated, in the general councils of government, the Board is one among many voices, including that of the Director, in recommending board national or Federal policy. It was clearly the intent of the House Bill to strengthen the position of the Board with respect to specific matters of policy in the conduct Foundation affairs, while transferring to the Director full authority for the implementation of policy by the award of grants and contracts. In commenting upon the provisions of an earlier version of the House Bill in April 1966, the Board stated that: "In order to assure the efficacy of the National Science Board as a policy-making body, it is recommended that the statutory responsibility of the National Science Board for * * * the policies of the Foundation be continued and be made explicit in the act."

To make this clear, it was recommended that the role of the Board be described in the following sentence:

"The Board shall establish and be responsible for the policies and programs of the Foundation."

This sentence was stated, by the Board, to mean—

1. The Board is to establish the purpose and general nature of the various individual programs of awards conducted by the Foundation.
2. The Board is to exercise a continuing general surveillance of the awards made under such programs.
3. The Board can modify or terminate such programs when, in its judgment, they no longer appear to serve the national interest adequately.
4. The Director will bring to the Board those applications for grant or contract funds which raise matters of policy or their interpretation.

"Under these circumstances, whereas it will be apparent that the Director will exercise the authority of the Foundation and with his staff will render the multitudinous judgments required in the award of research grants, construction grants, training grants, and fellowships, and in the management of the national centers and programs, ultimate responsibility for the nature and national purpose of these programs and the manner in which their operation reflects their goals continues to reside in the Board. Thereby can we retain the remarkable unique character of the National Science Foundation, the character which has won for it the respect and confidence of the scientific and academic communities as well as of the Congress, the administration, and Federal agencies generally."

As I have indicated, the phrase "be responsible for" was interpreted in a limited sense. There can be no thought that a part-time Board can daily, or weekly, exercise such responsibility. But it can effectively operate as the Board has suggested.

The Bill before you, however, indicates that "* * *, the Board shall establish policies *to guide* the Foundation." I have had no opportunity to review this phraseology with the Board and can offer only my personal opinion. Whereas H.R. 5404 states that, "* * * the Board shall establish *and be responsible for* the policies of the Foundation," S. 2598 provides that, "* * * the Board shall establish policies *to guide* the Foundation." In view of this history, I can only conclude that the latter provision would weaken rather than strengthen the position of the Board as the policy-making body of the Foundation.

The net effect of the present Bill, which transfers from the Board to the Director authority for the award of grants and contracts—an action which I deem to be sound and proper—and also removes authoritative responsibility for formulation of policy, would be to transform the Board into a relatively ineffectual, advisory body. It scarcely seems appropriate to have the members of such an organization appointed by the President with the advice and consent of the Senate.

It is entirely possible that the new language was actually intended to convey the fact that the policies of the Foundation must be in keeping and conform with the larger policies set forth by the Congress and by the Administration. Throughout its history, the Board has been fully conscious of this reality. It has been well aware of the fact that the National Science Foundation is an agency of the *Federal government* and, like all other agencies of government, must and should conduct itself in accord with the provisions of relevant legislation, of relevant Executive orders, and of general Administration policy.

If the intent of the present language is specifically to make this situation more explicit, then this Section should be so worded as clearly to do so. The present phrase, however, strongly implies that the Director and his Staff are free to accept or reject policies formulated by the Board. If the Act were thus amended, the academic and scientific communities would surely protest that the Foundation

had become an instrument which in the future could be much more subject to political manipulation apart from scientific and educational goals. The Board would seriously suffer in stature and in usefulness, in contrast to the statement of the Chairman in placing this Bill before the Senate: "Second, it would strengthen the National Science Board, the governing body of the Foundation, and add several functions to it." As I read it, insertion of the unqualified phrase "to guide" in Sec. 4a would actually strip the Board of its functions as "the governing body of the Foundation." If less than this is intended and this phrase is retained, it is imperative that the Report accompanying this Bill render completely clear what meaning the phrase "to guide" is intended to convey.

The historical success of the Foundation affords no basis for this marked diminution in the Board's responsibilities. Moreover, we should note that recommendations concerning national or Federal policy from a Board which had been divested of responsibility for the very agency with which it is most closely concerned would ring hollow and have little impact. Accordingly, I am certain that the academic and scientific constituencies of the Foundation and the Board itself would ask that I recommend to you that this Section be either retained in the form offered by H.R. 5404, or stated simply as ". . . the Board shall establish the policies of the Foundation" or either of these so qualified as to make explicit that such policies must be in conformance with policies established by Congress and/or the President.

Finally, on behalf of my colleagues on the Board, may I express our sincere appreciation to the Chairman and his Subcommittee for the care and concern which they have shown in considering the role and problems of the National Science Foundation and in drafting of S. 2598.

Thank you.

Senator KENNEDY of Massachusetts. I just have one or two questions.

Has the Board itself ever met with the idea of making recommendations to the Congress on legislative changes you think would be helpful? Or would you say that the legislation which is now before us, taking into account the comments you have made this morning, fill what you feel would be the basic needs for the Board and the Foundation?

Dr. HANDLER. We considered in great detail H.R. 5404, both before and after its passage. In the time since S. 2598 has been introduced, we have not met and have not been able to discuss the changes which exist between S. 2598 and the House bill, so I address myself personally to those. I would be delighted to bring these matters before the Board while it is in session these next several days.

Senator KENNEDY of Massachusetts. I think it would be reassuring to members of this committee, because we certainly want to have a full understanding of the opinions of the Board. I do not know whether you can get unanimity, with regard to any of the suggestions. But any comments you think would be helpful—agreements or disagreements and reasons for them—I would be extremely pleased to receive.

(The material requested and subsequently supplied for the record follows:)

NATIONAL SCIENCE FOUNDATION,
NATIONAL SCIENCE BOARD,
Washington, D.C., November 19, 1967.

Senator EDWARD KENNEDY,
U.S. Senate,
Washington, D.C.

DEAR SENATOR KENNEDY: My colleagues of this Board and I greatly appreciate the interest in the National Science Foundation, and the courtesies shown us on the occasion of the hearing concerning S. 2598.

As you requested, the Board gave specific consideration to S. 2598 and to H.R. 5404 at our meeting on November 16 and 17. The Board unanimously voted to associate itself with the testimony which I submitted on 15 November and asked to indicate to you that, although I had not had opportunity to discuss the sub-

stance of S. 2598 with the Board prior to the hearing date, they strongly endorse the statement I presented.

The Board asked me to state that, unanimously, they wished particularly to stress the positions I had taken with respect to the desirability of a fixed 6 year term of office for the Director and in objection to the substitution of "establish policies to *guide* the Foundation" for "establish and be responsible for the policies of the Foundation" in describing the policy making function of the Board. There is equal unanimity of feeling with respect to all other points made in my testimony except, possibly, the matter of a separate professional staff for the Board In this matter, there are several members who consider that a designated staff, albeit on temporary assignment to the Board might better permit the Board to serve the Foundation and the Nation.

Please let us know if we may be of any further assistance.

Sincerely yours,

PHILIP HANDLER, *Chairman.*

Dr. HANDLER. Please understand, Senator Kennedy, many of the changes actually stem from the Board's own recommendations in the first instance. We are well aware of that and are grateful to you, sir.

Senator KENNEDY of Massachusetts. One of the things I am interested in is how we develop a sense of priorities in areas within the Board. Obviously, it has to be a group decision. I am sure there are members of the Board who feel strongly that there should be new and different directions, infusions of new manpower, new ideas—to try to make the Board as representative as possible in the various disciplines.

To the extent that it is possible, could you give us some idea of the Board's decisionmaking process? How does, say, a relatively new science—such as oceanography—how does it struggle up into a position where some feel great strides should be made? How are these decisions made?

Dr. HANDLER. It is not simple, and it is not necessarily clear, either, at any one time.

The Board itself comes from all quarters of our country, represents virtually all disciplines. Our membership come from institutions of quite different character, quite different involvements in society. The Board has available to it, as does the Director, advice from the several advisory committees in specific technical areas of the Foundation's interest—a highly competent advisory committee in the physical and mathematical sciences, a similar one in the biological and medical sciences, another one in the filed of education, another one in the field of institutional relationships. The members of these committees are by no means silent nor are they bashful. And the Foundation has a highly capable and knowledgeable staff upon which the Board relies in great degree.

The members of the Board also bring with them to Board meetings information, sentiments, feelings gathered from around the country—based upon their normal activities when away from Washington.

In a general way, meetings of the Board are concerned with two different kinds of problems. One group relates to perceived national needs and how these might be met. And I would say that we have met these best in the field of education. We are just learning how to assist in institutional development.

We have done rather well in the field of weather modification, and are just feeling our way in the field of oceanography, a field in which Senator Pell is most interested. Mr. Spilhaus is a member of our Board, and he is rarely silent when matters relating to oceanography are brought before us.

As I said, these are perceived national needs. And in these regards the Foundation generates programs addressed to those needs. The more acute the need, the more readily we can address ourselves to that need within the total resources available to the Foundation.

On the other hand, much research is not addressed so much to perceived need as it is to perceived opportunity. Science does not move smoothly. In many fields of science one can undertake new endeavors only when the time is right, the stage has been set, the necessary techniques are at hand, and the conceptual framework has been developed. Under such circumstances, proposals are brought to the Foundation by the scientists themselves. And then the Science Foundation responds, as does the Board, to requests from the scientific community.

These are two quite different attitudes. The first one I think is the one to which you were addressing yourself, in which the Board must establish how to react to needs which are seen for the Nation, and what might be done about them. To begin, we gather the best advice we can, and then recognize the total framework in which we have to operate. The fact is that we have many very serious problems, and a fixed budget; hence we must try to carve up that pie so as to maximize the impact upon the Nation.

Senator KENNEDY of Massachusetts. Have you thought as well about how you might like to see the Board and the Foundation in 10 or 15 years? Are you thinking about this and planning for it?

Dr. HANDLER. We have engaged in a modest amount of long-range planning. I should say, as I failed to earlier, that we have structured the Board's work, other than when it meets as a full Board, by having several Board committees. One of these is addressed primarily to problems relating to education, one to institutional relationships, one to problems immediately relating to research. A fourth ad hoc committee has been addressing itself to the preparation of the first Board report.

Now, these three other committees really do engage in forward planning. That is their business. They do not exist to deal with the day-to-day work of the Foundation. They exist to consider how best to get on with learning how the Foundation might be of maximum benefit to our Nation, let us say in the field of secondary school education, or more recently, how to be effective in the field of science education at the college level, a field which the Foundation is just now entering. And they really are taking long forward looks, trying to ignore what goes on today, and construct in their imaginations how this might be done some time in the distant future. When I say distant future, I mean 5 to 10 years—I mean nothing further than that, sir.

For example, it is necessary, in the field of astronomy—for which the Foundation is the prime supporter—to consider the total thrust of this science, to consider what the opportunities are, what the limitations are, and then schedule the manner in which the Foundation might operate. In this regard, we have been aided enormously by a series of planning activities which are underway at the National Academy of Sciences, under the sponsorship of the Committee on Science and Public Policy, of which Dr. Harvey Brooks is the Chairman. He will appear before you in a little while. This Committee has undertaken long-range planning for scientific disciplines, that is, for

astronomy, the life sciences, chemistry, physics and the like. And the Foundation and the Board respond to these long-range plans in formulating how best to use the Foundation's own resources.

Your question, though, I think is what the Board itself should be like in 10 years. Is that correct?

Senator KENNEDY of Massachusetts. The Foundation and the Board.

Dr. HANDLER. Well, I guess I would have to add my voice to some statements made earlier today by Dr. Hornig and again by Dr. Haworth.

The support of science and of science and education through the Federal Government is fragmented among a great number of agencies. The Science Foundation, alone and uniquely, is charged with maintaining the health and vitality of the entire national scientific enterprise. And it is very difficult for it to do so with the resources at its disposal, which are too small a fraction of the Federal total expenditures for science. I would hope that in time the Science Foundation would come to occupy a much larger place in the total Federal support of science. Only when that is true will it be possible to program science—I do not mean its content but its support, mechanisms and institutions more meaningfully than we can do now.

I think that one day it will be necessary for the Nation to make an overt acceptance of responsibility for the Federal role in graduate and professional education—something which has not yet happened. We do support graduate education through the Science Foundation, largely through the fellowship mechanism and through the support of individual graduate students, through research grants.

We have not yet developed mechanisms nor looked sufficiently carefully at what the relationship of the National Science Foundation or the Federal Government will be to the total institutional structure in which this is done, i.e., all of the universities and all of the research institutes of the United States. And I believe that our chief task for the next several years is to look at the total picture and plan what the roles of the Federal Government, the NSF and the institutions themselves will be in the years ahead.

Senator KENNEDY of Massachusetts. Thank you very much.

Senator Pell?

Senator PELL. I would like to apologize for being late. I was at another committee meeting. I congratualte Senator Kennedy very much in both his willingness to take leadership in the subcommittee, and the General subject matter. I am sorry I missed the testimony of Dr. Haworth and Dr. Hornig.

First—have you thought of having a joint hearing with the Foundation of the Arts and the Foundation of the Humanities—because there are so many relationships between the national sciences and the social sciencies. I was wondering if you ever discussed that?

Dr. HANDLER. Hearing of what sort?

Senator PELL. A joint meeting.

Dr. HANDLER. We have had. Fortunately it is easy. The Endowment for the Humanities is housed in the same building. Our Board and their Council have had one dinner together. We plan to have many others.

Senator PELL. I am delighted to hear that.

Another point here—this bill gives you a little more freedom to work in the field of applied research. As you know, I have a strong interest in the sea-grant college program, which is under your wing. Bearing out the point you just made, I believe it took a little too long to get going. But now that it is underway, it seems to be doing very well indeed.

I wonder if you could submit for the record—in view of the fact that the legislation was signed by the President about 13 months ago—the number of grants that were made under this program to date. Or do you know offhand?

Dr. HAWORTH. Actually, Senator Pell, we have not yet made any grants.

Senator PELL. What?

Dr. HAWORTH. We have not actually made any grants. We are on the verge of making the first group. There will be some taken to the Board at this meeting.

Senator PELL. I am very glad. We have discussed this. I just would again make the point—I do think we ought to press ahead in this field, and that 13 months from the President's signature is maybe a little too long before the first actual impact occurs.

Also, I wondered which of the committees, the three working committees, of the National Science Board exercise jurisdiction over the sea-grant college program?

Dr. HAWORTH. So far, it has been discussed in the Board as a whole, because of the many ramifications of the program. It includes education, it includes research, and, of course, it includes the information transfer. So the sea-grant program does not fall naturally into any one of the Committees. There has not been an assignment yet; partly, of course, because it is a new program, and therefore it has been felt appropriate to discuss it in the Board as a whole.

Senator PELL. Isn't 13 months a little long?

Dr. HAWORTH. There were no funds in fiscal year 1967, except a program transfer made in June of this year. And we could not even announce the program legally until that was done. A large part of what has taken the time is that we were slow in getting organized. I admit that. But, of course, until the program was announced, universities and colleges could not start making proposals; the preparation of proposals by the institutions, their evaluation and the process of selection by the Foundation constitutes a long process.

We have another new program this year that is having exactly the same difficulty for exactly the same reasons. The process of formal proposals, evaluation of proposals and so forth, is a long one.

Senator PELL. Thank you. I thank you for the help you have been to the program and look forward to further discussion.

Senator KENNEDY of Massachusetts. Thank you very much, gentlemen. We appreciate your appearance.

We would like to submit some questions to you at a later time for responses to be made part of the record, if that is all right.

Our next witness is Dr. Frederick Seitz, President of the National Academy of Sciences and a member of the President's Science Advisory Committee. I see from the list of your publications, Doctor, that your primary interest is in the field of solid and nuclear physics. With you, I believe, is Dr. Harvey Brooks, a member of the National Science Board and the National Academy of Sciences.

We welcome both of you here.

I would like you to submit your statements in their entirety, and they will be made a part of the record. Perhaps you could summarize the contents, and we could discuss it as you go along.

STATEMENT OF DR. FREDERICK SEITZ, PRESIDENT, NATIONAL ACADEMY OF SCIENCES

Dr. SEITZ. Thank you, Mr. Chairman. In the interests of time and any discussion you may want to have, I will summarize my comments in just a few sentences.

First, I think it would be a great misfortune to the scientific community if the National Science Foundation, which has the obligation to support science itself, became involved in too much mission-oriented work of an applied nature. I think perhaps the mission is about right at the present time. I would dislike seeing it take on more mission-oriented work of an applied nature.

The second point I would like to make is that I feel it is essential, in view of the way in which our agencies operate, that the Director of the National Science Foundation be regarded as the individual with primary responsibility for the operation of the Foundation. It might be worth reminding you that one of the early proposed bills for the National Science Foundation which came after World War II did not give the Director the role which he has at present, and as a result President Truman saw fit to veto it.

Regarding the Board of the National Science Foundation, it seems to me that it occupies a role somewhat like that of a board of directors of an industrial organization, in the sense that it should have responsibility for policy, but should delegate most of the authority for operating the agency to the Director.

Finally, I welcome the fact that the present proposed legislation recognizes the importance of the social sciences within the framework of the National Science Foundation. I welcome the prospect of the opportunity to work more closely with our colleagues in the social sciences.

Thank you.

(The prepared statement of Dr. Seitz referred to follows:)

PREPARED STATEMENT OF DR. FREDERICK SEITZ, PRESIDENT, NATIONAL ACADEMY OF SCIENCES

Man has been involved in technology through the entire history of his existence—for fifty thousand years or more. In fact, the growth of technology has been indispensable to the improvement of his status upon this earth, his home. Until about five hundred years ago technology was based exclusively on knowledge derived through experience—largely trial and error—and tradition. Since that time, however, western man has succeeded in developing a new and more efficient source of technology—namely, what we call modern science, which rests upon the development of profound understanding of the laws of nature. Most of the very great advances of our Atlantic civilization in the past two hundred years have been traceable to new knowledge placed by scientists in the hands of engineers. Here one thinks, for example, of some of the advances associated with chemistry, electricity, electronics, scientific biology, and atomic energy.

The exploitation of science for the benefit of mankind is still in its infancy, and one can foresee vast developments in the future if we remain faithful to the scientific quest for understanding of the laws of nature.

Although I have here emphasized the uses of science, the enlightenment gained through science is fully as important to our lives as the gains in material well-

being and health that have resulted from this knowledge. It is very important, for example, for us to understand the position of our earth in this vast universe and to appreciate the fact that all forms of life that we know on earth or that have lived here in the past are closely related.

We in the United States were primarily users of European science until well into the present century, even though we did have a few very great scientists before World War I. We have had, of course, many excellent engineers and technologists since colonial times, and have managed to repay Europe adequately for the basic knowledge we borrowed by sending back countless inventions. It became evident to many of our leaders in World War II, however, that we must become strong in basic science. The reasons were spelled out clearly and eloquently by the great scientists who led our national effort in pure and applied science during that critical period. Consequently, the federal government permitted federal agencies, old and new, to support scientific research on a national scale following the war. These expenditures, coupled to our growing scientific population, made it possible for us to take a place among the leading nations in science. In the meantime, we also exploited science for many useful ends. Our successes since the war have proved that our various institutions for conducting research—most prominently the academic, governmental, and industrial institutions—can, with appropriate support, be exceedingly effective in generating good science and putting it to work.

It should be emphasized that mostof the agencies that have supported scientific research since the war are mission-oriented. This includes the Office of Naval Research and the other agencies of the Department of Defense, the National Institutes of Health, the Atomic Energy Commission, the National Aeronautics and Space Administration, as well as the agencies of the Departments of Commerce and Interior. For the most part, they have done exceedingly well in interpreting their missions broadly, because of the presence of wise and far-seeing members of the administration, and have provided sustenance to fundamental scientific research as well as to work more immediately tied in with their missions. The fact remains, however, that such agencies do have the responsibility for advancing their applied objectives. Practically all the agencies have found it necessary to abandon good scientific research at various times because of the competing demands of the more applied programs connected with their missions.

The National Science Foundation is unique among the federal agencies in the sense that its main mission has been to support good scientific research within the meaning of the scientific endeavor I described earlier. It has had, first and foremost, the obligation to keep science strong by aiding the process of exploring nature without immediate regard to applied goals. This purpose is in the long run of priceless importance for the welfare of science, and hence of science-based technology.

It is true that the National Science Foundation was very poorly funded for most of the first ten years of its existence. Those lean initial years were, I assume, associated with the fact that our nation still did not quite appreciate the great need to support to some significant degree research carried out primarily for the welfare of science itself, with the explicit understanding that practical dividends would inevitably emerge from the new knowledge. There was an inclination to leave almost all the support of science in the hands of the mission-oriented agencies with the hope that this would somehow maximize the practical results.

The launching of Sputnik by the Soviet Union caused our nation to review its attitudes toward science once again. There was a general realization that we had been much too narrowly practical in our outlook, and had allowed the Soviet Union to steal a lead in the very dramatic field associated with scientific satellites in which we could easily have been the innovators. Following this event, we not only created the National Aeronautics and Space Administration but also began to give the National Science Foundation far more adequate funds for the support of general science.

It seems to me that the lessons to be learned from Sputnik are very profound. Whenever we permit short-range practical objectives to deflect us from pursuing the types of basic knowledge which lie well within our means, we run the grave risk of suffering some significant loss, whether in prestige or in a practical innovation.

One of the greatest fears that has been expressed by the scientific community is that the National Science Foundation might eventually be transformed into an agency that is so involved in applied missions, such as the promotion of secondary school education or weather modification, that the support of basic scientific research will be limited to a starvation level. Should this occur—and I believe the

danger is far from remote—we could easily pay a heavy price by sacrificing positions of leadership in important fields of science. In fact, chemists, and physicists not involved in high-energy physics, have in recent years indicated in reports published by the National Academy of Sciences that they are losing ground. More specifically, they have evidence to show that the support of the type of independent research that is carried out by the academic scientist who works in his own laboratory with a small group is now beginning to fall behind the need. I do not believe that our nation can afford this retrogression at the present time. Experience has already made it amply clear that research of the type carried out by such independent investigators is vitally important for future technology, as well as the training of students.

I think I speak for a major segment of the scientific community in saying that, whatever other duties the National Science Foundation may be assigned, it should be obligated to give first priority to the support of frontier scientific research that will maintain our national strength in understanding the world of nature—quite apart from the immediate relevance of this knowledge to applied missions. We have the experience of the past to assure us that this procedure will pay significant practical dividends in the future.

Next I should like to turn to several points in the proposed legislation which may have a major impact upon the direction of science in the United States and upon the role which the National Science Foundation may play in the evolution of science and technology in the coming years.

Two matters that must be considered together are the roles respectively, of the Director and of the National Science Board of the National Science Foundation. It is important to bear in mind that administrative and management responsibility must reside in the Director of the Foundation. He is the full-time head of the agency, appointed by the President, by and with the consent of the Senate. You may remember that a bill passed by Congress just after the war, which did not take this point fully into account, was vetoed by President Truman. Thus I am pleased to see that this situation is completely understood and fully recognized in the proposed legislative changes. It is essential that the Director have management responsibility for the programs of the Foundation and thus be accountable for such programs to the President and to the Congress. One man can be held responsible for the programs of a government agency; twenty-four cannot.

The role of the National Science Board as an integral part of the National Science Foundation has many similarities to that of the board of directors of a private foundation or an industrial corporation. It must determine whether the programs of the Foundation conform to the intent of Congress as stated in its legislative actions, and whether these programs contribute as they should to the well-being of the scientific community and to the public welfare. This resembles the way in which a board of directors examines the responsibilities of management as outlined in the charter under which an organization operates, and makes certain that the welfare of the shareholders is given proper attention in the normal conduct of business. The National Science Board should be able to advise the Director and staff of the Foundation with respect to the policies that guide its programs.

Finally, I should like to endorse the specific inclusion of the social sciences among the sciences to be supported by the National Science Foundation. It is obviously more difficult to be quantitative in some of the social sciences than in the more exact physical sciences, but the research problems are no less real or demanding, and no less subject to judicious, intelligent, imaginative research, important for our progress.

Senator KENNEDY of Massachusetts. Can you tell me, Doctor, what the relationship is between the National Academy of Sciences and the Foundation?

Dr. SEITZ. The National Academy of Sciences was created in 1863 by Congress—incidentally, a Senator from Massachusetts was responsible for the original bill—Senator Wilson. The Academy has the responsibility to adivse the Federal Government on request on matters relating to science and engineering. We are now 104 years old. We have an elected body of members, now about 750, mainly from academic institutions.

As an advisory body, however, we draw on a much larger group, the National Research Council, which embraces about 400 advisory

committees engaging the services of about 6,000 scientist-engineers, including social scientists and political scientists. They work without fee. We have a staff of about 700 to serve the needs of the committees.

Senator KENNEDY of Massachusetts. And could you give us some idea of how the Government draws on the Academy, with regard to the different departments taking advantage of your personnel? How would you catalog it, as far as various departments are concerned?

Dr. SEITZ. In a typical case, an agency comes to us with a problem. Sometimes there is an informal discussion before they approach us formally, in order to get agreement on how a study might be conducted. Then a general letter will arrive asking if we will take an assignment, and we respond. Usually we accept the responsibility if it lies within our scope.

To give you an example: As you may know, since the thalidomide incident, the Food and Drug Administration has been operating under rather different rules regarding the licensing of drugs than it did before 1962. We have taken on the responsibility of examining all drugs licensed between 1958 and 1962 in an attempt to determine their efficacy—a particular problem at a rather high level.

We have many others related to quite basic science. For example, we might be asked to submit a report on the future of a field of science, like high-energy physics or radio astronomy.

So there is a broad mixture of pure and applied work.

Senator KENNEDY of Massachusetts. Do various departments meet on any regular basis with either you or maybe an advisory group, to explore some of the ways in which you can be of greater effectiveness or help to them?

Dr. SEITZ. It comes about in a variety of ways. Sometimes I am called to one of the departments to discuss an issue, or staff personnel may be called. In some cases individuals from an agency visit us. In some cases individuals in the agencies serve in an ex officio way on our committees, and are advisory to those committees.

Senator KENNEDY of Massachusetts. I suppose the departments themselves are completely familiar with the resources which you have available, and take full advantage of them. I just wonder to what extent they really consult actively with you, or with your various advisory groups, to handle the problems we face.

For example, a number of different task forces are established at different times by different Presidents. They were started by President Kennedy, and continued on through President Johnson. They study a variety of different subjects.

I wonder if in these fields, the Academy provides personnel. I suppose there must be some overlap.

Dr. SEITZ. Yes, there is some overlap. Very often the reports of some of the commissions or task forces or committees will carry a sentence or two in which there is a suggestion that the Academy be asked to serve as a kind of watchdog and carry on continuing studies. That was true, for example, in the case of the pesticide problem—the question of the effect of pesticides on the environment. We have what amounts to an ongoing committee in that field.

Senator KENNEDY of Massachusetts. Thank you very much.

Dr. Brooks, we shall be glad to hear from you now.

STATEMENT OF DR. HARVEY BROOKS, CHAIRMAN, COMMITTEE ON SCIENCE AND PUBLIC POLICY OF THE NATIONAL ACADEMY OF SCIENCES, AND DEAN OF ENGINEERING AND APPLIED PHYSICS, HARVARD UNIVERSITY

Dr. BROOKS. In the interest of saving time, I do not believe I will say very much about the formal statement which I would like to submit for the record, since most of the points I wanted to cover have been covered by other speakers this morning.

Rather, I would like to make a few specific remarks, both on what has been said by previous witnesses and also perhaps responsive to some of the questions that I have heard.

In the first place, I would like, as a member of the Board, to associate myself completely with Dr. Handler's testimony and with the specific recommendations he made concerning the legislation.

Second, I would like to make a brief remark in response to your question as to how the National Science Foundation goes about determining priorities for support as between different programs. This has already been pretty well sketched by Dr. Handler. But the point I want to emphasize is the key importance of the project proposal; that is, of initiative from the scientific community and from the institutions of the scientific community in determining what is actually done.

We may formulate a program and publicize it, but until somebody in the scientific community or some institution comes in with a concrete specific program of action, with the personnel delineated and so on, the National Science Foundation really is not in business.

I think this is partly what accounts for the time delays that Senator Pell was calling attention to. This does not mean, of course, that the Science Foundation is by any means a mere passive agent which waits for the community to come forward, since it can do and does do a great deal to stimulate and invite such proposals in areas which it considers to be important.

Nevertheless, the final commitment of funds and the final commitment to action depends on the receipt of concrete proposals from particular institutions within the scientific community.

We believe that this is the only fair way to operate, that in fact if you are going to start a new program, everybody ought to have a chance to participate and that, therefore, one should announce a program and the general guidelines for it, and then proceed to respond to the actual proposals that come forward from the community.

As for the question of priorities between fields of science, the input to this comes from many different sources.

You must remember that the whole staff of the Science Foundation is organized, partly at least, by scientific disciplines, and so for each discipline and subdiscipline, there is generally a program officer who is very knowledgable in his field. Many of these program officers are people who in fact come to NSF on leave of absence from universities for 2 or 3 years, so they come fresh from the laboratory, as it were, and are very familiar with what is going on in their field.

Secondly, of course, they are continually reviewing, and seeing the proposals that come in from the scientific community to the Foundation, getting opinions on these proposals from outside reviewers, and

so on. So they have a very good perspective and picture of what is going on at the frontiers of basic science in their fields of interest.

All of this input of proposal pressure, of initiatives and ideas from the scientific community, is continually flowing through the Foundation, through the staff of the Foundation, through the various advisory committees, and so on, and giving indications of what the growing points of science are. I would say, therefore, that the primary factor that goes into the allocation of funds is really the composite of the opinions of the scientific community, as represented by the proposals received and the opinions about them of many advisers.

Now, this has been supplemented in recent years by specifically commissioned studies in various scientific fields, made in fact outside the Science Foundation, generally in the National Academy of Sciences.

Dr. Handler referred previously to the Committee on Science and Public Policy of the National Academy of Sciences, of which Prof. George Kistiakowsky, of Harvard, was the founder and first chairman, and I am the current chairman.

This committee, which is partially supported in fact by a grant from the National Science Foundation Planning Division, has stimulated a series of studies of various scientific fields by knowledgeable groups representing those fields. So far there have been, I think, five such studies published, and there are three very ambitious studies underway currently in mathematics, in the life sciences—the latter chaired by Dr. Handler—and in the social and behavioral sciences sponsored jointly by the Social Science Research Council and the National Academy of Sciences.

The results of these studies are fed into the Government and into the National Science Foundation, and have a very strong influence on the policies and priorities for support—although obviously they cannot be the sole influence, since the support of science and the relative importance of different fields cannot be determined exclusively in terms of scientific considerations, but must involve other considerations of what problems are important from the standpoint of society and of the Government.

I think with those two general remarks, I will stand and let the rest of my remarks appear in the record.

(The prepared statement of Dr. Brooks follows:)

PREPARED STATEMENT OF DR. HARVEY BROOKS, CHAIRMAN, COMMITTEE ON SCIENCE AND PUBLIC POLICY OF THE NATIONAL ACADEMY OF SCIENCES, AND DEAN OF ENGINEERING AND APPLIED PHYSICS, HARVARD UNIVERSITY

I appreciate very much the opportunity to testify concerning this bill. I come before you really with several hats. I am a Member of the National Science Board, but I also currently serve as Chairman of the Committee on Science and Public Policy of the National Academy of Sciences, which has been responsible for the preparation of a series of reports surveying the opportunities and needs of the various scientific disciplines. I am responsible for a major division of a university which is dependent on the support of academic science by agencies of the federal government. I am also on the Board of Trustees of one major university and one liberal arts college, and I am a member of the Board of Trustees of one of the three major oceanographic institutions in the United States. In all of these capacities I have had the opportunity to see the problems of academic science support from the viewpoint of many different types of institutions, as well as from the viewpoint of the federal government. While I was a member of the President's Science Advisory Committee a few years ago I devoted much of my time and attention

to problems arising in the support of academic science and also problems of long-range planning for the support of science in the federal government as a whole.

In my remarks I would like to emphasize three major points:

1. The importance of the role of the National Science Foundation in the support of basic and academic science in the United States.

2. The importance of the National Science Board as a spokesman for the scientific community and the desirability of its maintaining a degree of independence and initiative.

3. The potential and desirable role of the National Science Foundation in the support of applied research.

Role of the National Science Foundation

During the postwar era the United States developed its scientific establishment as a more or less incidental by-product of the cold war. Successive supporting agencies with new technological or applied-science missions stepped forward in support of basic research—and, incidentally, graduate education—related to their missions. The National Science Foundation appeared on the scene early, but only became a significant factor in the support of academic research after about 1959. It was the first agency that really took responsibility, with a mandate from the Congress, for the health of American science and graduate science education as a whole, the only agency that worried about institutions, people, educational curricula, and the training of teachers as first-priority problems in their own right. It was also the only agency that took responsibility for the development of science primarily with respect to its intrinsic intellectual values—always with the understanding that by developing a strong scientific enterprise in all its aspects, all the more mission-oriented research and development activities would also be strengthened and a resource created for the future. Over the years the federal government, from having supported scientific projects here and there in order to enhance or accelerate what was already going on, has now become the major patron of science and of scientific education beyond the bachelor's level. The entire enterprise stands or falls by what the federal government does, and furthermore, the lead time or cycle time is much longer than for most federal activities. Deficiencies in support today cannot easily be rectified five years from now.

The National Science Foundation is increasingly the balance wheel in the pluralistic system of science support, especially important in a time when the country is reassessing its priorities and redeploying its technical resources. In such times of change it is particularly essential that there be a strong agency having an overview of scientific research and of scientific education, and with responsibility to think mainly in these terms. I have a conviction that our pluralistic system of support is a good one, that the National Science Foundation should not become the exclusive supporter of research and graduate education in science. Mission-oriented basic research often turns up new areas of investigation and new intellectual challenges, interesting for their own sake, that would not have appeared without the stimulus of a definite public need. Mission-oriented support also stimulates and enriches the agencies that provide the support and keeps them in touch with the advancing frontiers of science. But the National Science Foundation must have enough resources under its own control to explore new areas of scientific opportunity independently of short-term shifts in perceived public needs, in the confidence that such exploration according to the dictates of the internal logic of science will ultimately enable us to deal more effectively with all our national problems. Thus, as I see it, the Foundation will play a gradually increasing role in the total picture of science support. The very fact that it is not under compulsion to respond to every national emergency or immediate social need gives it the opportunity to look beyond the present to the future needs of the country.

One of the important features of the present bill, in my mind, is that it raises the social sciences to a status of equal partnership with the physical and life sciences, rather than relegating them to the position of "other sciences." This is in recognition of the fact that many of the problems with which the country will be faced in the last quarter of the 20th century involve a simultaneous and intertwined application of social and natural science knowledge, and that the development of the social sciences themselves will draw increasingly on techniques, concepts, and instruments developed in the natural sciences.

Role of the National Science Board

As the National Science Foundation has grown, there has been a shift in the role of the National Science Board. In the early days the Board approved every action of the Foundation's Director and staff, but as the number of individual grants has multiplied it has shifted to a policy-making role, delegating more and

more of its grant-making powers to the Director. This is as it should be, but it now needs more explicit recognition in the legislation. The Board should concentrate more and more on its central role in the making of policy for the National Science Foundation, and in providing the rationale and the recommendations for policy in support of basic research and science education for the government as a whole, taking into account the actions of all the other agencies and of the private sector. The part-time nature of the Board—its membership including working scientists, university administrators, and industrial officials familiar with the applications of science—ensures a much richer input to policy than could be achieved through a purely intragovernmental administration, no matter how competent. Also, the Board stands as a representative of the scientific community and a spokesman for basic science and education within the administration. It represents additional assurance to the scientific community that the long-range scope of science will not be sacrificed to short-term transient goals of the moment, or to public fashions or political expediency. The Board is a part of the administration, but it has, and should continue to have, a degree of independence to speak out for the long-term interests of the nation's scientific enterprise. I hope the proposed legislation will strengthen this independence and enhance the role of the Board in initiating science policy and proposing new programs. In this respect, I subscribe to everything that Dr. Handler has said in his testimony.

Applied Science

I come finally to the question of applied science. The proposed legislation gives the National Science Foundation the authority to move into applied science when and if desirable. This is perhaps the most controversial proposal in the present legislation. There are many in the scientific community who fear that the National Science Foundation will become the dumping ground for every applied program that other agencies are reluctant to undertake, and that eventually applied research, which is much more expensive than basic research, will drive out basic research altogether, and that then there will be no agency left in government that supports research projects primarily because of their intellectual importance—that is, their importance to the whole interlocking structure of our knowledge and understanding of nature. This is a real danger. On the other hand, there is no sharp line in practice between basic and applied research, and this distinction is constantly changing with time. What appeared to be basic research yesterday becomes highly applied tomorrow. Furthermore, there has been concern—legitimate, I think—that emphasizing the distinction between basic and applied research, in support, has reinforced an unhealthy attitude toward applied science among some graduate students and some professors in universities, particularly in engineering. I believe the National Science Foundation should support *scientific* research, that is, research that has scientific significance or practical significance (often both) extending well beyond immediate problems. A test of good research is general significance, whether this be in terms of conceptual understanding or in terms of widely applicable techniques or design methods. The university scientist or engineer—particularly the latter—should be free to carry his work occasionally to the point of feasibility demonstration on a small scale without losing support because it is no longer basic enough. On the other hand, this should not be a license for mere empirical puttering or for carrying out routine and repetitive measurements, necessary as such measurements may be in some kinds of applied work. However, this type of applied work should be left to other agencies, where it can be much better coupled to defined practical objectives. It is not generally appropriate for universities or for the National Science Foundation.

Understanding, that is, theoretical understanding, the creation and testing of conceptual or abstract models of reality against the real world, is the objective of science. In the past, understanding has always led ultimately to the ability to predict, and often to control. As the consequences of technology become ever more ramified, or indirect but also more far-reaching, understanding becomes more essential than ever before. We can no longer afford to develop or introduce technology without deep understanding of what we are doing. It is not sufficient that something works, or to prove that it works. We must know *why* it works and what its effects are in the environment. The kind of understanding necessary to predict and control technology—including biological and social technology—can come only from scientific research in which understanding replaces the mere assembling of facts. It is in this spirit that I think the new and broadened mission proposed for the National Science Foundation is important. I do not think that the National Science Foundation should support industrial-type research oriented toward the development of specific products and processes, nor should it support applied research that is well supported by other agencies. On the other hand, it may well

contribute supplementary support to projects in academic institutions supported by other agencies in order to facilitate deeper exploration or further generalization of results transcending the missions of the supporting agencies or its interpretation thereof. The National Science Foundation should support, for the most part, the kind of applied research that may be related to basic technology or basic technological capabilities, or that is related to the wider environmental or social effects of industrial technology. This is the kind of research that is undertaken prior to the clear identification of practical missions.

Indeed, it seems to me that the past role of the National Science Foundation in the field of weather modification is a good example of the kind of role it might fill in other applied research areas on a highly selective basis. When the National Science Foundation was first assigned this mission, there was great uncertainty as to whether weather modification could be undertaken at all, and much of the necessary fundamental knowledge of precipitation processes, cloud physics, and atmospheric circulation was lacking. Only when this knowledge was at hand was it possible to speak realistically of large-scale experiments in weather modification, or of operational programs. At this point it became desirable to consider other mechanisms for carrying on the technology of weather modification, leaving the National Science Foundation to continue with the more fundamental and generalizable parts of the program.

I see the National Science Foundation currently filling a similar role in the field of the development of scientific-information systems. This is also applied research. The Foundation's role has been to support demonstration and prototype experiments as well as to cultivate a broad research program. In a certain sense, one might say that the purpose of applied research in the National Science Foundation should be to point out new technical opportunities and new technical missions, which would then be taken over by other agencies. It should be a generator of opportunities rather than a responder to requirements.

Senator KENNEDY of Massachusetts. Thank you very much, Dr. Brooks.

Would you explore a little bit the importance of the Foundation supporting applied research?

Dr. BROOKS. Yes. I think this has been to some extent already covered in both Dr. Haworth's and Dr. Handler's remarks, and I subscribe very closely to what they have said, both in respect to the dangers of the Science Foundation getting too deeply involved in applied research, and as to the importance of being able to carry basic research far enough so that in fact people in the university, particularly in the more applied sciences, do not feel constrained by the limitation of support to what is defined as basic science.

There is no sharp line in practice in fact between basic and applied research. And this line is constantly changing. What appeared to be basic research yesterday suddenly becomes highly applied research tomorrow.

I believe fundamentally that the National Science Foundation should support scientific research—that is research which has scientific significance or practical significance or indeed both extending well beyond the immediate problem at hand. The test of good research is general significance, whether this be in terms of conceptual understanding or whether it be in terms of widely applicable techniques, or design methods.

A university scientist or engineer, and particularly the latter, should be free to carry his work occasionally to the point of feasibility demonstration without losing support, because it is no longer basic enough.

Senator KENNEDY of Massachusetts. Could you give some illustration of that point—perhaps in the field of water pollution or air pollution or transportation?

Dr. BROOKS. Yes. I think the criterion that should be followed is that the Foundation should be able to support research in an area

to the point where it will be picked up by a mission-oriented agency—whether it be an agency of the Federal Government, as in an area like pollution, or a private agency which might wish to exploit it. And this usually requires somewhat more than the mere publication of results. It requires contact between the scientist in different areas; it requires sometimes a small-scale feasibility demonstration, as for example a process on a laboratory scale, let's say, for example, of removing waste from water, or something like that. And I think it is this kind of carrying of things to what one might call a laboratory scale or slightly more than laboratory scale feasibility deomonstration that is needed if things that emerge from basic research are really to be carried into application.

Senator KENNEDY of Massachusetts. Do you think this is more true now than it was, let's say, 10 years ago? Or do you think there is a greater appreciation of the need for it now, because of a greater public concern for environmental and social improvement?

Dr. BROOKS. Yes. I think the main reason is essentially that whereas 10 years ago, 15 years ago, our major public concerns, our major mission-oriented research, was concerned with national security matters, and we had in fact an agency which supported research over a very broad spectrum, from the most basic to the most applied and developmental research; namely, the Defense Department and the agencies that worked in closely allied areas, such as the Atomic Energy Commission and the space agency—we are now moving into an era where we are very often dealing with problems in which the agencies responsible do not have very much scientific background and tradition, and where in fact it is much more difficult to establish this spectrum of activities from basic to applied research necessary to achieve optimum technical progress. My hope would be that to some extent the Science Foundation could serve as a catalyst in these areas. As they develop they should be taken over by the agencies that are responsible for those particular missions.

The point that I would really like to make is that very often even a mission does not become apparent or does not become possible until a certain amount of scientific or technical groundwork has been laid.

We did not even have a space agency until somebody had made an attempt to shoot something into space. In other cases we may not really be able to develop an agency with the technical capability until at least some preliminary groundwork has been laid, either through basic science or through the more generalizable kinds of applied science.

I think a very good example historically, perhaps, is the field of computers, where much of the basic work and the sort of feasibility demonstration—in fact all of it practically—was done in universities. Actually most of it was supported by agencies of the Defense Department. But as soon as this got to be the point where something having the possibility of working appeared, it was very quickly taken over by industry.

I think this is the kind of role which is going to be increasingly important, but I think it is important that the Science Foundation, if it does get into applied research, resist the temptation to carry things beyond the point where somebody else is ready to pick them up.

Senator KENNEDY of Massachusetts. We have authorized the Water Quality Act of 1965, the Clean Air Act, the Mass Transportation Act—a whole host of very significant programs which will expend hundreds of millions of dollars to try to meet a number of the problems we face here at home.

I would be interested in your relating the importance of applied science research to developing techniques which might very well save us millions of dollars in these areas, dollars which could then be allocated to other areas.

Can you make the case that the research which would be done—applied research—would really mean savings in the long run? Can you show that by your kinds of research, you will be able to develop, say, water pollution control techniques which instead of costing billions of dollars, might cost much less? That we will be able to do the same with regard to transportation—in which Senator Pell has been so interested—and in other areas as well?

Can you give us at least some idea whether this is so?

Dr. BROOKS. Well, I think I can—it is very hard to give examples off the top of one's head. I must apologize if I choose examples from my own department at Harvard. That is only because that is the only thing I can think of at the moment.

We do have—we are acting at the moment as hosts to a project of the American Society of Civil Engineers which is developing or exploring the possibilities of a system of combined sewage—that is the separated storm and sewage channels—which if it were successful could save an appreciable fraction of an investment which is estimated at somewhere between $20 and $40 billion in the next 20 or 30 years.

Now, this is the kind of applied research which can be done on a very small scale to demonstrate the possible feasibility of components and the underlying engineering and scientific pieces. Of course, to be successful it would take a tremendous amount of engineering which would become way beyond the scale of anything a university could do. But nevertheless, this kind of early exploratory work can often lead to tremendous savings in later capital investment and in later engineering development.

I can think of several cases with which I have been familiar where a graduate student worked out computer programs for doing an elaborate design calculation that saved factors of the order of a thousand in computer time. Industries had previously been expending that much more for this kind of design calculation. And when you consider the amounts that are now spent for computer time and for calculations in connection with many kinds of engineering design, the payoff for making relatively small improvements in design procedures and rationalizing design procedures through more efficient computer programs, through better analytical techniques and so on, is tremendous.

Senator KENNEDY of Massachusetts. Senator Pell?

Senator PELL. No questions. Thank you, Senator.

Senator KENNEDY of Massachusetts. I want to once again thank you both for being with us, for your comments and your statements. You have been extremely helpful.

We shall recess until tomorrow morning at 9:30 in room 4221, where we will continue the hearings.

(Whereupon, at 1:25 p.m., the subcommittee was recessed, to reconvene at 9:30 a.m., Thursday, November 16, 1967.)

NATIONAL SCIENCE FOUNDATION ACT AMENDMENTS OF 1968

THURSDAY, NOVEMBER 16, 1967

U.S. SENATE,
SPECIAL SUBCOMMITTEE ON SCIENCE
OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE,
Washington, D.C.

The special subcommittee met, pursuant to notice, at 9:45 a.m., in room 4221, New Senate Office Building, Senator Edward M. Kennedy, chairman of the special subcommittee, presiding.

Present: Senators Kennedy of Massachusetts, Pell, and Griffin.

Senator KENNEDY of Massachusetts. The subcommittee will come to order.

We continue today the hearings we began yesterday on the two bills to amend the National Science Foundation Act of 1950.

The testimony we heard yesterday pointed up the areas in which changes must be made if the National Science Foundation is to continue its position as a leader in science education and innovation in the United States. For example, our distinguished witnesses told us of the great need for applied research as one of the activities supported by the NSF. They also told us of the need to strengthen the authorization for the NSF to undertake research in the social sciences, and in the environmental sciences. We probed into the working relationships between the NSF, the National Science Board, the National Academy of Sciences, the Office of Science and Technology, and the science activities of various mission-oriented Federal departments and agencies. This testimony was helpful and constructive, and has done much to clarify the difficult differences berween the House-passed bill and the bill I introduced on October 30.

We will hear today from three witnesses who can shed further light on the differences. Congressman Emilio Daddario of Connecticut, the chairman of the House Subcommittee on Science, Research, and Development, deserves praise from all of us for his thorough and painstaking examination and evaluation of the National Science Foundation and its activities. The work of his subcommittee has helped open a continuing dialog among those most concerned about the future of American science. We will also hear from Senator Fred Harris of Oklahoma, the chairman of the Senate Subcommittee on Government Research. Senator Harris' concern for the geographical distribution of Federal research funds, and of the subjects supported by these funds, has produced a wealth of valuable material and has shaped many of the policies now in effect in the executive branch. We will also hear from Mr. Herman Pollack, the Director of International Scientific and Technological Affairs of the Department of State. I am

87-071 O—68——8

hopeful that Mr. Pollack will illuminate the policy problem relating to the pursuit of international science activities.

Let me, once again, express my belief in the importance both of the establishment of this subcommittee and the work confronting it. The advance of American science is important to the future of every American. Every dollar we invest today in raising the ability of our scientists, and their number, will pay handsome dividends tomorrow in a higher quality of life for all Americans.

Our first witness this morning will be Congressman Emilio Daddario from Connecticut. We want, as I mentioned, to extend a very special word of welcome to Congressman Daddario. I think all of us who are aware of his work and the work of his subcommittee know of his own very deep interest, commitment and understanding of the nature of this problem. We also know of the extremely useful contribution he has made in providing an understanding of the problems that face the National Science Foundation and its potentialities. So, we want to welcome Congressman Daddario, for we feel that he perhaps more than any other Member of the Congress, understands this problem and can make a very significant contribution to our understanding, to the members of the full committee and to the Members of the Senate. So, we welcome you, Congressman.

STATEMENT OF HON. EMILIO O. DADDARIO, U.S. REPRESENTATIVE FROM THE STATE OF CONNECTICUT, ACCOMPANIED BY PHILIP YEAGER, COUNSEL, HOUSE COMMITTEE ON SCIENCE AND ASTRONAUTICS, AND JOSEPH FELTON, COUNSEL, HOUSE COMMITTEE ON SCIENCE AND ASTRONAUTICS

Senator KENNEDY of Massachusetts. Would you please introduce your colleagues for the record.

Mr. DADDARIO. Mr. Philip Yeager, counsel of the staff of the Subcommittee on Science Research and Development, and Mr. Joseph Felton, also of the staff, are in the room with me, Mr. Chairman.

I first of all want to thank you for your kind and gracious words. Those of us who have been involved in this activity with the National Science Foundation, the subcommittee and the full Committee on Science and Astronautics, have looked at this bill as a very important piece of work, and one which does go to the heart of the development of knowledge in this country.

I have a statement, Mr. Chairman, which I would like to provide for the record, if I may.

Senator KENNEDY of Massachusetts. It will be included in its entirety.

Mr. DADDARIO. It reemphasizes some of the statements you have made. I was particularly pleased when you introduced your bill, S. 2598, and when it was assigned to the subcommittee which you chair. Your statement in the first instance about the importance of these hearings I thought hit to the heart of the problem as does the statement you made today, stressing the importance of the National Science Foundation, and the way it is constructed in the scheme of things.

First of all, I would like to point out that this restructuring of the Foundation is a congressional responsbility. We have taken it upon

ourselves; we have not waited until the executive has come up with recommendations about it.

NSF was created in 1950 and had not been reviewed in detail by Congress until we began our review in 1964. It was the purpose of our review to examine the charter of the Foundation in light of the experience gained to date in order to make it more responsive to the needs of our changing society, and to enhance its effectiveness in improving the quality of research and education in our universities.

We examined NSF carefully over a long period of time, and our recommendations are based on what we think is an objective analysis of its activities. It started with a great deal of background work by the Legislative Reference Service of the Library of Congress, which did a magnificent historical analysis of the Foundation as a preliminary to our examination. We had the added advantage of the National Academy of Science study done for our committee entitled: "Basic Research and National Goals." That study stressed the importance of the National Science Foundation as an agency of Government, its particular capability to develop knowledge, and the importance of giving it a more prominent place in the scheme of things.

This was followed by extensive hearings, and then by our own report entitled "The National Science Foundation: Its Present and Future." Later I introduced a bill which we modified from time to time as a result of continued discussions with the National Science Foundation, the Board, and members of the academic community, who, having some thoughts about the language of the bill as first introduced, had new recommendations to make.

One of the problems here is that the Congress is instigating and giving impetus to this restructuring. We, therefore, naturally run into some executive counteraction. The Bureau of the Budget, as we have had correspondence and testimony from them over a period of time, would like to have the National Science Foundation conform more readily to executive procedures established for other agencies. Yet, it is important to recognize that when the National Science Foundation was created in 1950, it was established for the purpose of building a bridge between the scientific and academic community and the Government. It had attached to it not as an appendix, but as an integral, functional policymaking part, the National Science Board. Because the Board is unique, because it is not Government controlled and because it was so strangely established, we have an unusual relationship—one which causes us some concern as to how we can improve NSF's operations in a way that will find unified backing here in the Congress and in the executive branch as well.

But as I say that, I think it is extremely important that we recognize that our hope and our ambition here is to make the Foundation and its relationship to the Board a more efficient one, to serve its original and historical purpose, and to make certain it retains this unique and attractive capability to enlist the aid of people in the scientific community upon whom we must depend to develop new knowledge. Because NSF is different, it will not necessarily always conform to executive procedures and in my opinion, should not. I think the National Science Board, as an example, can serve a tremendous purpose.

Having said that, Mr. Chairman, I would like, then, to let my statement stand for itself, together with the reports submitted by the

committee. Please note also that we do have the full support of the subcommittee and the Committee on Science and Astronautics.

I would now like to comment on the differences which exist between S. 2598 and H.R. 5404, and give you and your committee, Mr. Chairman, my analysis of them.

In section 3(a)(6) of the bills, you delete a requirement that the National Science Foundation keep track of money going to private contractors. We felt that this was an important requirement. In light of our experience with the space prgram, we saw develop in NASA a capability to keep track of Government funds going to the private contractors down to the second and third tiers, and we found it both useful and possible that these funds be followed. The purpose is to give all of us in the Congress an idea as to what is being spent, where it is being spent, and what the results are. We believe this is an important criteria in any legislation of this kind. I recognize that it is a difficult job, but I do not agree that it is an impossible job. In our report we stressed the importance of this. We indicated that it need not go down to the myriad areas of the subcontractor in the tens of thousands of cases, but that sufficient information would be provided if we were to do it at the first and second tier levels. We stressed, too, that this capability could be developed over a relatively long period of time.

One of the problems in coming to any conclusion about the development of knowledge and its application, and I think there is going to be more and more question about how knowledge is applied and whether it is being applied as expeditiously as possible, is the difficulty for us to come to conclusions unless we have substantial statistics. We stress again, that the space agency has shown that this is a manageable task. We urge that it be looked into, and that it not be sidetracked simply because it is difficult. We believe that it is a very important statistical addition to Government knowledge, which can be of extreme help to us all.

Senator KENNEDY of Massachusetts. Could I interrupt you, Congressman? Dr. Hornig yesterday testified on this very point, and I would like to try to elicit some precise response from you on it. He said that:

> I believe that a statutory requirement to this effect—
>
> This is the statistical reporting requirement—
>
> would impose an impossible task on NSF at this time because of the elaborate net of contractors, subcontracts, et cetera, from whom information would have to be gathered and then correlated at great expense.

You talk about the first two or three tiers. Do you feel that the information would be useful, and that as well it would not impose a very difficult task or a very great expense? Is that it?

Mr. DADDARIO. I think it would be a difficult task, but important enough so that it ought to be done. I do not believe that it would be necessarily expensive. Our feeling, as we analyzed it, was that if this information were available, we would be able to better manage the whole R. & D. program, and it would allow us to operate in a much more efficient manner. I do not think it is enough for an agency of Government which may be charged with bringing this information together, not to do a job because it is difficult. If we do not do it at a time when it is difficult, as time goes on it will, in fact, become impossible.

In section 3(d) we have no strong difference by the addition of the words, in your bill, Mr. Chairman, "and the Director."

This is language which we understand the Bureau of the Budget is concerned about. Our feeling is that the Bureau of the Budget's recommendations in all these regards have a tendency to water down the strength and effectiveness of the Board and to increase the policy functions of the Director. As I originally said, the Foundation is a unique establishment within Government because it has a Director and non-Government Board. The historical developments are extremely important and we probably should not go along with this change.

The Director is, in fact, a member of the Board. He always has been. He has been a voting member since 1962. As a member of the Board and as the Director with the authority he has as the head of the agency, he can and should work within that Board in pursuit of national policies for the promotion of basic research and education in the sciences. We believe that rather than strengthen the situation by putting in these words, it would tend to make him not a member of the Board in this particular instance. He would be wearing a different hat for a different function. This would tend to put the Board on one part of the scale and the Director on the other, and we believe that confusion could arise. We would like to avoid that.

Regarding section 4(a) of both bills, Mr. Chairman, the Senate version provides that the Board "shall establish policies to guide the Foundation." It is again a matter of semantics, I would expect, as to what "guide" means, and whether the language in the House bill, which says: "shall establish and be responsible for the policies of the Foundation," is better. I would submit that the word "guide," establish policies to "guide" the Foundation, can be construed as making the Board a mere advisory body. It now has the capability to establish the policies of the Foundation. It does not seem to me that the words, "shall establish and be responsible for," do anything more than to emphasize this responsibility of the Board.

I do think again that we should pay strict attention to the way in which the Board came into being, recognize its capability in this regard. I would urge that we ought not to have the Board "guiding" the Foundation, but we should have it establishing the policies. I believe they should be responsible, although I would expect that the inclusion of our specific language would not be particularly necessary. We might even come up with different language. But I——

Senator KENNEDY of Massachusetts. I think the objectives which you seek are identical to the ones that I seek. I think "and be responsible for" might be a bit severe. Perhaps in the drafting of that, you did not intend the connotation I ascribe to "be responsible for." I think we can, more than likely, work language out. I do agree with the objective you are trying to seek, though. I think it is a worthwhile goal.

Mr. DADDARIO. Yes. And I would add, Mr. Chairman, that our objectives being the same, we ought to be able to work out some language which we could agree on. I appreciate your comment in that regard.

Section 4(h) of the House bill has no comparable provision in the Senate bill. That is the provision that the Board may, at its option, have a staff which would be in a sense separate from the Foundation

administration. We discussed this over a long period of time. We discussed it privately with people involved. It had great support from Dr. Eric Walker, of Penn State, who was then the Chairman of the National Science Board. When we examined it, we did not favor it simply because he did. It seemed to us that the Board ought not to be put in a position where it had to scrabble around for staff from time to time on a somewhat haphazard basis. It ought to be permitted to have a staff working with it constantly so that it could maintain the force and effectiveness of its own identity. It was our opinion that the Board—or a sizable part of it—wanted this. It was further our opinion that they, in a sense, deferred to the Director, who, quite naturally, would prefer that the staff who worked for the Board would also work for him. I think this indicates the weakness in having staff cross back and forth. Under our bill they can be brought on board when and if they are needed. It need not be a large staff. In fact, we provide for no more than five professionals.

At any rate, we have in the bill, in yours and in ours, given the Board additional responsibilities. The annual report on the status of science, in my opinion, can become one of the most important governmental documents from the standpoint of where we are, why we are there, where we are going, and what we ought to be doing. I can see this develop over a course of time into one of the greatest aids to the Congress in the establishment of policies in regard to science. To do this as a regular function and in the way we expect it ought to be done, we believe a highly competent small professional staff might be a significant help. I know that there is contention about this. It was testified to yesterday. But, I believe it possible that one reason a part of the Board says it can pretty well do with the people the Foundation provides from time to time, is in the interests of harmony among themselves. Our responsibility goes beyond this. We must see to it that we make laws which will in fact allow them to do the job better. It is my strong opinion, Mr. Chairman, that we will not have the Board function as it should and come up with a report of such importance, as good as it ought to be, unless they have a staff available.

Senator KENNEDY of Massachusetts. From your own study of this, you feel that this can be done without creating the problems pictured by Dr. Hornig and Dr. Handler and Dr. Haworth, who feel that the creation of such a staff would generate and foster separate attitudes and a separatist approach on some questions, and make it more difficult to function efficiently. As I understand from what you are saying, you have given this particular problem a good deal of thought, and have come to the conclusion that additional staff would actually invigorate and perhaps by some diversity strengthen the whole function of the Board and the Foundation.

Mr. DADDARIO. As we talked, Mr. Chairman, to many people about this, we came to the conclusion that a staff might very well be necessary. Also, please note that we guard against the possibility of rival staffs by making the Director responsible for designating staff personnel. The argument that there will be rivalry, however, seems to me to be somewhat flat. The Foundation's directors have been and are talented, competent men. We also are dealing with people on the Board who donate a lot of their time to its activities, who are extremely dedicated to improving the science policies of the country, and who come to the Board because they have great capability in that

regard. Their intentions are to further the purposes of science. I believe they not only should have a staff if they want one—it is optional in the bill—it is my own opinion that privately they might like to have one. If not now, at some future date.

Mr. Chairman, regarding section 5(a), the Senate bill removes the clause providing that the Director "shall serve for a term of 6 years unless sooner removed by the President."

Now, this is another one of those differences of opinion which really are not that fundamental. We again lean toward the 6-year term. It was historically so designated to give the Foundation that peculiar place in Government which, in a sense, set it apart. You do not now have a change in the directorship simply because you have a change at the top of the executive branch after an election. Of course, that is important. But it did seem to me that if we were allowing for the appointment to the National Science Foundation of a person who would be acceptable to the scientific community that it would be helpful not necessarily to change him at the time the Presidency changes. On the other hand, I would expect that the practical result of it would be that the Director, if he had been chosen by a different President, would most likely do the courteous thing by submitting his resignation in the event the President wanted it. Of course, the provision provides in any event that the Director may be removed from office by the President. But the 6-year term does allow the position to have the ability at least to transcend a political change, and it implies that it is a nonpolitical appointment.

Again, I do not have too strong a personal position about it. My analysis of it is necessarily historical, and my reasons are those I have just given.

In section 5(e) of both bills, the Senate version removes the dollar limits and requires that the Director seek the Board's approval on grants and contracts only if "in his opinion" it involves a policy determination.

I believe the language of this section is extremely important. First of all, I believe that the Board ought to establish policy. I recognize again that the Bureau of the Budget would find it more manageable if it were to deal only with the Director. My opinion is that this may be laudatory from an executive procedural standpoint. But in this instance it would be a weakening, rather than a helpful influence. I think the language in the Senate bill which says that "the Director shall not make or revoke any contract, grant or other arrangement pursuant to section 11(c), without the prior approval of the Board if, in his opinion, such action involves policy determination", is in itself language which puts on the shoulders of the Director the determination of the policies of the Foundation. All he has to do is say that any particular program does not, in his opinion, involve a policy determination. That is all there would be to it.

Now, we did not come to our judgment about this through any haphazard thinking. We looked at the Board; we looked at the Director; we asked them how they operated; we saw that over a period of time the Board, in fact, began to establish an informal procedure through which it granted the Director the authority to do certain things on his own. Eventually they came up with a resolution which granted him the authority to do exactly what we have included in the House language. This conforms to a practical development of a

relationship with the Board—a relationship between the Board and the Director—allowing these amounts to be the governing figures in what he can approve without getting the Board's approval.

We think that the Board can and should have the time and the ability to approve programs over these amounts, to think them over carefully, to establish a policy about what ought to be done in this regard. Once approved, the Director has the responsibility to carry them out. This is how it has worked. This is the relationship they have developed. All we are doing is taking that practical experience and doing what we think to be a very logical thing; that is to invoke it into law.

Senator KENNEDY of Massachusetts. I do not know whether you have this information, and perhaps I should have obtained it yesterday, but do you have a breakdown of the number of contracts over the $2 million figure which are actually approved? I mean, how many transactions are we talking about by this restriction?

Mr. DADDARIO. I do not have the figures here and I agree with you that we should have them. When we last looked at it, the figure over $2 million was not high, Mr. Chairman.

Senator KENNEDY of Massachusetts. I was thinking of the number of awards that this provision would actually affect, whether it is rather a small group or a large group. I suppose our staff can find this out.

Mr. DADDARIO. I think we should check into it again. The only information I can give you at the moment is that it is not a large figure. It is exactly because it is not that these figures represent a practical application of the relationship between the board and the director.

Senator GRIFFIN. Could I just add that I think, as regards the $500,000 figure, the same information would be of interest; would it not?

Senator KENNEDY of Massachusetts. We ought to find out. We will instruct the staff to write to the NSF and to find out the number of transactions, both for the $500,000 figure and the $2 million figure as well. I think it would be helpful for our own deliberations.

(The information subsequently supplied follows:)

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., November 30, 1967.

Hon. EDWARD M. KENNEDY,
U.S. Senate, Washington, D.C.

DEAR SENATOR KENNEDY: During the hearing on November 16, 1967, before your Special Subcommittee on Science, in a discussion between you and Congressman Daddario, a question was raised on the number of actions which would be be required by the National Science Board if it were to approve grants or contracts exceeding $2,000,000 in total or $500,000 per year.

Had the language contained in S. 2598 concerning National Science Board approval of certain transactions been in effect during the two years from November 1965 to November 1967, without further delegation from the Board to the Director, a total of 103 grants or contracts would have been placed before the Board for action. Of these, 49 were in the "over $2,000,000" category.

Due to delegations from the National Science Board to the Director to approve transactions in fiscal year 1966 for the Antarctic Program, the Special Foreign Currency Program, the Science Information Exchange, and also for the Oceanographic Research Vessels Program for the period fiscal year 1966 through 1968 as well as the programwide approval of Graduate Traineeships, Board approval was actually required and obtained in 61 cases.

If you would like further information, I would be pleased to provide it.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

Mr. DADDARIO. Mr. Chairman, in section 6(b) we provide that the assistant directors are to be appointed by the President and confirmed by the Senate. This is another place where we really have no particular argument. As we were putting the legislation together it was our feeling that it would do two things if we were to do this. It would keep the National Science Foundation during what we believe to be a time within which there will be great developments in this agency, closer to the control of the Congress by having the Senate take a careful look at those people who are to be appointed. We think that it would attract people of the highest caliber, and we believe this to be important, too, during a period which we would expect to see considerable growth in the National Science Foundation.

Our idea here, and our hope, was that this would also increase the stature and the position of the director's office. Again, this is a simple matter of judgment, and I am sure we can come to an agreement. In the final analysis, we provide that there be assistant directors in any instance. We are both, I am sure, attempting to develop a way through which we can attract the people of the highest competence.

In section 10 of the Senate bill, you add a new subsection (j) which has no comparable provision in the House bill. We have no particular feeling about that section. It is our understanding that the fund transfers between agencies and the increased flexibility is already provided for through the Economy Act of 1932. This in a sense, reinforces that. We would have no reason to make any other comment about it.

Mr. Chairman, I would in closing, simply like to state again my great pleasure with the fact that you and your subcommittee have taken this interest, and it is my hope that the bill will become law. I think this is extremely necessary. It will be of great value to the country in the future and the sooner we do it, the better.

I would be happy, of course, to answer any questions which you may have and which I am capable of answering.

Senator KENNEDY of Massachusetts. Thank you very much, Congressman.

I think in your own discussion of the differences between the bills, you have raised some extremely useful and important points, which I had not seen as fully developed as related to us by your own comments and by the work of your committee. I think you have given us a great deal of food for thought.

I have reviewed the changes you suggested as we were going through the bill. I understand the points that you have raised on these matters. I would like to give them some additional thought. I think they will be extremely helpful to the members of the committee in marking up the legislation.

I see from your testimony, which will be included in its entirety in the record, a very comprehensive review of the functionings and the workings of your subcommittee. I also see a breakdown of the functions of the Foundation and the activities of the Board, and also the workings of the Director and the staff and of the executive committee. I think this information will be of great value and help to the members of this committee because I know it is the result of a great deal of work and understanding.

I have no further questions. I will ask Senator Griffin if he has any.

Senator GRIFFIN. I would like to join in welcoming my former colleague, Congressman Daddario.

Mr. DADDARIO. It is a pleasure to have the opportunity to see you, Senator Griffin. We do not have that chance too often.

Senator GRIFFIN. I am familiar with his interest in the subject and the leadership he has provided.

The staff furnished me just now with a copy of this report which was put out in 1966 by the House Committee on Science and Astronautics, which looks to me like a very important document insofar as the consideration of this legislation is concerned. I wonder about the supply of these. Are they in short supply or are they readily available? I am asking the question because, in view of the fact that our Senate committee is spending a relatively brief period of time trying to cover a subject that you have dealt with at great length, I want to be sure that this is available to the Members of the Senate as they approach this subject, and if it is not available in printed form in sufficient quantities, I wonder if we might consider the possibility of having it put in the record of these hearings?

Mr. DADDARIO. Mr. Senator, I will check to see. I believe they are in very short supply, and I think——

Senator GRIFFIN. That was the impression I got when I was talking to the staff.

Mr. DADDARIO. You raise a very important point in that regard. I think is worth commenting on. This document and other documents involving the development of the science-government relationship, such as the National Academy study on "Basic Research and National Goals," and their study of applied technology, have been exhausted or sold out at the Government Printing Office. Those copies which we have available are in considerable demand. We find there is high interest in the community about these. Many of our universities and colleges use these congressional studies as textbooks for new courses. I think what you are doing here adds to that particular interest. We will determine how many copies we have and let you know. Perhaps we could make arrangements, even on our side, to have an additional printing of this. We can work it out, I am sure, Mr. Chairman, through our staffs.

Senator GRIFFIN. Perhaps we could discuss it later.

Senator KENNEDY of Massachusetts. I am sure it is a worthwhile point. I am sure there is a great deal of information in there and we should have it included in our report unless we find it runs into——

Senator GRIFFIN. In talking with the staff member, I asked if this is something I can take with me. He said it is the only copy he has. So, even for my own purposes——

Senator KENNEDY of Massachusetts. In light of the scarcity of this worthwhile publication, I order it printed at the end of the hearing record.

(The publication referred to appears on p. 197.)

Mr. DADDARIO. Mr. Chairman, there is just one other point. In our report we comment on the activities of the National Science Foundation in support of scientific activity relating to international research and foreign cooperation. That, I believe, is worth reviewing. I will not go into it except to say that one of our concerns is that our science attaché programs have a better place in the scheme of things,

that our science attachés are better used. The recommendations that we make, we believe, would allow the National Science Foundation to develop a capability through which some of its people could, from time to time, be assigned to attaché positions with the State Department and be transferred back and forth, developing career opportunities which would not break down because of a too long continued involvement in an attaché capacity. We think it will bring better people, bring better order, and will allow to be fed into our foreign policy the greatest information in the field of science and technology. We believe this would be a very important additive to the formulation of such a policy.

Senator GRIFFIN.I have no further questions.

Senator KENNEDY of Massachusetts. One of the things you have placed into your National Science Foundation Act bill is an emphasis on applied research. Could you give us your reasons for that? I think you spelled it out in your report but I think it is of importance and I would appreciate it if you could respond for this hearing record.

Mr. DADDARIO. Mr. Chairman, a main reason for making recommendations in this area is that the National Science Foundation was established for the development of basic research. It is the only agency in Government with an almost exclusive fundamental research responsibility. But it does not have any legislative authority and, therefore, no ability to take knowledge as it is developed and carry it along in an applied way to the point where it can be expeditiously developed elsewhere—that is, reach a point where it could then be transferred to an operational agency. Moreover, it is often difficult to know where basic research ends and applied research begins—particularly in engineering. We want the Director to have the authority to handle such situations, which authority he does not presently have.

The example of what appears in a sense to be a negative move—where we recommend that the meteorological activity be taken out of the Foundation—is actually an indication of why we believe this ought to be done. The National Science Foundation, although having acquired some ability to apply this where areas of opportunity arise, should not get itself overburdened by the greater cost that comes in at the applied stage of the game; it might then be unable to accomplish its basic activities.

So, we want the Director to have at least the option. It is not mandatory. We want him to have the authority to conduct applied research but we want to see to it that he gets rid of the applied research activities as quickly as possible and not have it become so burdensome that it takes his eye away from the basic responsibility. I think it fits into a proper balance if we do it that way.

Senator KENNEDY of Massachusetts. In my final question, in reading through the debate in the House, I noticed a good deal of debate on the inclusion, within the ambit of the National Science Foundation, the social sciences. Could you review the concerns which were expressed in that debate, and your response?

Mr. DADDARIO. Well, we did have a debate on that, Mr. Chairman, on both occasions when the bill was brought up on the floor. I think Mr. Fulton of Pennsylvania, raised the point. I, frankly, never

understood the argument and I would hope that the fact the bill passed means that the House supported the inclusion of the word "social" in the definition of "sciences".

I think it is a sign of maturity. When the original act was passed as I am able to interpret it, the word "social" was kept out of the list simply because Congress felt it would raise too many points. Rather than argue about it, it was felt the Foundation could do some social science activity under the definition of "other sciences." Over a period of time this is what worked out. They did begin doing some social science work. Then recently Congress began asking: why do they not do more? It was in recognition of the problems of our society, of the fact that we need basic research in this particular area—not that they could not have done it anyway, but to emphasize they ought to—that the word was put in there. I do not believe that the House was particularly taken by the argument that just because we were including the word, that it would become an all-prevailing activity. I think it is important in this regard to recognize that one of the basic and fundamental conclusions we reached was that even though the National Science Foundation is the main place where basic research is to be supported, we did not conclude that it was the only place where it ought to be done. We felt that the mission-oriented agencies ought to do a great deal of basic research in order to maintain their own capability to perform their mission objectives—even though the research was basic rather than applied. I think this theory necessarily applies to the social sciences as well as to any other.

Senator GRIFFIN. If I could follow that up—and I realize that this information may be available and I have not seen it—if they have been doing social science research, to what extent have they been doing it, roughly speaking?

Mr. FELTON. We could supply those figures for the record, Senator. It has not received a great proportion of the NSF budget at this point. There are about half a dozen fields that the Foundation is supporting under the social sciences. This includes anthropology, history—this type of thing.

Mr. DADDARIO. We have that in one of our reports which I do not presently have available, but we will submit them so that they can be included in the record if the Chairman allows, Senator Griffin.

Senator KENNEDY of Massachusetts. We have them here.

Mr. DADDARIO. They are not large figures, but they show the involvement, and I think it will be an increasing involvement in this area of basic research. The Congress certainly is demanding that this be so.

Senator KENNEDY of Massachusetts. We will include at this point in the record the National Science Foundation obligations by discipline, fiscal year 1966.

(The document referred to follows:)

National Science Foundation obligations, by discipline, fiscal year 1966

[In thousands of dollars]

Discipline	Total	Scientific research	Science education	Institutional support of science	Science information activities	International science activities	Planning and policy studies	Program development and management
Mathematics	45, 520	12, 913	27, 809	4, 449	270	79	------	------
Physics	50, 120	26, 630	13, 650	9, 536	229	75	------	------
Chemistry	40, 962	18, 828	15, 658	5, 719	666	91	------	------
Biology	79, 040	45, 323	20, 417	12, 843	282	175	------	------
Social sciences	29, 732	12, 995	11, 048	3, 893	816	43	937	------
Engineering	47, 241	19, 203	20, 247	6, 276	1, 439	76	------	------
Astronomy	24, 032	20, 616	752	2, 638	15	11	------	------
Atmospheric sciences	26, 693	23, 620	768	2, 155	124	26	------	------
Earth sciences	36, 885	26, 939	7, 275	1, 417	1, 178	76	------	------
Oceanography	29, 883	29, 062	645	168	------	8	------	------
All other [1]	56, 320	-------	6, 036	29, 282	6, 601	240	1, 072	13, 089
Total	466, 428	236, 129	124, 305	78, 376	11, 620	900	2, 009	13, 089

[1] All other includes those obligations in support of programs which cut across disciplines and, therefore are not attributed to any single discipline.

Senator KENNEDY of Massachusetts. Thank you very much, Congressman. We appreciate a very illuminating hour with you. It is very, very helpful, and we once again thank you for your appearance here and for your responsiveness to the various questions.

Mr. DADDARIO. Senator Kennedy, I appreciate your asking me here, and it is always a pleasure to see both you and Senator Griffin. Thank you.

Senator KENNEDY of Massachusetts. I think the record ought to also show your niece was here, Lori Daddario, paying a great deal of attention to your excellent comments.

Mr. DADDARIO. I noticed she was sitting on the sidelines, Senator. It is nice to see her.

(The prepared statement of Mr. Daddario follows:)

PREPARED STATEMENT OF HON. EMILIO O. DADDARIO, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CONNECTICUT

Mr. Chairman, I am pleased to appear before you and the other members of the subcommittee today in support of the proposed charter revision of the National Science Foundation, which is in the form of amendments to the Act of 1950.

H.R. 5404, which has been referred to your subcommittee, represents an effort by a great number of people that began three years ago. We believe it will enable the Foundation to deal much more effectively with contemporary problems in science and technology.

Before going into what I consider are some of the major provisions of H.R. 5404, I would like to describe how our review of the National Science Foundation developed.

As you are aware, the National Science Foundation was created in 1950 in the wake of extensive congressional debate and some controversy over its mission and form. It was largely the result of public realization of the values of research and development in connection with World War II, plus the war's technological aftermath. Fundamentally the Foundation was charged with the duty of fostering basic research for the United States, together with promoting education and training of those needed to do the research.

For the most part, once organized and functioning, the Foundation carried out its programs in an atmosphere of relative quiet and moderate growth. Its contacts with Congress were, and until recently have remained, casual and generally confined to an annual inspection of the NSF budget.

A significant change began to take place in the post-Sputnik era. From a technological point of view, public opinion crystallized around the concept that basic science was no longer an ancillary, but a primary, instrument needed to guard the public safety, health and economy. From an organizational point of view, Congress responded to the new emphasis on science in a variety of ways—including the establishment of the House Committee on Science and Astronautics, which was given legislative jurisdiction over the Foundation as well as scientific research and development in general, space exploration, and other matters.

While the Science and Astronautics Committee does not have authorization authority in regard to the NSF budget, it has continually endeavored to educate itself to the workings and growth of the Foundation—both of which lately have accelerated rapidly in scale and, to some extent, in scope.

Late in 1964, pursuant to a directive from the full committee chairman, Representative George P. Miller, the Subcommittee on Science, Research and Development began a comprehensive review of the Foundation and its operations.

At that time the subcommittee arranged with the newly formed Science Policy Research Division of the Library of Congress for a complete background report on the Foundation. The report, entitled "The National Science Foundation: A General Review of Its First 15 Years," was completed and submitted to the subcommittee in May 1965. Shortly thereafter the subcommittee met in executive session over a period of time to familiarize itself with the contents of the study—which was a factual one and made no effort to evaluate NSF performance. The purpose was to assimilate a still more detailed working knowledge of the Foundation, its operations, and place in the scheme of the executive family.

In June 1965 the subcommittee began its public review of the Foundation in hearings which ran through the first week of August. In its hearings, the subcommittee sought to produce useful information about: (1) How well had the National Science Foundation performed the tasks which Congress set out for it in the act of 1950? (2) What roles, responsibilities, and missions should the NSF assume in the future? (3) What tools would the Foundation need in the years ahead to accomplish its work?

The main topics discussed in the testimony and fully examined by the subcommittee were—

The authority and mission of the Foundation.

National science policy.

The internal organization of the National Science Foundation and its related National Science Board.

The external relations of NSF with other agencies of the government, academic institutions, and professional associations.

Programs of basic research and applied research.

The support of science education.

The availability of manpower and money.

Science in relation to foreign policy.

The dissemination of scientific and technical information.

During the course of the hearing, 41 witnesses representing 14 agencies of government, 13 educational institutions, and 9 professional and nonprofit associations appeared before the subcommittee or submitted statements. To supplement the testimony, a total of 565 written questions in nine categories was prepared by the subcommittee and staff for subsequent submittal to the witnesses. More than 100 of these questions were addressed to the Director of the Foundation, Dr. Leland J. Haworth. The record of hearings and supporting material have been published in two indexed volumes entitled "Government and Science: A Review of the National Science Foundation."

In September and October 1965, the subcommittee resumed its executive sessions. The testimony and other data were reviewed and analyzed; findings and conclusions worked out, and preliminary instructions for the drafting of legislation to amend the Foundation's organic act were delineated.

In December 1965 the subcommittee issued a comprehensive report entitled "The National Science Foundation—Its Present and Future," which subsequently was adopted unanimously by the full committee. The report outlined the difficulties and problems which have been uncovered in the previous hearings, and set forth a number of recommendations for legislative and non-legislative change, together with a number of observations concerning matters which will require continuing oversight.

The report states quite candidly that it is, and is intended to be, a critical one.

I will not go into the specific legislative recommendations contained in the report since they, for the most part, have been incorporated into the bills before you today. However, I would like to explain what we mean by the use of the term "critical" in the report since I believe it was the central issue in our hearings and served as a basis of what we attempted to achieve in the legislation.

The report states:

"The subcommittee does not mean critical in the sense of pointing fingers at failure, mismanagement, or nonfeasance but critical in the sense of evaluating a major ongoing operation of government against the backdrop of the future and the needs of the nation.

"The subcommittee's inquiry has, inevitably, disclosed some shortcomings of the first type. On balance, however, their effect has been so far submerged by the main positive thrust of the Foundation's usefulness that concentration on them by the subcommittee could not be considered warranted at this point.

"Shortcomings of the second type are something else again. Still, these stem less from personal aptitudes, or lack thereof, than from the swift tempo of contemporary living and the unparalleled growth of science and technology. The moment and impact of each is having a highly significant effect upon the other, to the point of much mutual dependence. Put another way, the problems of current government, as well as everyday life, clearly depend upon science and technology for at least a part of their solution—an important part. Correspondingly, science and technology, which today more than ever cannot afford to become stagnant, must rely to a large extent upon government and the motives provided by the pressing difficulties of modern society to induce a satisfactory rate of evolution.

"It is within this context of scientific, political, and social interaction that the subcommittee evokes its cardinal criticism; namely, that the Foundation is operating, and is largely organized to operate, in a manner which was satisfactory a decade ago but which does not appear adequate for either today or tomorrow."

Using the committee's report as a basis, I introduced a bill, H.R. 13696, on March 16, 1966, proposing a number of changes in the organization and operation of the Foundation. Three days of hearings were held on the bill in April, and testimony was heard from representatives of the Foundation, the Office of Science and Technology, the Department of State, the Bureau of the Budget, and the National Academy of Sciences. At the conclusion of these hearings, the subcommittee met in executive session to consider the recommendations for changes in the bill which had been suggested by the witnesses. Certain changes were made in the bill, and on May 3 I introduced a clean bill, H.R. 14838 which later was approved unanimously by the subcommittee and full committee. The bill was passed by the House with minor amendments on July 18, 1966, but was not acted upon by the Senate prior to the close of the 89th Congress.

On February 15, 1967, I introduced H.R. 5404 which is basically the same as H.R. 14838. H.R. 5404 was approved by the full committee on February 21, 1967, and was passed by the House on April 12.

I would now like to discuss, if I may, what I believe are some of the major provisions of H.R. 5404.

FUNCTIONS OF THE FOUNDATION

The bill would authorize or direct a number of new NSF activities:

(1) Support for applied research is authorized, but is made permissive and is at the discretion of the Director. It must be borne in mind that NSF was established to further basic, or fundamental, research, and it was not our intent to change that element of the Foundation's character. Nonetheless, there are important occasions when Foundation backing for applied research appears warranted. These include, but are not limited to, research necessary for the solution of major national problems involving the public interest and the furthering of engineering research into early phases of application, after which other groups may take over the hard facets of applied research and development.

(2) NSF is presently required to collect and collate data on national scientific and technical resources. The bill would have the Foundation analyze and interpret the data as well. This is most important because it is an essential input to the decision making processes of Congress and of the scientific offices of the President, particularly as science and technology more and more become critical links in the chain of our national well being.

(3) In order to facilitate information on where Federal research money goes, NSF is given a new task of keeping tabs on the perergination of such funds.

This requirement is intended to make it possible for Congress or the executive branch to find out quickly how much Federal research money finds its way to what educational institution, nonprofit organization, or private contractor—and from what agencies.

(4) If the Secretary of State requests it, NSF is authorized to undertake the support of scientific activities relating to international cooperation and foreign policy. National objectives abroad may thus be supported by NSF, at the discretion of the Director but with the concurrence of the State Department and utilizing funds available to either. The new authority represents an extension of that already given to NSF with regard to international cooperation. It permits NSF support of scientific "activities," not merely research or education, and in support of objectives broader than the promotion of science or science education so long as they coincide with national policy. This authority thus joins that already provided in connection with the Defense Department and national security, but gives the NSF Director power to determine whether or not to comply with such requests from either department.

(5) The Foundation is enjoined in this bill to give support to the social as well as the physical sciences. The authority for such support already exists, but the bill spells it out more specifically by way of emphasis. The intent of the amendment is by no means to direct a disproportionate amount of total NSF support for the social sciences, but to insure that an adequate effort is made to permit advancement in these scientific areas which, while still relatively primitive, are extremely important to human welfare.

The bill would also remove one of the Foundation's functions.

This is section 14 of NSF's current act which was amended in 1958 to give the Foundation responsibility for research, basic and applied, on weather modification. The bill repeals section 14 in its entirety for a number of reasons. One is that the ramifications of weather modification are so broad as to encompass far more issues than scientific ones. Another is that research in this area has reached the point where it requires much developmental work as well as continued basic reaearch; NSF retains ample authority to continue support for the latter—and it clearly should. Still another is that in view of recent administration reorganization with regard to responsibility for the application of the environmental sciences, it would appear unrealistic and improper to permit the current legal requirement on NSF to stand. The Departments of Commerce and Interior are assuming much of the responsibility in this area, which the Foundation may continue to back up with apt support for some of the fundamental research still needed.

COMPOSITION AND ACTIVITIES OF THE BOARD

The National Science Board, which is the governing body of the Foundation' has no counterpart elsewhere in Government. It is a 24-member group that bears almost complete legal responsibility for exercising the authority vested in the Foundation in spite of the fact that it is a part-time non-Government-employed Board without direct responsibility to the administration. The reason for this arrangement, which was set up by Congress in 1950 after a long controversy, is to assure an adequate voice—through the Board—for the scientific community in matters involving Government support of basic science and science education.

The Board may, however, and in actual practice does, delegate much of its authority and function to NSF's chief executive officer, the Director.

H.R. 5404 would update and clarify a number of the Board's characteristics and duties.

(1) Qualifications for membership on the Board have been slightly revised and expanded so as to assure the representation of a broader range of interests and scientific disciplines. Particular attention is directed to the fact that the Board should include members representing the social sciences, engineering and industry—in addition to the basic, life and agricultural sciences. It may be noted that while there is no specific mention of industry representatives, such persons are eligible by permitting the appointment of those eminent in "public affairs".

(2) The Board is made primarily responsible for establishing and overseeing the policies of the Foundation and is relieved of operational duties. This is consistent with what has become a de facto method of operation through delegation of Board powers to the full-time Director—who, incidentally, is an ex officio member of the Board.

(3) In view of the fact that Reorganization Plan No. 2 of 1962 removed from the Foundation any previous authority to coordinate or evaluate the scientific research conducted or supported by other Federal agencies, the language of

existing law which pertains to NSF responsibilities toward national science policy has been left confused and relatively meaningless. Accordingly, the bill now provides that "the Board shall recommend and encourage the pursuit of national policies for the promotion of basic research and education in the sciences." By this language it is intended that the Board have a strong advisory voice in the determination of national science policies as promulgated by the administration.

(4) The Board has been given a major new responsibility—that of rendering an annual report to the Congress on the status and health of science and its various disciplines. Such a report will be of inestimable value to Congress in its deliberations on policy matters which depend or impinge upon science and technology.

(5) To assist the Board in its new tasks the bill provides for a small professional staff to be made available to the Board at its discretion. The staff is not intended to serve the Board as advisers in its policy determinations nor to lapse into a competitive position with the staff of the Foundation. The staff is limited to five professionals, plus clerical help, but the Director may provide such additional help as the Board may from time to time request in accordance with its needs. It is intended that such staffing be kept flexible. If the Board wishes to maintain a permanent staff, this is permissible. If it prefers a rotational arrangement, this may also be arranged. Within the limits of numbers and salaries set out, the mode of staff operation is at the discretion of the Board and the Director.

NSF DIRECTOR AND STAFF

The bill makes a number of important changes in the legislative philosophy governing the Office of the Director.

(1) All authority relating to the management and operations of the Foundation is vested in the Director. This proposal is intended to increase the administrative stature of the Director, to give him the authority and flexibility he needs for fast and efficient decisions, and to cut down on redtape.

(2) The Director is given specific statutory authority to delegate such of his duties and powers as he deems appropriate. Such authority has already been extended to the Director through Reorganization Plan No. 5 of 1965, and this legislation merely incorporates it. However, one new limitation is imposed. The Director may not redelegate any policymaking functions which may have been passed on to him by the Board. The reason for this is to insure that basic responsibility for policy is retained in the Board, on which the Director also serves as a voting member, and thus to guard against undue attenuation of policy responsibility.

(3) While the Director is given operational authority over the affairs of the Foundation as distinguished from the policymaking function of the Board, it is recognized that the formulation of the programs of the Foundation, and the relative magnitude of the resources to be assigned thereto, transcends the boundary between operations and policy, and involves an element of each. Consequently, the bill provides that the formulation of programs in conformance with the policies of the Foundation shall be carried out by the Director in consultation with the Board.

(4) The bill also places a limitation upon the Director with regard to making grants, contracts, etc., with other organizations or persons. If the grant or contract in question involves a new type of program or an annual commitment of over $500,000 or a total commitment over $2 million, prior approval of the Board must be obtained—subject, of course, to such waiver as the Board may promulgate.

(5) In keeping with the view that the Foundation deserves, and should be accorded, a top-level role in the Federal scientific structure, the bill elevates the Director from level III to level II of the Executive Schedule Pay Rates. The Director is thus placed on a par with the heads of most other independent agencies, a position he should clearly have, considering the Government-wide nature of the Foundation's mission and the many important relationships it must maintain both in and out of the Federal environment.

(6) For the same reasons as set out in the preceding paragraph the bill elevates the NSF Deputy Director from level V to level III. This again is consistent with the structure in other independent agencies.

(7) The bill further provides the Director with four Assistant Directors who are deemed essential if the Foundation is going to have the supply and caliber of help necessary to do its job in the future. The assistants are to become part of the Office of the Director and be assigned by him to their duties. They are appointed by the President and subject to Senate confirmation.

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ORGANIZATION AND STRUCTURE OF NSF

Rather than stipulate the Foundation's internal structure around particular branches of science as does present law, the bill leaves such organization to the Director. This is necessary in the modern fluid world of science and technology where an important prerogative of chief executives is flexibility of operation.

THE EXECUTIVE COMMITTEE

The law has always provided authority for the Board to operate, at its option, through a subgroup known as the Executive Committee. In 1962 the Executive Committee was set up on a permanent basis, composed of five voting members with the Director as Chairman. The Board could delegate such of its powers and functions to the committee as it saw fit—policymaking functions excepted.

This bill incorporates the provisions of the reorganization plan. It also removes the restriction against the delegation of policy functions to the Executive Committee if the Board wishes to delegate these.

Since the convening of the 24-member Board is at times difficult and time consuming, this added facility should aid and expedite NSF programs where quick decisions or approvals are needed. It is to be noted that the Board retains authority to withdraw any powers or functions it may assign either to the Executive Committee or to the Director.

In summary, Mr. Chairman, I believe H.R. 5404 and the bill you have introduced (S. 2598) represent an important and practical method of improving the organization and operation of the Foundation. I am confident that whatever differences that may exist between the two bills can be resolved, and that the enactment of this legislation will result in a significant improvement of our national capability for research and education in the sciences.

Senator KENNEDY of Massachusetts. We welcome Senator Harris to the committee. Senator Harris, I made a brief statement earlier this morning in which I reviewed your interest in this whole problem, and the works of the committee you have been chairing, the Senate Subcommittee on Government Research. We know that you have written about the case for the National Social Science Foundation. So, you come before this special subcommittee with a considerable background and interest and experience in this area, and I want to say how delighted we are to have you appear here and how much we appreciate your comments and the work that you have done in the past on this subject.

STATEMENT OF HON. FRED R. HARRIS, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator HARRIS. Thank you very much, Mr. Chairman and Senator Griffin. I am honored you invited me here to testify in regard to S. 2498. I commend you for holding these hearings to focus attention on the National Science Foundation and to help improve its operations.

I might say that I am honored also to follow as a witness this morning Representative Daddario, whose very real and lasting contributions in the whole field of science and technology are rightly deserving of great praise. As you know, Mr. Chairman, I share your great interest in the health, progress, and development of American science and your belief in the basic importance of science and technology to the future of this Nation. May I say, also, that, as chairman of the Senate Subcommittee on Government Research, which has held rather extensive hearings and seminars on the whole subject of Government science policy, the application, development, and use of biomedical knowledge, the health of the social sciences, and the distribution of Government research and development contracts

and grants, I was proud to join with you in our recently successful fight in the Senate to secure Senate approval for the full appropriation recommended by the President for the National Science Foundation.

The mission of the National Science Foundation is central to American educational, economic, and scientific progress. No past investment America has made in any field has brought returns which exceed those it has received from its investment in scientific research. American affluence and our standard of living are in large measure attestations of this fact.

History alone, then, should teach us the true and obvious lesson of the need for continued Federal support of scientific research. But the ever-widening frontiers of knowledge and technology are even more compelling reasons why our support for scientific research should be more than just maintained; it must expand with greatly expanded needs.

Therefore, S. 2598 is, I feel, a basically good bill, needed to smooth and improve the operations of the Federal agency which continues to play such a vital role in scientific research and education.

Now, on some particular provisions of the bill, I believe that section 3(c) of the bill will remove a vague, indistinct, and sometimes arbitary present line between basic and applied research and allow the Foundation to move into areas of application, engineering, and technology, which demand increased support and development, though, of course, the Foundation's primary task will continue to be in the field of "basic" research, and this policy determination by the Congress should be made clear in the committee report.

I support section 5(e) of the bill removing what I feel was an unwise restriction on the Director for prior approval of certain expenditures which was contained in H.R. 5404. I see no reason for a separate staff for the National Science Board. I support provisions for more adequate compensation for the Director and Deputy Director of the National Science Foundation.

Senator KENNEDY of Massachusetts. On this point about the separate staff, we had Congressman Daddario's testimony this morning in which he made quite an interesting and compelling case. I wonder if you share Dr. Hornig's reservation about the duplicity of two staffs moving in similar areas, and the concern that he has for it. I wonder if that is the reason for your reservation about the rather limited staff recommended in the House bill.

Senator HARRIS. Yes. My feeling is exactly that expressed by Dr. Hornig yesterday. Listening to Representative Daddario this morning, I realized that perhaps we are not so far apart if we are considering a rather small secretariat for the National Science Board, but even so, I prefer the Senate bill in that regard, because I think it is better to encourage the Board and the Director to work more closely and I think that can best be done by sharing the same staff.

I welcome the amendments to the NSF Act which would increase the authority of the National Science Board and which would clarify and fortify its role in national science policy affairs.

I strongly support, therefore, section 4(g), which directs the National Science Board to report each year on the status and health of science in America and elsewhere, national scientific resources, progress in selected areas of research, and opportunities for application to social needs. I believe that the enactment of this provision

could help the President and the Congress make more conscious and considered judgments in accordance with a rational national science policy.

I endorse, also, section 4(a), which authorizes the Board to "establish policies to guide the Foundation." This change from the House-passed bill is, I think, a wise one.

In other words, I prefer the Senate language to the House language. The differences have been cleared up somewhat by the dialog that we had here this morning between yourself, Mr. Chairman, and Representative Daddario. I think the intent of both of you and of both bills is really identical. Actually, I share the view expressed by previous witnesses that it would probably be better to take out the word "guide" from the Senate language and simply say that the Board shall establish policies for the Foundation.

The periodic meetings of the Board do not allow it to follow through on policy recommendations and to assure their implementation, and it should not do so because this would involve them with the details of administration and would conflict with the overall intent of the proposed legislation and the ability of the Board to fulfill its proper role, that of policymaker for the NSF and a source of scientific advice for the executive department of the Government.

Now, in regard to institutional support, the Subcommittee on Government Research has held very extensive hearings on the subject of the distribution of Federal research and development funds among the universities and colleges of America. I was particularly impressed, therefore, with the language dealing with institutional development in the report on H.R. 5404 from the Committee on Science and Astronautics. The Subcommittee on Government Research now has in preparation a detailed report on this very important subject, of such great interest to Members of Congress and to others throughout the country. I endorse the statement in the House report on page 19, wherein it is said that:

> It is the concensus of the Subcommittee, that in order to obtain optimum effectiveness for the NSF research dollar, a greater effort must be made to bring out the science potential . . . both teaching and research . . . in a larger number of institutions. This is not to suggest a down-grading of the project-grant systems, which has worked well and proved itself many times over. Nor is it to suggest that the actual number of dollars be reduced because of added emphasis on institutional or development grants. What is suggested is that as the Foundation's role expands, a greater proportion of its attention and support be given over to the needs of institutions as such . . . both large and small in accordance with their individual capabilities.

The report goes on to say, quite rightly:

> There is, of course, a danger of diluting scientific capability where it now resides, unless precautions are taken and careful criteria are worked out to determine the allocation of the research dollar among institutions which will use them well.

Aside from the other important effects on the Nation's future, it can hardly be questioned, as Dr. Donald Hornig, Director of the Office of Science and Technology in the White House, stated before the Subcommittee on Government Research, that the quality of education received by students is better in institutions where high-quality research is being done. I believe this committee should make it clear that the National Science Foundation must continue and expand its efforts to build scientific and research excellence in increased

numbers of institutions of higher education, in all areas of the United States.

We must pursue that goal without slowing down the progress being made at the presently more favored institutions. We must bring more coordination into the various types of institutional support funded by the Federal Government, and we must also get maximum results from local planning and effort. States and regions must be encouraged to inventory their scientific and research resources and capability, adopt plans for excellence in various fields, with a minimum of overlapping and duplication among institutions in close geographic proximity, and make local sacrificial effort toward fulfillment of the plans. Federal and local effort could then be much better dovetailed.

The National Science Foundation, acting alone, cannot, of course, bring about this desired result, but I believe this committee could give it a stronger mandate for helping to build additional centers of excellence, for better coordination with other Federal agencies supporting institutions of higher education in various ways and for the greater encouragement of State and regional planning and effort.

Senator KENNEDY of Massachusetts. Now, on this point, Senator Harris. As I understand what you are really driving at, you think there should be a conscientious effort by the National Science, Foundation when they allocate various research and development programs, to take advantage of potential for excellence in research. But what you are not advocating, is that the National Science Foundation be mandated to direct any particular research program to one particular place, if it cannot really be done. Is that an accurate reflection of your views?

Senator HARRIS. That is right.

Senator KENNEDY of Massachusetts. I suppose what you really have here is a balance. As I interpret your comment, if you continue to use favored institutions, you build up greater capacity, perhaps, in those favored institutions, and it will all be really a one-way street. The funds would go just into certain areas, unless an effort is made to try to develop some additional areas of research, and to recognize what the national demands are over a period of time. This should certainly be something that is recognized by the Foundation in the provision of research contracts.

But what concerns many of us, is whether the NSF should try to spread the awards evenly, trying to develop scientific research in areas where for one reason or another, there is not either the skilled manpower or the capacity or the propensity to be able to produce. I wonder if you could expand on your own thinking on this, because I know you have given it a good deal of thought.

Senator HARRIS. Right. I basically agree with what you have said. During the last year our subcommittee held very extensive hearings in this field which is, as you know, a matter of great concern to the Members of the Congress. We began by confronting, two rather polarized views held by various witnesses who appeared before us. One view was that somehow you could work out a mathematical formula, simply dividing the money like you divide a pie. Well, we thought from the first, and I think that has been confirmed by our hearings, that that simply is not possible for many different reasons.

The other view was that this is not a real problem at all, that things have been going along very well and that there need be no worry at

all about the distribution of Federal research and development grants and contracts. I think that view is wrong, and one of the principal reasons why it is wrong is the statement of Dr. Hornig, to which I alluded earlier, and that is that education in an institution of higher learning is better where high-quality research is being done, and, therefore, if high-quality research is not being done in the various areas of the country and in the various institutions, the students there are not receiving the quality education they would receive if it were being done. I think there are other aspects of the problem, as well. For example, the economic impact of Federal research expenditures. It is my view that you can draw three basic conclusions about the distribution of Federal research money. One, that we simply cannot dismantle or slow the progress of existing centers of excellence around the country; that from the national view, it is very important that we have excellent research capability, and that it does not really matter, again from the national view, where that capability is located. And so that capability must be maintained and nourished and whatever we do must not be detrimental to existing centers of excellence.

Secondly, I think it can be concluded that mission-oriented agencies have to go where they can expect-high quality results. The taxpayers have a right to demand that, and where we are looking for results, as the Federal Government is in most of its research and development expenditures, results associated with particular missions, contracts certainly cannot go to a place where you cannot expect the best quality work to be done.

Thirdly, I think we can conclude that excellence is primarily a local responsibility. In other words, MIT was an institution of excellence before it received Federal funds. It was not the other way around. But, I think you can also, very rapidly thereafter, conclude that an institution which does receive massive Federal funds will be in a much better competitive position next year with those which did not receive Federal funds than it was the previous year, and furthermore, that those Federal funds serve as a magnet to draw away from the less favored institutions much of their talent. I think a great many examples can be cited where a person who was able to get a personal research grant when he was at one institution, a favored institution of standing, is not able, or is less able to get it when he moves to a less favored institution, and a great many examples of this were cited to our committee.

So, it seems to me, that this is a very real problem, that cannot be solved by some rigid formula. I do not think you can solve it in this bill and I do not think, as I said earlier, that the National Science Foundation can do it alone, but I do think we need to coordinate all the various programs we already have in existence that make funds available to higher education for research. We do not do that now, and we do not have a very rational overall approach to the problem.

Furthermore it seems to me that a coordinated program ought to be set up in such a way as to provide incentives to the local institutions in a State or region to inventory what resources they have for doing research, what fields they are going to build excellence in, and encourage them to set forth step-by-step plans by which that may be done with increased local effort.

Then, I think it would be possible to dovetail Federal and State plans on a better basis than is now the case, and we could then move toward establishing additional centers of excellence. As I say, that cannot be done altogether in this bill, but I think some of those things might be encouraged either in the bill or in the report.

Senator KENNEDY of Massachusetts. One of the aspects of NSF expenditures is the development and improvement of institutional science programs. Looking through the last year's program, for example, you see a pretty good geographical balance as far as the funds being expended to improve the institutional capabilities.

Senator HARRIS. That is right, and that is why they are such an important factor.

Senator KENNEDY of Massachusetts. There are more obvious geographical differences for basic and fundamental research. It does appear that NSF is attempting, with regard to the institutional development funds they expend, which are 16 percent of their total program grants, to even things out. They do reasonably well, at least in a rather preliminary examination, in the funds they have provided to the various States. I think this reaches the points which you have talked to, and they are the importance of building, of establishing the institutions themselves. I think that this is of some encouragement.

I order printed at this point a tabulation of National Science Foundation activities for fiscal year 1966, by State.

(The information referred to follows:)

NATIONAL SCIENCE FOUNDATION—GRANTS, CONTRACTS, AND FELLOWSHIPS AWARDED BY STATE, FISCAL YEAR 1966

PROGRAM GRANTS AND CONTRACTS

State	Total program grants and contracts		Basic research support		Development and improvement of institutional science programs		National research programs, centers, and special research facilities		Science education programs		Science information service and science research planning		Fellowships	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount	Number	Amount	Number	Amount	Number	Amount
Alabama	64	$1,468,965	5	$80,500	6	$59,300			52	$1,328,465	1	$700	7	$42,634
Alaska	27	1,771,381	14	895,100	1	121,718	4	$643,600	5	108,606	3	2,357		
Arizona	105	15,065,812	45	1,650,200	3	4,219,477	7	7,944,970	46	1,236,820	4	14,345	24	87,618
Arkansas	39	786,415	8	188,100	2	37,850			29	560,465			7	31,598
California	939	52,539,889	494	25,653,935	41	7,226,698	61	9,216,262	263	9,486,114	80	956,880	836	4,914,104
Colorado	159	16,849,695	59	2,063,850	10	1,120,810	9	10,780,300	78	2,882,835	3	1,900	36	219,158
Connecticut	175	7,687,358	96	3,950,750	9	2,163,652	5	134,200	54	1,209,501	11	229,255	160	795,652
Delaware	23	712,355	11	345,800	1	52,741	1	119,000	10	194,814			3	10,832
District of Columbia	222	13,225,854	42	2,071,850	5	143,369	44	1,293,895	77	5,986,167	54	3,730,573	21	104,554
Florida	188	13,631,607	83	3,486,790	11	5,194,074	15	2,842,950	73	2,104,704	6	3,089	29	177,092
Georgia	111	3,888,028	32	757,000	8	846,551	3	104,200	64	2,126,236	5	54,041	28	128,648
Hawaii	62	2,761,032	29	1,466,900	2	183,295	10	603,900	16	478,476	5	29,461	5	28,465
Idaho	31	674,375	8	225,100	2	50,214			20	398,521	1	540	4	8,615
Illinois	486	21,792,695	237	10,870,400	23	2,982,717	13	1,372,600	165	6,055,832	48	511,146	300	1,349,259
Indiana	256	14,012,788	99	3,796,450	15	4,051,604	6	2,629,100	124	3,437,996	12	97,638	79	426,156
Iowa	124	4,093,792	43	1,529,950	7	206,072	2	625,000	71	1,732,140	1	630	59	287,362
Kansas	145	4,289,323	54	1,893,150	8	254,690	5	458,600	76	1,681,543	2	1,340	27	124,210
Kentucky	83	1,443,664	27	647,900	7	145,250	1	23,600	48	626,914			9	18,317
Louisiana	140	10,862,979	33	1,008,150	10	7,637,696	5	432,200	87	1,757,320	5	27,613	21	128,376
Maine	37	790,652	8	148,400	2	22,427			26	613,805	1	6,020	3	3,264
Maryland	147	5,322,234	64	2,841,600	4	267,007	8	750,623	49	892,279	22	570,725	54	229,346
Massachusetts	514	28,469,269	259	14,975,400	24	1,078,754	20	2,954,319	173	8,366,292	38	1,094,504	750	3,709,798
Michigan	341	13,237,280	140	5,423,750	15	1,895,420	7	827,200	158	4,812,498	21	278,412	185	804,217
Minnesota	177	5,801,365	65	2,215,500	11	232,247	7	357,055	88	2,985,851	6	10,712	67	226,650
Mississippi	50	1,117,134	5	108,800	3	54,711			42	853,623			8	24,639
Missouri	176	6,476,835	67	2,577,420	11	1,202,593	7	433,350	87	2,244,362	4	19,110	46	205,994
Montana	43	780,921	10	183,600	3	64,818	3	55,200	27	477,303			4	19,810
Nebraska	58	1,078,986	19	477,000	4	97,598	2	28,600	33	475,788			16	49,277
Nevada	26	718,773	10	404,600	2	75,879	2	39,200	12	199,094				
New Hampshire	64	2,253,359	23	841,350	5	314,242	3	302,800	30	792,812	3	2,155	16	49,116
New Jersey	175	13,983,338	72	6,111,612	8	4,782,178	9	948,249	79	2,074,483	7	66,816	196	978,573
New Mexico	88	2,947,890	30	831,030	6	167,256	10	442,400	40	1,505,734	2	1,470	14	66,503
New York	949	40,366,087	448	19,744,060	47	7,055,680	40	2,683,689	342	8,824,011	72	2,058,647	347	1,691,748
North Carolina	206	13,437,610	79	3,172,150	10	4,136,384	8	3,164,000	102	2,686,880	7	278,187	55	298,029
North Dakota	44	918,707	8	135,000	3	46,556	1	16,300	31	720,471	1	380	6	6,527

Ohio	355	10,356,899	115	4,160,400	20	606,530	19	1,355,650	182	3,609,434	19	624,885	83	333,707
Oklahoma	98	2,735,039	30	854,200	4	155,659	4	142,600	60	1,582,580	------	----------	32	231,391
Oregon	170	6,359,296	82	2,812,100	10	1,200,554	6	641,100	70	1,703,699	2	1,843	29	178,670
Pennsylvania	536	17,380,860	227	8,983,070	29	2,333,401	20	1,000,800	211	4,494,791	49	568,798	135	680,325
Rhode Island	94	4,944,293	47	1,784,500	3	1,145,997	4	848,500	27	891,977	13	273,319	19	93,414
South Carolina	51	1,188,660	15	316,800	3	69,907	1	14,800	31	786,883	1	270	9	21,464
South Dakota	50	1,352,543	4	120,200	4	84,004	4	229,700	37	918,016	1	623	3	3,264
Tennessee	150	3,821,836	42	1,616,400	8	225,414	5	234,600	94	1,745,032	1	390	27	186,081
Texas	320	27,110,340	99	3,381,100	18	1,627,460	19	18,252,895	168	3,574,287	16	274,598	91	413,467
Utah	87	2,739,815	35	1,137,700	3	144,716	7	370,800	37	1,073,044	5	13,555	18	69,897
Vermont	30	930,849	7	183,400	3	413,956	2	18,431	18	315,062	------	----------	3	3,263
Virginia	135	3,225,985	37	1,122,200	11	424,014	4	146,600	76	1,526,465	7	6,706	25	104,003
Washington	187	8,315,431	99	5,204,800	8	278,529	14	1,233,000	59	1,589,999	7	9,103	54	243,744
West Virginia	49	5,840,155	12	240,100	5	99,227	2	5,133,730	30	367,098	------	----------	4	16,024
Wisconsin	220	7,695,758	104	4,671,700	7	259,226	16	881,631	84	1,826,302	9	56,899	170	800,409
Wyoming	21	810,453	3	81,700	1	34,487	1	240,000	16	454,266	------	----------	6	18,201
Total	9,027	430,066,650	3,683	159,443,517	466	67,293,609	446	82,972,199	3,877	108,477,690	555	11,879,635	4,130	19,923,465

Senator HARRIS. Those funds are going to become increasingly important, too, because the Congress this year has drastically cut the amount of money that NASA, for example, had for institutional development. Initially, they had $46 million for that purpose. The last 2 years it was $30 million. This year it has been cut to $10 million in the recommended budget. So, the NSF funds are becoming increasingly important.

Now, with regard to the social sciences, I support section 3(a), which specifically includes the social sciences within the authority of the National Science Foundation. While this language will not expand the present authority of the National Science Foundation to support research in the social sciences, because they already have that authority and are exercising it, it is nevertheless worth while and will give added and greatly needed recognition to the social sciences. Despite the greatly increased complexity of modern social, economic, and political problems, research and education in the social sciences continues to be sadly underfunded.

In 1965, basic research of all types funded by the Federal Government amounted to $1.69 billion, of which the social sciences received only $37 million, or 2.2 percent. The estimated obligations for 1966 and 1967 were about the same, 2.5 and 2.8 percent. Nor is there much difference when Federal support for applied research is considered. For 1965, Federal social science expenditures for applied research amounted to only 2.8 percent of the $3.16 billion the Federal Government spent for all types of applied research, and for 1966 and 1967, estimated expenditures are only 3.9 and 4.8 percent.

Even more revealing is the decline in the social science share of Federal research funds over the last 30 years. In 1938 the social sciences received 24 percent of total Government expenditures for research. By the early 1950's, however, the percentage had diminished to about 8 percent, and for the last 10 years the share of the Federal research dollars—not including development—devoted to research in the social sciences and psychology has varied narrowly between 3½ and 5 percent.

It should be made clear, however, that the enactment of section 3(a) does not by any means obviate the tremendous need for speedy enactment of S. 836, a bill which I cosponsored with 20 other Senators, including, I am proud to say, yourself, Mr. Chairman, to create a separate National Foundation for the Social Sciences.

The Subcommittee on Government Research, where this bill is now pending, has completed hearings and is in the process of preparing its report. We have heard from more than 90 witnesses, primarily from the American social science community, and they have been overwhelmingly in support of the bill. Supporters of a separate National Foundation for the Social Sciences included such organizations as the American Bar Association, National Education Association, American Historical Association, and such distinguished American academicians as:

Dr. Kingsley Davis, chairman of the international population and urban research at the University of California;

Dr. Vincent Davis, the Graduate School of International Studies at the University of Denver;

Prof. Louis Pollack, dean of the Yale Law School;

Dr. Henry King Stanford, president of the University of Miami;

Dr. Geoffrey C. Hazard, Jr., executive director of the American Bar Foundation;

Wex S. Malone, president of the Association of American Law Schools, Louisiana State University Law School;

Dr. Rensis Likert, director, Institute for Social Research, the University of Michigan;

Dr. Fred Harvey Harrington, president of the University of Wisconsin;

Dr. F. Max Millikan, Center for International Studies, Massachusetts Institute of Technology;

Arthur Schlesinger, Daniel Patrick Moynihan, Margaret Mead, Robert Sears of humanities and sciences, Stanford University;

Dr. Harold D. Lasswell, Edward J. Phelps, professor of law and politics, Yale University Law School;

Dr. Gwendolen M. Carter, director, program of African studies, Northwestern University;

Dr. Myron Glazer, Department of Sociology and Anthropology, Smith College;

Myres McDougall, Sterling professor of law, Yale University Law School;

Dr. Warren Miller, Inter-University Consortium for Political Research, Ann Arbor, Mich.;

Dr. Samuel P. Hayes, president of the Foreign Policy Association, New York, N.Y.;

Paul L. Ward, executive secretary of the American Historical Association.

Social science needs a constituency, and it will get one only when people become aware of the contribution it can make to the solution of their problems. We cannot expect that awareness to come so long as the Federal support for the social sciences is confined to mission-oriented Federal agencies or the natural-science-oriented National Science Foundation.

I do not believe that the National Science Foundation, 90 percent of whose budget is spent in the natural and physical sciences, will ever be able to foster the kind of innovative—and, therefore, sometimes controversial—social science research which complex modern problems require, for fear of endangering the support for their less controversial natural and physical science efforts. Further, I believe that we need a quantum leap in the amount of support for social science research which will only come with the added visibility, status, and prestige of a separate social science foundation.

The National Science Foundation is greatly to be lauded for its increased funding of social science research, but I believe it will continue to be strongly oriented toward social sciences. Such disciplines as political science, law, and social or applied anthropology, for example, have little prospect, in my view, for increased funding so long as they remain under the umbrella of the natural and physical sciences. Nourishment and encouragement of such disciplines will come in a separate foundation in which the social science community will have primary responsibility for the full and complete development of all the social sciences.

I would like to furnish for the record, Mr. Chairman, a more complete statement on this matter which I wrote for the August 1967 issue of Science magazine.

(The article referred to follows:)

[From Science, Aug. 4, 1967]

The Case for a National Social Science Foundation

(By Fred R. Harris)

A folksinger I saw recently said, as a part of his onstage patter while tuning his guitar, "If I ever get this thing tuned again, I'm going to weld it." Many of us feel that way about modern domestic and world problems; we want to get things solved and settled once and for all.

But the central fact of our age is change, a fact not easy for us to accept or live with. And however much we may tend to perceive reality not as it is but as it once was, change nevertheless does come. It has occurred. It is occurring. It will occur.

Consider the twin facts of America's population growth and continued urbanization. Think of an America of today's population where 14.5 million young people live in such poverty that their diet is below the basic nutritional requirements; or where last year 52,500 people were killed on our crowded highways; or where the air we breathe in most of our major cities is a hazard to health; or where many or our rivers are unfit for fish, not to mention human beings; or where housing and educational needs are staggering. And then try to envision, for example, the problems of housing and education just 11 years from now, and just in the three super-cities—strips from San Francisco to Los Angeles, from Buffalo to Chicago, and from New York to Washington—which, experts say, will then have 125 million Americans, more than half the nation's population.

On a larger scale consider today's world of 3.3 billion people, a world where there is an everwidening gap between the rich one-third and the poor two-thirds, where already there is a hunger crisis. Then visualize the world as it may be just 33 years from now when, experts say, the 3.3 billion will have become 7.5 billion, through population growth mainly in the poorer nations.

Think of the problems that have been brought about in education, for example, by the explosion of knowledge and technologyr esulting from the fact that 90 percent of all the scientists who have ever lived are alive today, and that 85 percent of all the Ph.D. degrees ever granted in America have been granted since the end of World War II. These problems, too, will multiply and precipitate change.

In addition, there will be changes resulting from altered age distribution. Today in America more than half of all our people are under 25 years of age. These are the best educated, the most dedicated, the best prepared young people this country has ever produced. They will be examining us and what we do. They already are.

Consider even the concept of freedom in the light of present and future conditions. The president of Massachusetts Institute of Technology, Howard Wesley Johnson, recently said:

"We are beginning to discover that the right of free citizens to move freely without hindrance can be made meaningless by the breakdown of mass transportation, and the right of free assembly can be negated by impassable city traffic, or, for that matter, by uncontrolled crime in the city streets. We are beginning to suspect that free speech and free press might become irrelevant if we were slowly strangled by the air we breathe or slowly poisoned by our drinking water. We are beginning to see that equal rights and equal job opportunity, when finally obtained by citizens long denied them, can be made meaningless by intolerable housing conditions or by ineffective education systems. We are beginning to realize that if exploding populations create a world of starving humans almost standing on each other's shoulders, all concepts of freedom can become irrelevant, and American prosperity could be infuriating and incendiary to billions deprived of either hope or future."

George Bernard Shaw once said: "Some men see things as they are and ask, Why? I see things that have never been and ask, Why not?" The public official, the social scientist, and those concerned with mankind everywhere must ask, Why not? We cannot begin to answer that question until we have greater knowledge and understanding of man and his relationships with other men. Nor can we answer it until we have better cooperation between public officials and social scientists.

TESTIMONY BEFORE SENATE COMMITTEE ON GOVERNMENT RESEARCH

That is why the state of the social sciences has begun to concern a wide and varied spectrum of people, including public officials. That is why, without exception, those who have appeared before the Senate Subcommittee on Government

Research have spoken of the need for greater federal support for research and scholarship in the social sciences, whatever they feel about the form that increased support should take. Federal officials so testifying have included representatives of the Department of Labor; the Office of Economic Opportunity; the State Department; the U.S. Information Agency; the Department of Health, Education, and Welfare; the Peace Corps; Defense Department; and the National Science Foundation.

Robert A. Levine, representing the Office of Economic Opportunity, said:

"The thing which strikes me most sharply is the lack of availability of first class social science research manpower. The Great Society is not going to rise spontaneously from a legislative fiat. An adequate supply of intellectual manpower to clearly define problems and develop effective methods for accomplishing the tremendous social tasks is a key component in the realization of these goals."

Jack Hood Vaughn, director of the Peace Corps, joined with those advocating greater support for the social sciences when he testified:

"We know far too little about the countries in which we work, and far too little about the whole process of human resource development which is our work."

Paul Miller, Assistant Secretary for Education in the Department of Health, Education, and Welfare, summed it up for all those of similar view:

"I do feel, and, again, the intent of our testimony is that we need in the government much larger support for the social sciences."

But, strangely enough, there seems to have been in our government an inverse correlation between the size of the object to be studied and the amount of money we are willing to make available for such study. We have spent many billions of dollars, for example, for research on the atom, while expenditure for the study of man and society remains at a very low level. We spend $16 billion annually for science and technology and, roughly, only $250 million per year for social science. The National Science Foundation, for instance, out of a total budget of $480 million, this year will spend approximately one-twelfth, or $40 million, for support for the social sciences. I have become increasingly convinced that such frugality is much too expensive in the long run.

Miller, again, spoke of the problems caused by the imbalance in expenditures between the natural and the social sciences when he testified before our Subcommittee.

"The overwhelming success of our natural science activity has been a double-edged sword: While it cannot be denied that modern scientific developments have led to technological innovations which enhance all our lives, it must also be acknowledged that this same technology has, at times, vastly outstripped our ability to control it. Smog, water pollution, congestion and human dislocation suffice to list but a few examples. The point I wish to emphasize is that the continued disparity between support for the natural and the social sciences runs the risk of creating a cultural imbalance wherein technological innovation far surpasses our ability to assimilate it.

"If we direct our attention to the demands of today's world and the needs of tomorrow's, a great majority of our problems are clearly of the sort to which the social sciences have and should increasingly turn their attention. It makes no difference whether we look at our own country specifically or if we look at the world generally. Men face problems of building and renewing the economies of nations. Men are trying to create new kinds of political institutions which are more responsive to people. Men face the real problem of living with—in fact, preserving—diversity in a world brought closer and closer by new marvels of transportation and communication. For all these and other problems, we can no longer afford to relegate the social sciences to a second-rate, stepchild position."

A NATIONAL FOUNDATION FOR THE SOCIAL SCIENCES

With these problems in mind, and joined by 20 other Senators, I have introduced in the Senate of the United States a bill (S-836) to create a National Foundation for the Social Sciences. The Foundation, with a beginning annual authorization of $20 million, would encourage and support research and scholarship in the behavioral and social sciences and give much-needed visibility and added funds for these vital disciplines; it would be free from the daily operating concerns of the mission-oriented departments and agencies of the federal government.

The Foundation would do no in-house research but would, in keeping with the precedent set by the National Science Foundation and the National Foundation for the Arts and Humanities, on a completely unclassified basis, underwrite, fund,

and support academic research and increased research capability and manpower in the fields of political science, economics, psychology, sociology, anthropology, history, law, social statistics, demography, geography, linguistics, international relations, communications, and other social sciences. It would seek to "civilianize" U.S. social science research in foreign countries and would provide a much-needed alternative to the support now available for such research from the Department of Defense and the intelligence agencies; attitudes toward the latter in some foreign countries have caused serious difficulty for the United States and for our social scientists generally.

Passage of the bill will *not* diminish available research funds from any agency or department now supporting social science research but will supplement such support. The present social science research will continue to be needed, and such research will continue to increase, according to testimony before our Subcommittee by representatives of federal operating agencies. This is borne out, also, by experience in regard to the recently created National Foundation for the Arts and Humanities. Despite the fact that archeology and linguistics are disciplines within the jursidiction of the Arts and Humanities Foundation, expenditures in these fields by the National Science Foundation are continuing to rise and will continue to do so, according to the testimony of Leland Haworth, director of NSF.

The bill will *not* interfere with the growing and highly desirable interdisciplinary effort between the natural and social sciences but, rather, will encourage it. The principal deterrent to such interdisciplinary work in the past has, in my judgment, been the lower status and prestige of the social sciences and the lack of recognition accorded them. This is reflected not only in the attitudes of many natural scientists but also in the attitudes of much of the general public. As Secretary of Labor Willard Wirtz told our Subcommittee:

"I believe that the limiting factor is a very real doubt in democracy's mind as to whether it really wants any more expert advice as far as the social sciences are concerned, for this is peculiarly an area in which every single one of us thinks that he is an expert and that if he is not enough of an expert, he would rather play it by hunch than to try to find out what somebody else's expertness might imply.

"I do not believe it is much exaggeration to say that the present attitude toward the social sciences is just about the same as the prevailing attitude toward the physical sciences at that point in time in which people looked and saw that the sun comes up in the morning and goes down at night and said let us not bother any more about it."

The establishment of a National Social Science Foundation *will* give the recognition, status, visibility, and prestige the social sciences need. Some social scientists fear this visibility, but I do not agree with those who do. If visibility for the social sciences is to be viewed with apprehension, then I would suggest that university courses in those subjects be conducted in secret. Social science does not need the cover of the natural-science umbrella; it can and it must stand or fall on its merit. "Perhaps the time has come," Thomas L. Hughes of the State Department told our Subcommittee, "for the social sciences to be willing and confident enough to run the risks of being appraised in terms of their own contribution to knowledge and society."

Social science needs a constituency, and it will get one only when people become aware of the contribution it can make to the solution of their problems. We cannot expect that awareness to come so long as federal support for the social sciences is confined to mission-oriented federal agencies or the natural-sciences-oriented National Science Foundation.

INNOVATIVE THINKING

The establishment of a National Social Science Foundation will permit the kind of innovative thinking which modern problems demand. Innovative and original thinking, when it deals with people rather than things—people who are also constituents and voters—is likely to be controversial. Some argue that increased federal support for research and scholarship in the social sciences should come through expansion of the present effort of the National Science Foundation in these fields, rather than through establishment of a National Social Science Foundation—and this is the official view of the present Administration. I do not agree, for a number of reasons, most of which I have already stated. Almost reason enough, however, is the fact that the National Science Foundation can obviously ill afford to foster the innovative and original—and therefore controversial—thinking about modern problems which is needed, if that kind of social science research may put in jeopardy the nine-tenths of its

budget which is spent in the relatively noncontroversial natural and physical sciences.

Mission-oriented federal agencies are even more restricted to noncontroversial social science research. Thomas L. Hughes, again, put it very well when he testified before our Subcommittee:

"As the social sciences develop, it is particularly important that government support not force them into an inflexibile system inhibiting a variety of public and private initiatives. This can be avoided by deliberately fostering innovation, a function with high risk but one which a foundation can better run than can an operating agency which must always keep its program supportive of its mission."

Secretary of Labor Wirtz made the same point about social science research funded by the Department of Labor:

"Our capabilities are such that we have to limit ourselves to those things that we are surest about, as far as their relevance and as far as their results are concerned. There is not risk research in what we are doing."

Secretary Wirtz went on to say, quite rightly in my view, that whether or not establishment of a new agency, such as a National Social Science Foundation, is warranted depends upon whether the govenment is willing to sponsor research in the social sciences on broader, more innovative lines. He added:

"If it is, such inquiry cannot be expected to come from the established departments or agencies of the government. If more conventional research is contemplated, the present structure probably permits it.

"The more we look into our human and social problems, the more we recognize need for innovative, disciplined scholars who can act as engineers in the social change our society needs.

"If we are ready to look at those things, then it seems to me we have to find a new approach to social science research, and if we are not, my testimony to you would be that the present situation is not so very bad."

I think our government must be willing to foster such new thinking and research if we are to meet the new problems of our changing times. I believe this can best be done by giving the social sciences separate recognition and responsibility through the establishment of a new federal agency, the National Social Science Foundation.

I hope that we will be successful in this effort to increase our knowledge of man so as to better serve the cause of mankind.

Note added in proof. Since this article was prepared, more than 50 additional witnesses primarily social scientists, have testified on this subject before the Subcommittee on Government Research; the overwhelming majority of them favor the creation of a separate National Foundation for the Social Sciences.

Senator HARRIS. I believe that Secretary of Labor, Willard Wirtz was right when he testified before the Subcommittee on Government Research, saying that, whether or not the establishment of a separate National Social Science Foundation is warranted, depends upon whether the Government is willing to sponsor research in the social sciences on broader, more innovative lines. He added:

> If it is, such inquiry cannot be expected to come from the established departments or agencies of the Government. If more conventional research is contemplated, the present structure probably permits it.
>
> The more we look into our human and social problems, the more we recognize need for innovative, disciplined scholars who can act as engineers in the social change our society needs.
>
> If we are ready to look at those things, then it seems to me we have to find a new approach to social science research, and if we are not, my testimony to you would be that the present situation is not so very bad.

I think our Government, Mr. Chairman, must be willing to foster such new thinking and research if we are to meet the new problems of changing times. I believe this can best be done by giving the social sciences separate recognition and responsibility through the establishment of a new Federal agency, the National Social Science Foundation.

Again, Mr. Chairman, and Senator Griffin, I applaud your continuing interest in scientific and research matters and your holding these hearings. I am glad to have had an opportunity to testify before you.

Senator KENNEDY of Massachusetts. Thank you very much, Senator Harris for a very comprehensive and illuminating statement.

I know that you have been very interested in the development of the National Social Science Foundation. I wonder if you will elaborate a little bit the reasons for this, for the benefit of this hearing record. I know the case is constantly made that we have no mission-oriented group working in the fields of chemistry, in the fields of biology, in the what are considered the hard science fields. And yet, we do have various agencies doing extensive research in health, education, and urban problems. We have the various task forces which were developed in the early 1960's and continue to the present time. We have the National Academy of Sciences, which is available to the various agencies to provide detailed studies on many of the points that might very well be included under a Social Science Foundation.

Could you elaborate, for the benefit of this committee, what you feel would be the advantage of having the Social Science Foundation? And why you do not believe that there would be an overlap or duplication among the various research efforts being made, and which are undertaken by responsible agencies?

Senator HARRIS. First, let me say I think there is no danger whatever of overlapping or duplication, and thereby spending unwisely money on social science research, because I think the massive social, economic, and political problems we face are so great that it almost escapes our comprehension. And that is brought about by a lot of things: The tremendous population explosion—there are a great many more of us; the changing pattern of age distribution; the great mobility of our population—people have moved into the cities and are continuing to do so at the rate of 500,000 to 600,000 a year; the great explosion of knowledge in science and technology—85 percent of all the Ph. D. degrees ever granted in America have been granted since the end of World War II; and then the kind of problems that accompany these facts, air and water pollution, education, housing, transportation, how to live in cities, what to do about the rural to urban migration, if we can do anything at all. All these things, I think, almost stagger the imagination and what so many mission-oriented agency officials said before our committee, is quite true: how little we know about them. For example, Robert A. Levine, representing the Office of Economic Opportunity, which has stimulated innovation and imagination in the social field, said:

> The thing which strikes me most sharply is the lack of availability of first class social science research manpower. The Great Society is not going to rise spontaneously from a legislative fiat. An adequate supply of intellectual manpower to clearly define problems and develop effective methods for accomplishing the tremendous social tasks is a key component in the realization of these goals.

And Paul Miller, Assistant Secretary for Education, at the Department of Health, Education, and Welfare, said:

> I do feel, and again the intent of our testimony is, that we need in the Government much larger support for the social sciences.

Secretary Willard Wirtz said:

> I believe that the limiting factor is a very real doubt in democracy's mind as to whether it really wants any more expert advice as far as the social sciences are concerned, for this is peculiarly an area in which every single one of us thinks that he is an expert and that if he is not enough of an expert he would try to play it by hunch, rather than try to find out what somebody else's expertness might imply.

I think that is what we have been doing for many years. He said:

I do not believe it is much exaggeration to say that the present attitude towards the social sciences is just about the same as the prevailing attitude towards the physical sciences at that point in time in which people looked and saw that the sun comes up in the morning and goes down at night and said, let us not bother any more about it.

I think the problems are so complex and there are so many of them that we are not going to waste money by adding, and I do not mean that an NSSF should be an exclusive source of social science research funding but an added, pluralistic, additional source of social science research funding. It is not designed to supplant any effort now going on, but to add a new agency whose specific mission it would be to support all types of social science research.

Furthermore, I think it is almost impossible to overlap or duplicate in this field, because I think we need various kinds of views even on the very same narrow kinds of research questions. But, as to the mission-oriented agencies, I will just cite two statements made before our subcommittee. Thomas L. Hughes, Director, Bureau of Intelligence and Research, in the Department of State, said:

As the social sciences develop, it is particularly important that Government support not force them into an inflexible system inhibiting a variety of public and private initiatives. This can be avoided by deliberately fostering innovation, a function with high risk but one which a foundation can better run than can an operating agency which must always keep its program supportive of mission.

And then just this last one. Secretary Wirtz said:

Our capabilities are such that we have to limit ourselves—

He is referring to the Department of Labor—

to those things that we are surest about, as far as their relevance and as far as their results are concerned. There is not risk research in what we are doing.

I think it is risk research, innovative research, basic research, that we particularly need in the field of social science.

Senator KENNEDY of Massachusetts. Then, why not give the various agencies some of that risk research? Why not permit them to develop various pilot projects, and other programs to meet what might be imaginative solutions? Why not use that approach?

Senator HARRIS. I am for that and we already do that to a small extent. We ought to do much more of that. But, I think even so, Mr. Chairman, it is hard for us to realize what a stepchild the social sciences have been and how inhibited has been their development. I think one reason why that has been true is that there has not been any single agency which the social science community could look to for help to build the social sciences and give them the prestige that the natural and physical sciences have. I think you will not be able to accomplish that in ordinary operating agencies to the extent we must, although I support every social science research and development dollar that we can afford to spend, whether it is in a mission-oriented agency or whatever, because the problems are so great.

But I think, for example, due to the disciplinary walls that exist in institutions of higher education, and that has not been changed, we do not have the kind of interdisciplinary effort within the social sciences that we might have and that we should have. I think that

is another aspect of what can be done with a separate National Social Science Foundation.

Senator KENNEDY of Massachusetts. Risk research obviously has some wide potential. My real concern—and I would be interested in how you view this—is whether this is going to be research in a vacuum, or whether you see this kind of research, particularly in the social sciences, being readily applied to either existing programs or flexible enough so that there can be some real development of various pilot programs and projects.

Senator HARRIS. I should certainly hope so. For example, we do not really know what it is that causes one person to be motivated and to take advantage of his opportunities and another person not to be.

Jack Vaughn testified before our subcommittee that the fact that we do not really know much about community development or human resource development is pointed up by the spectacular case of the American Indian on whom we have spent $4.8 billion over the last years and who is now served by his own Federal Bureau and his own health service and his own set of employees totaling around 22,000 and yet is the minority with the highest rate of unemployment, the highest rate of underemployment, the lowest family income, the highest dropout rate, and the worst health statistics in this country.

I think one of the problems of the Office of Economic Opportunity is that in order to sustain its program it needs one of two things. It can stand a shortage in one or the other. One, they need very dedicated, highly motivated people to work in their programs, and two, they need well-articulated guidelines and methodologies.

Well, there just are not enough dedicated and well-motivated people to go around, and secondly, it is very difficult to set out exactly what it is you are trying to do when you begin to work in community development.

The same is true in AID. I could mention others, because we compiled a tremendous inventory of research needs made by social science organizations which are now starved for funds. For example, let us consider the problem of the Social Science Research Council. Dr. Austin Ranney, who is chairman of the Committee on Governmental Affairs of SSRC which received a Ford Foundation grant, had last year applications for research which were meritorious and which should have been funded totaling over $500,000, but they were only able to fund $60,000 of them or a ratio of about 1 in 10.

Senator KENNEDY of Massachusetts. What is the scope of the development of your Foundation? Have you thought through as to how much would be necessary to fund it?

Senator HARRIS. We chose as a beginning figure, which is far too low, $20 million and that is a rather arbitrary figure, because you could just start almost anywhere. The Foundation itself would be set up along the same lines as the National Science Foundation, with a Board of Director appointed from various social science disciplines by the President, with a Director, similar to the National Science Foundation, and they would have jurisdiction not only in research but also education, training, institutional development, et cetera.

Senator KENNEDY of Massachusetts. Now, we have an expenditure for the social sciences under NSF. Would you exclude the NSF from also experimenting in the social sciences?

Senator HARRIS. Not at all, Mr. Chairman. I think it is absolutely essential that we all understand that what we are talking about in the National Social Science Foundation is an added source of funding. As I said, I think if you look at the Board of the National Science Foundation and its general orientation, though it has moved, and I say quite laudably, into the social science field, it has always emphasized those social sciences which were more akin to the natural and physical sciences and I think they have tended to look down their noses at the social sciences as not really being sciences at all. I think there is a great deal of development yet needed in the social sciences but they will never be mathematically exact sciences as some of the natural and physical sciences are.

Now, I think the NSF should continue what they are doing. I think they will be able to continue to fund and increase their support for interdisciplinary social service research and, that kind of research where there is a fuzzy line between the natural and physical sciences on the one hand, and the social sciences on the other. I think one of the greatest deterrents to that kind of interdisciplinary effort is the much lower status of social sciences. I think if they had greater visibility and prestige that kind of interdisciplinary effort would be enhanced and encouraged and that I think will come about through the creation of a National Social Science Foundation.

Senator KENNEDY of Massachusetts. Why not then, just upgrade the social sciences within the NSF? Why is not there some value to a cross-fertilization of ideas on many of the great problems that our country faces, by having an interdisciplinarian approach toward these questions? Why is not that more advantageous than just providing the hard sciences on one side and the social sciences on the other, with the attendant problems suggested by moving in apparently relatively separate directions?

Senator HARRIS. Mr. Chairman, I have touched upon that several times, but let me just say again, I do not think that there is any possible way that, No. 1, you can achieve the quantum leap in support for the social sciences that we need by continuing it entirely under the umbrella of either mission-oriented agencies or the National Science Foundation, which is, and properly so, just as a matter of fact oriented toward the natural and physical sciences. I think the social sciences ought to have primary responsibility for the development of the social sciences. I do not think they ought to be treated as a small minority within the National Science Foundation and hope that that organization thereby would be able somehow to develop the social sciences in the way that they need to be developed. I think social scientists ought to have primary control of the development and the future of the social sciences, and I think that we are never going to get the long-term support for research grants that is needed for social science research or for interdisciplinary social science research from the National Science Foundation.

Now, there are some who think you could do it in NSF and, as I say, I laud what has been done in the past and which I believe they are going to continue to do. They are going to continue to increase social science support according to Dr. Haworth, despite the overlap in jurisdiction with the National Foundation for the Arts and Humanities. The establishment of that Foundation has not led to a cutback of the amount of money or effort by NSF in the disciplines which come under

the jurisdiction of both Foundations. It has, in fact, increased it. I think the same would hold true for the social sciences with an NSSF. I think if you were to ask yourself how soon we would have a social scientist as Director of the National Science Foundation, that you would have one answer as to why we need a separate Nationa Social Science Foundation.

Senator KENNEDY of Massachusetts. Senator Griffin?

Senator GRIFFIN. Senator Harris, I join in welcoming you before our committee. I would not presume to challenge your statement or testimony concerning the amount that we are spending on research in the social sciences, but I would like to call your attention to something that appeared in the New York Times on October 13. Kermit Gordon, president of the Brookings Institution, formerly Director of the Bureau of the Budget, said that the amount of Federal assistance for social science studies has risen even fivefold in the last decade and was closer to 6 percent of the $5.3 billion of the Government research budget last year. Six percent of that would be $318 million.

Then, he goes on to say he does not say that is enough.

I do not know where he gets his figures and where you get yours, but there seems to be a considerable discrepancy.

Senator HARRIS. I would have to know what kind of things he is including in that, but the figures we have given you are very firm figures which have been testified to authoritatively in our hearings. In order to resolve these differences we would have to know what he includes in his definitions, et cetera, but I really think that whatever he says in regard to the figures for social science he would have to agree with every witness who appeared before our subcommittee, governmental as well as academic, and the other witnesses. In addition, we derived these figures from both Dr. Haworth's own testimony and an NSF-produced document entitled "Federal Funds for Research Development, and Other Scientific Activities" (NSF 66–25, vol. XV). In addition, every witness said that we have just got to greatly increase the amount of money for social science research and education; I could not agree more strongly. The Manhattan project which developed the atom bomb was perhaps the greatest single factor in getting the Government in the business of funding the natural and physical sciences and following that we have continued to support atomic energy programs and defense programs. Then after sputnik we began our space program. The money, prestige, the drama, that accrued as a result of the programs has spurred the development of the natural and physical sciences and has encouraged the influx of students to these fields.

With the separate Social Science Foundation, in one fell swoop we will have helped to upgrade the status, visibility, and recognition for the social sciences and with increased funding, I think we can emphasize the drama and excitement of the social sciences, which, I believe, will have a tremendous effect not only on developing these fields but on attracting the brightest young people into them.

Senator GRIFFIN. With all this glamor that you are talking about, is the number of people getting their Ph. D.'s in the pure sciences as opposed to social sciences changing drastically?

Senator HARRIS. They are going up rapidly and according to Dr. Gerald Holton, of Harvard, who testified before us, during the next 30 years there will be 10 to 20 times the number of people wanting to

do basic research in the social sciences that there now are and it will make a very good case for meaningful expenditures on the order of 20 to 50 times the amount of 1967 dollars. I expect those projections will hold true and I hope that we will be ready to meet those needs and to reap the benefits for society.

Senator GRIFFIN. In your bill to establish the Social Science Foundation, is that an open end authorization?

Senator HARRIS. It does not really matter to me, Senator. I cannot respond to you directly, but I would be quite willing to consider the matter carefully.

Senator GRIFFIN. I do not know. I do know that the National Science Foundation authorization does not have any particular termination to it and no requirement, as I understand it, for any review. This is the first review, as Senator Kennedy pointed out in his statement yesterday, that has been made by the Senate since 1950, other than what the Senate Appropriations Committee can take time to do.

Senator HARRIS. Very good point.

Senator GRIFFIN. I have no further questions.

Senator KENNEDY of Massachusetts. Senator Harris, thank you very much for a very helpful commentary, very helpful information.

Senator HARRIS. Thank you.

Senator KENNEDY of Massachusetts. Our third witness is the Honorable Claiborne Pell, Senator from Rhode Island. We are delighted to hear from you, Senator.

STATEMENT OF HON. CLAIBORNE PELL, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator PELL. Thank you, Mr. Chairman.

As I see it, one of the most important features of the pending measures is the addition of responsibility for applied research and technology to the National Science Foundation's traditional sponsorship of basic research. Outside of the short-lived Mohole project, and a somewhat application-oriented program in weather modification, the only such program thus far encompassed by the Foundation is the national sea grant program.

The original idea of having the NSF house this program was based on the close association which NSF has enjoyed with the academic institutions who will, in the majority of cases, be performers of the program's functions. While wishing to see the program move ahead as fast as possible, I am, on the whole, satisfied with the way the Foundation is managing the program:

1. Foundation officials are as knowledgeable in the realm of technology as they are in science; they have apparently experienced little difficulty in locating, identifying, and recruiting competent consultants in technological fields.

2. The Foundation has demonstrated similar ease and facility in acquiring a staff competent to carry out the program's assignments.

3. The Foundation is generating program doctrine and policy with a minimum of fuss and hesitancy.

4. Similarly, there is little hesitancy on the part of the applied research and technological community to submit this type of proposal to the Foundation.

5. The Foundation has formed useful alliances with strongly application-oriented organizations, such as the National Academy of Engineering's Committee on Ocean Engineering, the Panel on Ocean Engineering of the National Council for Marine Resources and Engineering Development, and the Ocean Sciences Technological Advisory Committee of the National Security Industrial Association.

6. State governments and intrastate, intercollegiate consortia have joined in common technological programs and projects and have declared willingness to participate in the NSF programs on this basis.

Based on these observations, and assuming that increased Federal agency sponsorship of technology and applied research is needed in the first place, I would have no hesitation in assigning added responsibility to the National Science Foundation.

Senator KENNEDY of Massachusetts. Thank you, Senator Pell, for your statement and, I might add, for your fine work as a member of this subcommittee.

Our final witness this morning will be Mr. Herman Pollack, Director of International Scientific Technological Affairs, Department of State.

Mr. Pollack, we want to extend a word of welcome to you for your appearance here and for your statement. We had some references to your program yesterday in our testimony, and we are interested in your comments here this morning. You may proceed in your own way.

STATEMENT OF HERMAN POLLACK, DIRECTOR OF INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL AFFAIRS, DEPARTMENT OF STATE

Mr. POLLACK. Thank you, Mr. Chairman, members of the committee. I have a relatively brief statement. I think it will be simplest if I proceed through it.

Senator KENNEDY of Massachusetts. Fine.

Mr. POLLACK. And then answer such questions as you may have.

The Department of State is pleased to have an opportunity to comment on S. 2598. This bill to broaden the charter of the National Science Foundation is of dierct interest to the Department of State.

First and foremost, the authority provided in section 3(b) would provide our Government with an important additional tool for the achievement of its foreign policy objectives. This section of the bill would authorize the Foundation to initiate and support specific scientific activities relating to international cooperation or national security when requested to do so by the Secretary of State. As I shall elaborate, this would add a new and useful dimension to our relationships abroad.

The Department of State has found the National Science Foundation, within the limits of its present charter, a ready and competent partner in providing professional scientific guidance and assistance to programs for international scientific cooperation. The Foundation has had extensive and useful experience in international scientific relationships. The Department would welcome a wider role for the National Science Foundation in the international field.

However, the National Science Foundation is constrained in its foreign activities by the requirement that its support to those activities must relate directly to its basic objective of strengthening domestic science.

Incidentally, this requirement governs foreign activities of the Government's scientific and technological agencies generally. In our view, the practice of foreign affairs in this last third of the 20th century calls for greater freedom of choice than is possible under this otherwise worthy limitation. As science and technology permeate our personal lives, our industrial and academic relationships, and our expectations for the future, so they have come to permeate the relationships among nations.

American preeminence in science and technology is a major facet of our strength and image throughout the world. Recognition by the Congress of this growing importance would encourage direct and positive use of our American strength in scientific fields in many areas which are now administratively difficult, or even impossible. From our viewpoint in the Department of State, authority for the Foundation to act directly in support of American foreign policy is the single most interesting feature of this bill. This authority would make it possible to enlarge the use of our tremendous scientific capability in dealing effectively with the foreign policy opportunities afforded by worldwide scientific and technological developments. I believe many such opportunities are missed or are aborted because the Washington scientific community has become accustomed to criteria which stress direct and immediate benefits to American science. For want of enabling legislation of the kind now under consideration, it has not always been possible to evaluate the merits of participation in international scientific activities from the viewpoint of the national interest, broadly conceived.

It is not possible to speak with precision on the kinds of requests the Secretary of State might make of the Foundation. However, among the possible categories, we could foresee possibilities of U.S. contributions toward scientifically sound and interesting cooperative projects with scientists in another country in which the partnership might be unequal.

Senator KENNEDY of Massachusetts. Let me ask you a question on this point. The legislation says that when requested by the Secretary of State or Secretary of Defense, the Foundation is authorized to initiate and support specific scientific activity in connection with matters relating to international cooperation and national security, by making contracts or other arrangements for the conduct of such scientific activity.

Now, what are the kinds of activity that you might request which we are not already doing?

Mr. POLLACK. Let me, if I may, walk into that by reciting a development that occurred just last evening. When the President and Premier Sato concluded their conversations they issued a communique. The newspapers this morning picked up the references to the islands primarily, but there was a chapter 9 in that communique which we will be hearing more about in the weeks and months ahead.

The first paragraph of that had the President and Prime Minister express their satisfaction with the activity and expanding scientific cooperation between Japan and the United States. They especially recognized the contributions made by the United States-Japan cooperative medical science program, which was established as a result of their last meeting in January 1965 and the continuing achievements of a United States-Japan Committee on Scientific Cooperation.

An additional paragraph in this communique dealt with the subject of outer space, marine sciences, and atomic energy.

Now, the United States-Japan Committee on Scientific Cooperation, which was established 6 years ago by a comparable meeting between President Kennedy and Premier Ikeda, is a program that is carried on by the National Science Foundation. It is not difficult, in establishing a program with a country as advanced scientifically as is Japan, to find areas of cooperation in which the benefit to American science will be sufficiently great to permit, without further concern about existing authority, the expenditure of appropriated funds. The National Science Foundation carries on that program.

Senator KENNEDY of Massachusetts. For the benefit of the record, I would like to have some areas spelled out more specifically.

Mr. POLLACK. I want to lead to this distinction, if I may, by saying that the medical program, however, was a program directed toward the health problems of Asia, and there was a question at the time this program was announced where the authority might come from. There does exist only one other instance, to my knowledge, of authority in the hands of a technical agency to carry on a program that is not justified in terms of the benefit to American science or American scientists. This is Public Law 86–610 which was the bill that established the National Institute of International Health and Medical Research. The purpose of this act was to advance the international status of health sciences through cooperative enterprises in health research, research planning, and research training. Another, and more customary provision was to advance the status of the health sciences in the United States.

We chose, for reasons of making clear the authority to spend funds for this program directed toward the health problems of Asia—a program with both humanitarian and political benefits—to use the broader authority that did not tie the activities back to benefits to American science.

Not too long ago we held in Washington a major conference on water for peace. This was part of the Presidential program on water in which he has pledged, on several occasions, to share our knowledge with the rest of the world. We had received requests from countries to have some of our experts come over and help survey their water problems and their water management activities. We constantly encountered, in our efforts to respond to these requests, the absence of clear authority on the part of any of the mission agencies to send their experts abroad when the return to the American program is not an immediately discernible and overriding one.

We had not too long ago a country in Asia, in whose future we have a tremendous political as well as economic investment, which found it to be desirable and useful from the viewpoint of the development of their own industries to send a group of scientists and technologists to visit U.S. facilities, both governmental and private. There was no problem here of the absence of funds. The problem here was the absence of foreign exchange. They were perfectly willing to work in exchange with us, one for one. The problem here was that when you sought the capacity to supply the funds for the travel of an American scientist to this country, there was very little that we could find in that country that could be related back to a benefit to American science. And yet, the accomplishment of this exchange of scientists and technologists

would have tremendous benefit to the relationships of the United States with this country.

We have Thailand, a country in which, of course, there is an American relationship that is very important and very intimate. The Embassy there has been very much interested in bringing into closer contact Thailand scientists and American scientists. Our office and others in Washington have sought, when we have been aware of men who would be traveling in that area of the world on other business, to have them visit Bangkok and other cities in Thailand. But we would not have the capacity to have an American scientist travel to Asia solely to visit Thailand, specifically, since we could not justify such a trip under the benefits to American science that would result from it. We have to look for somebody who is traveling in that area for other reasons; where the travel to Bangkok does not involve any additional expenditure of funds.

The agreements that we have had with Japan have given rise to interest on the part of other countries for comparable undertakings. There is no problem in developing such an undertaking when dealing with an advanced country; they can meet us on more or less equal terms, and the American scientist will get as much as he gives. This is not the case when dealing with some of the developing countries, including some that have developed respectable, scientific activities but where they nevertheless do not provide the opportunities for American scientists to acquire additional knowledge or additional understanding to the extent that would be possible in dealing, let us say, with some of the key Western European countries or with Japan.

We at this point are without the ability to use the flexibility that would be ours, were this kind of enabling legislation to exist. We do not now have any basis on which we could undertake a relationship where we could not clearly demonstrate a benefit to American science, or to the program of the mission-oriented agency—which is another way, I think, of saying the same thing.

We have repeatedly run into a situation, small in its scope but significant in its consequences, of developing countries, which have expensive scientific equipment in need of repair and maintenance. I have visited facilities in developing countries and seen laboratories where work is at a standstill because a part is missing, or the machine is broken down, and the competence does not exist to repair it.

We would like to find some way to develop a program, the cost of which I think would be relatively small, which would both provide training to indigenous people in the maintenance of this very advanced equipment and would provide help basically on a foreign exchange problem which is now the overriding one, much more so than the absence of funds at all, for the supply of small electronic parts. We are talking in terms of just dollars, not thousands and not even hundreds in some cases.

It would be very much in the interest of the long-term relationship between the United States and these countries for their laboratories to be based on American designed equipment, both for economic and for foreign policy reasons.

Senator GRIFFIN. Why should not that be handled under our foreign aid program?

Mr. POLLACK. Well, there are two reasons why—it can be and in some cases it is—the foreign aid criterion does not always recognize

the contribution of a scientific research laboratory as necessarily benefitting, in terms of the priorities they have to follow, for the early economic development objective which is their overriding consideration.

Secondly, some of the countries that we are talking about are not AID recipients. Taiwan and Iran are two instances. In Iran, especially, there is a great need for just the kind of program I have been describing, relating to scientific equipment now not being effectively used because of lack of competence to repair and maintain it and, in some cases of course, the absence of parts.

Basically, what I am suggesting, with respect to this authority, is not so much directed at big and bold projects, but at a host of small individual projects targeted into precise opportunities. American science, as a whole, is one of the most tremendous strengths we have in our international relationships at this point in time, but it is a strength which is very broad and is massive in its application. What we miss is the ability to go in with a little surgical tool and do a useful activity at a particular point in time, when the benefits would be most immediate and direct to the attainment of a foreign policy aim and goal.

Senator GRIFFIN. Is not this a long way afield from the original purposes that Congress thought they were implementing when they established the National Science Foundation?

Mr. POLLACK. I cannot answer that question, because I am not clear as to what the original concept was, but the evolution—I think NSF was established about 1950 and strengthened about 1958 or 1959—but the evolution of the U.S. role in the world in the last decade and a half now requires that the scientific strength which we have acquired, the world leadership which we now hold in practically every scientific and technological field, has got to be recognized as one of the vehicles, just as our economic strength is, of importance to our relationship with the rest of the world.

I am suggesting that we are not now in a position to make as effective use of that scientific strength as we would be were this authority available to the National Science Foundation, and possibly some other agencies also restricted in the sense being forced to tie back to a benefit to American science. We ought to be able to think of the national policy as more broadly conceived, which would include specifically foreign policy. We are missing too many opportunities. We are tying our hands, we think, in an unnecessary fashion, a fashion in which other countries do not tie their hands. We are losing out on some of the competition for position that could be avoided with a little broader authority available to the NSF in this instance—maybe to other agencies subsequently.

The NIH is now the only agency which has authority sufficiently broad to permit the kind of activity that we are talking about. It has been rarely used, but I assume this would be rarely used as well.

I can cite another example that we frequently have occasion in the Department and in the Government to seek innovating ideas that would support the achievement of an aim of our policy, and we have not been alone in trying to think of ways in which our competence in the area of science and technology might be brought to bear effectively in the Middle East. Many of the suggestions that have been tossed out in the brainstorming that has taken place on this

subject have, as I have indicated in my testimony, died in the process of being born because of the general recognition on the part of the participants from the Government of the absence of authority to do many of the things that might otherwise be beneficial. Put another way, our ability to perform internationally in the scientific field is largely limited by the necessity for supporting the programmatic interests of the mission agencies. In the case of NSF, their programmatic interest is of benefit to American science, very broadly viewed. I indicate in my statement that none of these categories would involve large amounts of money, and all of them would be subject to NSF concurrence and to availability of funds. However, the existence of this authority and its use in moderation would add a flexibility which would be most helpful to the attainment of our foreign policy objectives.

I should like now to turn to another aspect of this legislation of interest to the Department of State.

Senator GRIFFIN. If I can interrupt you, your testimony bothers me a lot. The NIH authority that you refer to, does that involve supplying hospital equipment and things of that kind?

Mr. POLLACK. No. The NIH—the program relates to cooperative enterprises in health research, research planning, and research training. The specific program I referred to with Japan, which the President and Premier Sato referred to yesterday, is a research program.

Senator GRIFFIN. As I understand it, you would use this new authority, for example, to provide laboratory equipment and repair laboratories and provide scientific equipment and things like that to the countries you think ought to have it, as a part of what you would do. Is not this just a whole new avenue of foreign aid that would have no congressional review if we gave it to you? I say again, it seems to me it is a long way away from what Congress had in mind when they established the National Science Foundation.

Mr. POLLACK. Well, I think I have to make the following additional points. We face a choice, in the areas in which I have been talking about, of whether the Department ought to seek this authority for itself or seek to continue to have our international scientific relationships in the hands of the scientific and technical agencies in town.

Now, for many reasons we have concluded that the Department of State ought not to attempt to establish the kind of scientific competence within its own area that would duplicate the competence that is available in other agencies.

The National Science Foundation is distinguishable from the Atomic Energy Commission and NASA by virtue of the fact that its range of interest is as broad as the Government's. It is a natural partner to the Department of State in international scientific activities, although we tie in with the AEC on atomic energy and NASA on space. But the National Science Foundation is the only agency in town which has a very broad charter. We have concluded we would be far better off to seek a partnership with the National Science Foundation in this field than to undertake to obtain this authority directly in the Department. The funds that would be expended on the program might come from the Department; we might have some broad authority under our appropriation that would be available to us. Others would come probably from the National Science Foundation.

Senator GRIFFIN. Is it all right if we write that in the bill that the funds would come from your Department?

Mr. POLLACK. Well, it will have a dramatic dampening effect on the ability of the program to achieve what we are talking about.

Senator GRIFFIN. I think there might be more of an interest, it might be more acceptable, if you wanted to put it in that way.

Mr. POLLACK. I cannot speak cogently on the question of whether this takes the National Science Foundation beyond the original objectives which the Congress had in mind for it, as I said earlier.

Senator KENNEDY of Massachusetts. What have you done in the past? Will you tell us that? Give us some idea of what you have been doing in the very recent past. And about the amount of funds that are being used for this program.

Mr. POLLACK. We have dealt with this problem in several ways. I would prefer not to name countries because I am not sure that would be useful, or necessary to be responsive.

In some instances, we have sought help from the private foundations, where authority is lacking for the Government to finance, let us say, the travel of a scientist—if his participation in an activity in the United States was deemed to be especially important by our Embassy and by our policy specialists in the Department of State. In other instances, in the water-for-peace program we have had to change the terms of reference of some of the activities, to a point where they no longer quite serve as directly and immediately the objective that the other government had in mind, in order to make it possible to justify the expenditure of funds appropriated to the mission agency to send its staff abroad. This has added complexities that have generally had a discouraging result; it has put a damper on the imagination and the initiatives that our Government otherwise would have been capable of displaying.

We have gone into very elaborate and difficult administrative arrangements to meet this problem of foreign exchange. We now have several arrangements scattered around town that we have worked out, wherein the costs of transportation are paid in the local currency but the cost in the United States is picked up in U.S. dollars. We have sought to provide enough of a return on this so that the net costs to the Government ended up being the same. In turn we supply the transportation to the other country and they would pick up the local costs. It has been an awkward, time-consuming, and dampening requirement.

Now, we have done all of the things that we have been capable of thinking that we might be able to do and still remain within the intent of the legislation governing the various agencies in town.

Senator GRIFFIN. It seems to me, you ought to put down on paper what it is you need and come up to Congress and ask for it and see if you can get it. It looks to me as though that is a roundabout way to spend a lot of funds. Maybe they should be spent. But they are going to get lost in the shuffle, and I just want the record to note that we are not overlooking it.

Senator KENNEDY of Massachusetts. Maybe you could submit for the record the amount now being expended under the program and going back, say, for the last 10 years. You might include a general profile of what these funds have been expended for, and how the Department relates this to the general purpose of the NSF. I think this would be very important, particularly since you are quoting some areas which you feel are going to be new horizons from the agreement that

has been made in the last 24 or 36 hours. I think we ought to have some idea. So, could you supply that for the subcommittee?

Mr. POLLACK. Yes, I will. I will also make clear that not all of the examples I have cited would be appropriate subjects necessarily for the NSF to follow. I was trying to set in these examples, provide you with a general understanding of the limitation that is broader than the NSF and runs as well into the so-called mission agencies in Washington. And, ultimately I think they will turn out to be the wisest course of action for our Government to provide some broader authority to these agencies as well in the use of their contracts in support of our foreign policy.

Senator KENNEDY of Massachusetts. I can see where, under certain circumstances, there is a particular study or particular program being developed in this country which is of importance and significance. And there is a particular foreign scientist who can add a piece to the puzzle. Therefore, it seems to be important that that scientist come over to this country and be able to spend 4 or 5 weeks or something in the development of a program. But, I think we ought to know exactly what has been done and what you visualize under the provisions of the NSF. I think it would be very helpful to us.

Mr. POLLACK. All right.

Senator KENNEDY of Massachusetts. We are trying to feel our way along with this legislation, and I think it would be helpful for us to have that information.

Mr. POLLACK. I will be glad to supply that to you, sir.

(The information subsequently supplied for the record follows:)

NATIONAL SCIENCE FOUNDATION INTERNATIONAL ACTIVITIES SUMMARY

The attached tabulation, prepared by the National Science Foundation's Office of International Science Activities, summarizes the NSF's awards to foreign institutions and international organizations over the past decade. In each instance these awards were justified by their direct contribution to the advancement of U.S. science.

In addition, the Foundation has undertaken the following programs at the request of the Department of State:

United States-Japan program.—The NSF makes grants to domestic institutions which are matched by Japanese funds in support of Japanese participation. NSF expenditures for this Program, initiated in 1961, and appropriated by Congress for the purpose, have averaged between $500,000 and $700,000 per year.

United States-Italy program.—The NSF is the U.S. Executive Agency for coordination of U.S. participation in this Program. The Foundation has funded some proposals from the scientific community for the Program; these awards were made in competition with regular Foundation support for basic domestic research. The Italian scientists are supported by the Italian National Research Council.

Grants under the cooperative programs with Japan and Italy are made solely to U.S. institutions; no grants to foreign institutions are involved. In these programs, although undertaken at the request of the Department of State, NSF expenditures have been governed by the criteria of benefit to American science.

OECD and NATO science programs.—The NSF coordinates U.S. participation in OECD science programs, and has provided important support to U.S. scientific cooperation with NATO. The NSF support of United States participation in OECD and NATO does not involve awards and grants of NSF funds.

Thus, at the present time the NSF has an extensive range of foreign programs. All meet the basic criteria of benefit to American science, under which support is given to foreign institutions in which American scientists will train or work; to the travel of scientists; to participation in cooperative research activities; to the supply of information; and to related professional assistance.[1]

[1] In addition to the foregoing broad categories of foreign activities carried on under NSF authority, the NSF does carry out programs at the request of AID, utilizing both AID funds and authority. These include educational programs with universities of Central America, an education program with the Government of India, and a miscellany of specific one-time activities such as a survey of science education at the university level in Iran and provision of advice on the establishment of a science teaching center in Southeast Asia.

No new kinds of activities are contemplated under the provisions of Section 3(b) *of S. 2598*. The essential difference is that under S. 2598 the NSF criteria for the expenditure of its own funds could be expanded to include the broad foreign policy interests of the United States as defined by the Secretary of State.

The Department of State envisions highly specific uses of this new authority. Large international scientific programs, such as the International Geophysical Year or the cooperation through the International Atomic Energy Agency, provide substantive returns to U.S. programs—there is no problem of authority for U.S. participation in them. At the other end of the spectrum, the developing nations receive crucial help from AID and from other nations. This authority would be used in those "gray areas" in which there are no compelling substantive benefits to U.S. science nor to the program of any U.S. technical agency, and which do not qualify under AID criteria; but where the activity is not only meritorious from a scientific viewpoint but has special foreign policy attraction as well.

In the course of the Department's testimony, the question was raised as to whether this new authority was within the intent of the Congress as expressed in the National Science Foundation Act of 1950. The Department of State believes that it is relevant to note that the 1950 Act authorized the NSF, in Section 3(a), "at the request of the Secretary of Defense, to initiate and support specific scientific research activities . . . relating to the national defense." Section 3(b) of S. 2598 is a restatement of that authority which adds the Secretary of State to the Secretary of Defense as one who may request the NSF to engage in scientific activities and broadens the criteria of relevance from "national defense" to "international cooperation or national security". The extension of this authority to cover broad aspects of the national interest appears to be consistent with the original purpose of the NSF.

It is contemplated that the individual "scientific activities" in which the NSF might engage under this authority would generally involve small expenditures of money. We would expect any large expenditures to be subjected to the budget and appropriation procedure. In every instance the NSF would, under the language of Section 3(b) of S. 2598, retain the decision as to whether or not to engage in a scientific activity proposed by the Secretary of State.

NSF AWARDS TO FOREIGN INSTITUTIONS AND INTERNATIONAL ORGANIZATIONS

[By NSF division. Dollar amounts to the nearest thousand]

Fiscal year	DES	OAP	MPS	BMS	SOC	GES	PES	ISA	SRP	SPE	Total	Total number of awards
1957	----	----	$27	$60	----	----	----	----	----	----	$86	9
1958	----	----	10	34	$13	----	----	----	----	----	56	6
1959	----	----	14	106	----	----	----	----	----	$9	130	11
1960	----	----	108	379	22	----	----	$66	----	42	617	31
1961	----	$6	136	386	27	----	----	28	----	11	594	32
1962	----	----	456	673	70	----	----	65	----	17	1,281	----
1963	----	21	939	638	69	----	----	71	$12	----	1,750	38
1964	----	25	194	260	25	----	$5	14	----	197	720	27
1965	$30	----	175	511	45	$65	----	----	----	----	826	26
1966	50	----	155	367	32	417	16	----	----	----	1,027	24
1967	248	----	45	179	27	299	6	----	----	----	923	24
Total	328	52	2,259	3,593	330	781	17	244	12	276	8,010	228

KEY TO SYMBOLS

DES—Division of Environmental Sciences.
OAP—Office of Antarctic Programs.
MPS—Division of Mathematical and Physical Sciences.
BMS—Division of Biological and Medical Sciences.
SOC—Division of Social Sciences.
GES—Division of Graduate Education in Science.
PES—Division of Pre-College Education in Science.
ISA—Office of International Science Activities.
SRP—Office of Science Resources Planning.
SPE—Division of Scientific Personnel and Education.

Note: This tabulation of National Science Foundation awards to foreign institutions in 32 countries and 10 international organizations, for fiscal years 1957 through 1967, does not include purchase of services such as translations, etc. These figures reflect only awards made at NSF initiative and do not include work undertaken at the request of the Department of State. In each case the criteria of benefit to U.S. scientific programs and intrinsic scientific merit were fully met.

Mr. POLLACK. Now, another aspect of this legislation which is of interest to the Department of State is the subject of my next few remarks. Referring to the needs for research in the social sciences, Secretary of State Dean Rusk said earlier this year:

> As the scientists put their minds to the problems of the future, it is just as important that the social sciences and the humanities do the same. The old notion that somehow the future is not the business of the humanities and the social sciences is rapidly disappearing because the other half of our great universities is hurling us into the future at a breathtaking pace. Unless those who think about the problems of man similarly address themselves to the future, and not merely to some remote past nor to the views spoken somewhere else at an earlier stage, then we will have vast problems confronting us in the future. This joint action among all groups * * * is indispensable if we are to move ahead as rational human beings into this uncharted future.

S. 2598 authorizes the National Science Foundation to initiate and support basic research in the social sciences, and "to support * * * applied scientific research relevant to national problems involving the public interest." We understand that this combination of authorities would permit the support of applied research in the social sciences directed toward the social, economic, and political accommodation by the nations of the world to the consequences of the far-reaching scientific and technological progress now taking place.

The need for analysis of the scientific and technological process from the humanistic and social viewpoint is urgent. Science policy determinations should rest not only on the conclusions of the many tchnological forecasting studies in progress, and the political and economic realities which affect possible alternatives; they should also be based in responsible study of the social, economic, and political implications of those alternatives.

I submit that it would be appropriate for the NSF, which is so clearly charged with the promotion of science, to take on a major responsibility for the promotion of academic interest and activity in the social and international consequences of scientific and technological advance.

As a last point, let me say briefly that public service in international affairs increasingly requires men and women who can integrate an understanding of the scientific and technological bases of modern society with a deep and penetrating understanding of international relations.

A number of American universities have started programs to blend science and public policy, including foreign affairs. Some few have established new institutes within the university to this purpose. This past Sunday's New York Times quotes Dean Franklin L. Ford of Harvard as saying that "Science must again become a recognized and valued part of the culture of educated men and women." We agree entirely.

The National Science Foundation is already supporting some university programs designed to provide the diplomat-scientists or, if you will, scientist-diplomats which the future demands. The Department of State would welcome an enlargement of this support by the NSF in the interest of increasing the supply of this new breed of synthesists, the need for which is becoming pressing.

In summary, and of the first importance, the Department of State believes that there is a need for clear authority for the National

Science Foundation, acting with the Department, to engage in international scientific activities in support of U.S. foreign policy objectives. Section 3(b) of S. 2598 provides that authority.

Secondly, the Department hopes that it will be possible, under this legislation, for the National Science Foundation to stimulate creative social science research into the international problems posed by exploding technology, and to support the development of university programs which will blend science and public affairs to help meet the requirement for scientific literacy in the Foreign Service.

That, Mr. Chairman, concludes my statement.

Senator KENNEDY of Massachusetts. What procedures will be established by the Secretary of State to initiate scientific activity in connection with matters relating to international cooperation? Are you just going to play it by ear or are you going to try to establish some procedure to find out ways that you can take advantage of the Foundation?

Mr. POLLACK. No. We had contemplated that the Foundation and the Department and other interested technical agencies in town would spend some time in developing guidelines for the use of this authority, taking into account the orientation of the Foundation, as Senator Griffin was expressing, the purpose of the Foundation and the areas in which the investment would bear the greatest return.

We also proceed, of course, on the assumption that any activity, especially in the scientific field, which is not scientifically sound and justifiable is from any point of view a bad enterprise and we would want the Foundation to bring into this picture that kind of judgment as well.

Additionally, the Foundation already has great experience internationally. They know a good deal about the international scientific community. They are especially active in the field of international science education activity and they would have a considerable input to the development of this program. But, it is also obvious that at least in the initial years of the existence of this authority we would be feeling our way and experimenting.

Senator KENNEDY of Massachusetts. I have nothing further.

Senator GRIFFIN. Nothing.

Senator KENNEDY of Massachusetts. Senator Pell?

Senator PELL. Thank you Senator Kennedy. Without objection I should like to insert into the hearing record at this point a letter to me from Dr. Roger Revelle, director of the Harvard University Center for Population Studies, which speak about S. 2958 and its relationship to the national sea-grant college program.

(The letter referred to follows:)

HARVARD UNIVERSITY,
CENTER FOR POPULATION STUDIES,
Cambridge, Mass., November 15, 1967.

Senator CLAIBORNE PELL,
Member of the Ad Hoc Subcommittee on Science of the Senate Labor and Public Welfare Committee, U.S. Senate, Washington, D.C.

DEAR SENATOR PELL: I am writing in relation to Senate Bill S. 2598, which would amend the National Science Foundation Act of 1950. I hope this amendment will strengthen the Foundation's ability to support an important new program which the 89th Congress assigned to the Foundation for administration—the National Sea Grant College Program.

Probably the most important and far-reaching educational invention ever made in the United States was the Morrill Act which created our land grant

college system. (Interestingly enough, this was passed and its implementation was begun while the nation was distracted by the agonies of a terrible war.) Many of these "colleges" have since become great and famous universities, but throughout their history they have devoted much of their effort to research, teaching, and public service on the practical problems of agriculture and industry in their own States. The marvelous development of American agriculture to a level of productivity that would have been inconceivable 50 years ago is due more to the work of the land grant universities than to all other factors combined, and these universities have gone forward in a myriad different ways to serve the social and economic interests of the people in their local regions.

Now you have wisely and far-sightedly proposed that this concept of the land grant colleges be applied to the development of marine resources through the creation of a sea grant college program which would bring to bear diverse human skills on the problems of utilizing the oceans and their bordering seas for the benefit of people.

Having been for many years Director of the Scripps Institution of Oceanography, I am especially aware of the needs for economists, sociologists, political scientists, engineers, and natural scientists to work together on these problems and to develop an education and research framework which will attract students and specialists from many different backgrounds. Although scientific research on the oceans is fundamental, it is not enough if the United States is to play its potential role in inhabiting and using the oceans.

In spite of the fact that we produce about a third of the gross world economic product, the United States lags far behind other countries in harvesting the sea. Yet the oceans have never been as important to us as they are today. World order depends on the ability of the United States Navy to concentrate our forces in space and time at any point on the coastlines of the world. We can be completely sure that this ability will be diminished unless we regain and enhance our maritime preeminence in every aspect of use of the oceans. Such preeminence depends above all on educating young people to understand and enjoy working at sea, in fisheries, submerged operations, and engineering development. And this can be done only if our colleges and universities are enabled to develop broadly-based faculties and research staffs to study and teach about the oceans.

The Sea Grant Program offers the first opportunity ever available to our higher educational institutions to enlist their full resources toward this objective. Always, in the past, university involvement has been largely limited to fundamental research in the physics and biology of the sea. We now realize that we need to bring in many different sorts of scholars and applied natural and social scientists. They need to learn how to talk to each other and to work together. The Sea Grant College Program will make this possible for the first time on a national scale.

For all the above reasons, I endorse enthusiastically the use of Federal funds to help in the development of sea grant colleges and the Sea Grant Program. It is an excellent example of the ways in which the Federal Government can stimulate, but not exercise undue control over, industrial and educational enterprises directed toward the fuller utilization of marine resources.

Very sincerely yours,

ROGER REVELLE, *Director.*

Senator PELL. I am very pleased to see Mr. Pollack again. We have had friendly relations for many years.

One point bothers me some and that is the role of the social sciences within the National Science Foundation. But the establishment of the National Endowment for the Humanities was not the choice made that it would be the governmental agency charged with the responsibility in the Social Sciences? Man has greatly evolved in his ability to develop the weapons of mass destruction, he has developed the means to move around more swiftly, but the human beings involved are the same kind of people with the same thought processes as those who lived in Greece 2,000 years ago, even though they fought wars with countries only 25 miles apart and it took them 3 or 2 or 1 day to march there. We have improved the technology but have we developed the mental maturity to the same level?

The National Science Foundation emphasis in the past has been to improve the technology of man but has not necessarily been to improve the ability of man to handle that technology through understanding of the Social Sciences. I question whether the Social Sciences should be given greater emphasis by the National Science Foundation when there is a government agency expressly concerned with the humanities.

Mr. POLLACK. In the first place, I do not think the Department of State is electing to support any chosen instrument in this field, and I certainly think there is sufficient room in the arena for more than one to play. I think the advantages, one of the advantages the National Science Foundation would have is that there already exists within a foundation at least an understanding of the scientific and technological developments that are occurring. What is missing is the marriage of that understanding and the study of the variety of behavioral and social sciences in areas in which these two begin to overlap; the greater urban problems, air pollution, et cetera.

That fusion might occur more quickly, but in any case, it would certainly occur effectively within the National Science Foundation. The potentiality is there, but I am by no means arguing that this ought to be the exclusive arena. I would certainly like to see, as I indicated, the National Science Foundation go beyond simply considering itself responsible for promoting science and also consider itself responsible for promoting activities on the part of people who are going to think through the consequences of the scientific revolution.

They are supporting, for example, very effective work in weather modification. Well, the consequences of successful achievement of technological competence to modify the weather is going to be tremendous in economic terms, in social terms, and in international terms. It is also going to present tremendous problems internationally.

Senator PELL. Let me try and be a little more specific. Under the definition of social sciences, that is where greater emphasis would be made by the National Science Foundation, would you include, for instance, languages?

Mr. POLLACK. Yes, I would.

Senator PELL. Would you include history?

Mr. POLLACK. Yes.

Senator PELL. Philosophy?

Mr. POLLACK. I would be disinclined to place any limits because it is a little difficult to foresee what competence will provide a useful insight into the answer to a problem.

Senator PELL. I would like to read into the record at this point the definition of humanities as set up in the National Foundation for the Arts and Humanities Act of 1965, and as amended by the Special Subcommittee on the Arts and Humanities of the Senate.

> The term humanities includes but is not limited to the study of the following: Language, both modern and classical, linguistics, literature, history, jurisprudence, philosophy, architecture, and those aspects of the social sciences which are of humanistic content and the study and application of the humanities to human environment.

Now, I see very real problems here as you move in this direction. The need is there very strongly, as I said earlier. We must control these machines and we must cultivate the human nature, which is utilizing the instrument. However, I wonder if we have fully explored the role that the Endowment for the Humanities could be playing.

In this connection, I am delighted to be informed by the chairman of this subcommittee that the views of Dr. Keeney, the Chairman of the National Endowment for the Humanities, will be sought. Also, I would hope that in writing up any legislation we would seek to avoid any proliferation of responsibility in this field. I would like to see as much of the responsibility kept under the aegis of the National Endowment for the Humanities. To my mind, the National Science Foundation is essentially what it says, a vehicle to improve the technologies, and I am not sure that you can meaningfully blend the social sciences and technical sciences under one roof.

(The following letter was subsequently supplied for the record at the request of Senator Pell:)

NATIONAL FOUNDATION ON THE ARTS AND THE HUMANITIES,
NATIONAL ENDOWMENT FOR THE HUMANITIES,
Washington, D.C., December 14, 1967.

Hon. CLAIBORNE PELL,
U.S. Senate,
Washington, D.C.

DEAR SENATOR PELL: As requested by you the following information is submitted in regard to: (1) National Endowment for the Humanities Social Science policy; (2) present arrangements between the National Science Foundation and the National Endowment for the Humanities for support of projects in the social sciences; and (3) the extent of National Endowment for the Humanities support of the social sciences to date.

The National Foundation on the Arts and the Humanities Act of 1965 Section 3(a) brings the humanistic aspects of the social sciences within the authority of the National Endowment for the Humanities. That section reads: "The term 'humanities' includes, but is not limited to, the study of the following: language, both modern and classical; linguistics; literature; history; jurisprudence; philosophy; archaeology; the history, criticism, theory, and practice of the arts; and those aspects of the social sciences which have humanistic content and employ humanistic methods."

The National Endowment for the Humanities publication "Program Information 1968," which is the primary method of disseminating information regarding Endowment programs to scholars and teachers, institutions of higher education, and other interested groups and individuals, states on pages 10–11 the following:

NOTE ON ENDOWMENT SUPPORT OF THE SOCIAL SCIENCES

Four disciplines which are sometimes thought of as within the social sciences are defined as humanities by the law establishing the Endowment. These disciplines are archæology, history, jurisprudence, and linguistics. The Endowment supports these disciplines in the same way as it supports other disciplines enumerated as belonging to the field of the humanities.

In addition, the Endowment is authorized to support "those aspects of the social sciences which have humanistic content and employ humanistic methods." Therefore, if the objective of an applicant for support of research or teaching in the social sciences is one which will develop the individual's ability to infuse his work with humanistic elements, or one which will introduce or strengthen the humanistic aspects of his discipline, then an application for support under any of the Endowment's programs is welcomed.

Applications are welcomed from all fields of the social sciences. The scholar in these fields whose proposal is scientifically oriented is eligible to apply for support from the National Science Foundation. The aim of the Endowment is to provide support for those who conceive of their method of approach and of their objective as part of the humanistic tradition—as, for example, historical and philosophical investigations in the various disciplines. Scholars whose research is such that it might be eligible for support from both the National Science Foundation and the National Endowment for the Humanities may apply to both the Endowment and the Foundation and should indicate that they are doing so.

For the time being, since Endowment funds are severely limited, particular interest will be given to proposals which employ interdisciplinary approaches between the humanities and the social sciences, and those which seek, through

basic research or teaching, to emphasize the relevance of the various disciplines of the social sciences in understanding and improving the quality of public and private life.

This statement of Endowment intentions with regard to support of the social sciences is an interim policy, and will be modified in future announcements to reflect the experience gained during the interim period.

In regard to arrangements between the National Science Foundation and the National Endowment for the Humanities in the area of the social sciences, both the National Science Board and the National Council on the Humanities have agreed to a general statement in regard to the responsibilities of each agency separately and jointly. The statement approved by the National Council on the Humanities provides for the following:

1. The National Science Foundation will continue to fund its programs in the social sciences which seek to strengthen the social sciences as sciences.

2. The National Endowment for the Humanities will continue to support the humanistic aspects of the social sciences.

3. The National Endowment for the Humanities and the National Science Foundation will jointly consider funding proposals in the social sciences which have broader implications than those which each agency would separately consider.

4. The National Endowment for the Humanities and the National Science Foundation will establish an inter-agency committee to plan for the social sciences; the responsibilities of the group will be to plan programs aimed broadly at strengthening the social sciences in all aspects, which would be implemented as indicated in items 1 through 3 above.

5. Close liaison will be maintained by the two agencies with the National Institutes of Health, the Office of Education and other agencies whose programs in part deal with the social sciences.

In regard to support of the social sciences by the National Endowment for the Humanities, the great bulk of NEH grant and fellowship activity to date took place in fiscal year 1967. During that year the Endowment obligated a total of $4,105,192. Of that amount $149,894 was expended in social science fields such as sociology, political science, anthropology, and government. Each fellowship or project included within this group was adjudged to be "humanistic" in content and methods. As the program information booklet notes, the Act identifies four disciplines as humanities which are frequently thought of as falling within the social sciences. Those disciplines are archaeology, history, jurisprudence and linguistics. Of these, for example, S. 836, a bill to provide for the establishment of the National Foundation for the Social Sciences, enumerates specifically history, law and linguistics as social sciences. Fiscal year 1967 obligations in each of these fields were as follows:

Archeology	$134, 473
History	1, 234, 500
Jurisprudence	29, 202
Linguistics	73, 750

Thus in fiscal year 1967 the National Endowment for the Humanities obligated $1,621,819 in fields of studies clearly identified as social sciences or frequently considered as social sciences. This amount comprises 39½ percent of all funds obligated during that period. From this it is clear, I think, that the National Endowment for the Humanities has an evident and sustained interest in supporting the social sciences through fellowships, research projects and educational and public programs. Indeed the Endowment shares the conviction frequently expressed today that federal support of the social sciences, as of the humanities, is relatively less than the national interest requires. It is our conviction that the social sciences require increased federal assistance for the same reason that the humanities themselves require vastly increased federal support. Both fields of knowledge tell us what we know of man, his institutons and his aspirations. In a century in which man's ability to dwell together in peace and each man's capacity to achieve his full potential remain substantially unrealized goals, the social sciences and the humanities must be seen as world resources whose significance could not be easily overstated.

Sincerely,

BARNABY C. KEENEY, *Chairman.*

Mr. POLLACK. Senator, it is a complicated subject and I do not think there is any single correct answer. One of the points that has become very clear to us in the Department is the need for blending of those two great fields—science and the humanities or the social sciences—you can use either term from my point of view—is becoming a very real imperative. We encounter this continually in the Department of State, where it has recognized, that our policy officers are now dealing with some tremendous problems—the nuclear is an obvious one—on which an understanding of the technology becomes imperative for wise and sensible answers to the politics and the relationship problems that are posed.

I think you can make a case for going about this in many ways rather than for any single way but certainly one of the cases that ought to be made is the one that would bring the scientists and the social scientists together if possible, in the same person. This is a kind of breed that the Foreign Service is going to have to develop in great quantity almost instantaneously and you cannot do it instantaneously. This is why we are so pleased to see Harvard as one of the great leading institutions in the country revamp its concepts on the role that science will play in the education of an undergraduate. I frequently have occasion to talk to new Foreign Service officers and for some time I was under the impression that they were coming out of the universities better prepared than I was 25 or so years back, to deal with the world we are dealing with today. I have discovered what Harvard is now discussing and that is that the humanities graduate of our great universities is generally very, very poorly equipped to understand very much about the nature of the technological civilization he is a part of.

So, I am making a case here for the merits of some blending of this and if this is taken into account in the formulation of the way in which the Government goes about increasing activity in this field, that point will be met. But, the critical requirement is to begin moving rather quickly to stimulate greater activity in this field, whether it is done through the humanities council, the NSF, or a separate council on the social sciences. That is really less relevant than the need to get going.

Senator PELL. As was brought out yesterday in the hearings, both the National Science Foundation and the Endowment for the Humanities are in the same building, which hopefully gives them an opportunity for cross-fertilization. Was not the last "homo universale" John Milton, who had real competence in every discipline of the mind then known. In truth, the body of knowledge has grown and the need for specialization has increased. The only solution is that the computer and its concomitant will provide a means whereby all the available knowledge, in no matter what discipline, can be brought to bear on a specific problem.

Are you familiar with ekistics, the science of human settlements?

Mr. POLLACK. Yes.

Senator PELL. Ekistics attempts to relate the development of the city, to the whole man and his need for beauty, privacy, and convenience as well as his need for rapid transportation and a variety of other services all interrelated. No one man can cope with the problem for you cannot have all these disciplines in one mind, so you relate them through programming a computer and then trying to develop the

city which is subordinated to the human being, which is certainly not the case today.

Would you believe such a subject as ekistics should be in the National Science Foundation, or the National Endowment for the Humanities.

Mr. POLLACK. I met yesterday with a group of men from HUD who were talking about this very same kind of problem.

They have just apparently received less than 6 months ago authority to engage directly in research in support of the objectives of HUD. I am not aware that the National Science Foundation has done anything very significant on the complex of problems surrounding urban development. I would think that on a program of this kind there would be some merit in getting what is the most directly related mission agency, HUD, a group like the National Science Foundation, a group like the Humanities Council, our great National Academy of Sciences, both on the engineering and academic side. I think this is too big in its implications and scope, et cetera, for any single group to do justice to it. And I think I would probably come to the conclusion that this is not to be narrowly bureaucratically assigned to one or the other as the exclusive or, for that matter, even the lead agent.

Senator PELL. I guess my basic problem is that I always thought it was easier for the humanist to understand the scientist than for the scientists to understand the more theoretical aspects of humanities. That is why I would like to see the emphasis in the endowment. However, I look forward to hearing the other side and learning as this dialog between this subcommittee and the administration moves on in the determination as to how we widen or whether we widen the National Science Foundation.

I thank you very much.

Senator KENNEDY of Massachusetts. Thank you very much, Mr. Pollack. We have requested that note from you, and if you can, in your own good time, pass that on to us, we would appreciate it.

We will conclude the hearing for today.

At this point in the hearing record I order printed any pertinent additional material that is received for the record.

(The material referred to follows:)

ANNOUNCEMENT OF ESTABLISHMENT OF SPECIAL COMMISSION ON THE SOCIAL SCIENCES

MEMORANDUM

JANUARY 29, 1968.

To: Mr. K. Dun Gifford, Legislative Assistant, Office of Hon. Edward M. Kennedy.
From: C. C. Ohlke, Head, Congressional and Public Affairs.
Subject: Commission on the Social Sciences.

Attached is a press release which will be issued on Thursday, February 1. It announces the establishment of the National Science Board's Commission on the Social Sciences. As you can see, the objective of this commission is to see what NSF can do in the way of a better job as well as relating social science research to the problems of our day.

Let me know if I can provide you with any additional information.

Sincerely,

C. C. OHLKE.

NSF Special Commission on the Social Sciences Appointed

Establishment of a Special Commission on the Social Sciences was announced today by Dr. Philip Handler, Chairman, National Science Board, and by Dr. Leland J. Haworth, Director of the National Science Foundation.

The Commission is established pursuant to the authority provided in the National Science Foundation Act of 1950, as amended, for the establishment of Special Commissions. It consists of eleven persons eminent in science and public affairs, and is an independent body responsible to the National Science Board.

The Commission will bring a broad and diversified background to its work, including experience in the areas of sociology; urban planning; psychology, economics; political science, geography and resources; law, labor, administration, public affairs; industry; social commentary; engineering.

Members of the Special Commission on the Social Sciences are as follows:

Dr. Orville G. Brim, Jr., President, Russell Sage Foundation, New York, New York.

Dr. Samuel J. Eldersveld, Professor of Political Science, The University of Michigan.

The Honorable Marion B. Folsom, Director, Eastman Kodak Company, Rochester, New York.

Dr. William L. Garrison, Director, Center for Urban Studies, University of Illinois at Chicago Circle.

Miss Margaret A. Hickey, Public Affairs Editor, Ladies Home Journal, St. Louis, Missouri.

Dr. Gardner Lindzey, Chairman, Department of Psychology, The University of Texas.

Mr. Carl T. Rowan, Columnist, Chicago Daily News, Washington, D.C.

Dr. Paul A. Samuelson, Professor of Economics, Massachusetts Institute of Technology.

Dr. Cecil G. Sheps, General Director, Beth Israel Medical Center, Professor of Community Medicine, Mount Sinai School of Medicine.

Dr. Allan F. Smith, Vice President for Academic Affairs, The University of Michigan.

Dr. H. Guyford Stever, President, Carnegie-Mellon University.

At its first meeting the Commission will elect its own chairman and vice chairman.

The Special Commission on the Social Sciences has been asked to address itself to the following:

1. A statement and analysis of the mechanisms and institutions, societal and governmental, that are needed so that the understanding and knowledge gained by the social sciences may be drawn upon and used effectively when they are relevant to understanding and dealing with significant problems in our society.

2. An analysis of what forms of collaboration may be necessary among the social and natural sciences, and engineering, and among their practitioners in addressing these problems; and recommendations concerning how such collaboration might be brought about.

3. A statement of what measures and programs, to be administered by Federal agencies including the National Science Foundation, are required so that the social sciences may be more effective both in generating new knowledge and in its utilization, and so that our society can gain maximum benefit from the growing knowledge derived from fundamental research in social sciences.

Creation of the Special Commission on the Social Sciences at this time is desirable because of the vigorous growth of basic research in the social and behavioral sciences and because of the need to increase the Nation's capacity to use the knowledge so gained.

A parallel effort in the study of social sciences is under way through the Committee on Science and Public Policy of the National Academy of Sciences. That study will focus on the strengthening of research in the fundamental aspects of the social sciences and thus will be complementary to the Commission study.

The National Science Foundation has supported education and research in the basic social sciences almost since its inception and has steadily increased the support throughout the years. Two bills to amend the charter of the Foundation, H.R. 5404 and S. 2598 which are currently under consideration by the Senate, would make explicit the Foundation's authority to support the social sciences. H.R. 5404 has already passed the House of Representatives. The bills would also authorize the Foundation for the first time to support investigations in applied science including investigations in the social sciences.

The Special Commission on the Social Sciences is the third such commission established by the National Science Board. The first such commission was the Special Commission for Rubber Research, which made a final report in 1955. The second was a Special Commission on Weather Modification, which rendered a final report in 1966.

QUESTIONS SUBMITTED TO THE NATIONAL SCIENCE FOUNDATION BY SENATOR GRIFFIN AND THE RESPONSES OF THE FOUNDATION, NOVEMBER 30, 1967

Hon. ROBERT P. GRIFFIN,
U.S. Senate, Washington, D.C.

DEAR SENATOR GRIFFIN: This is in reply to the questions transmitted by your letter of November 20, 1967, addressed to Dr. Philip Handler and to Mr. T. W. Wirths in addition to me. It is my understanding that you plan to include these answers in the record of the hearings before the Special Subcommittee on Science of the Committee on Labor and Public Welfare which were held on November 15 and 16 to consider S. 2598 and H.R. 5404.

Enclosed are the responses to your questions.

If you would like further information from the Foundation on these or other matters, please call on us at any time.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

Question 1. If Congress should add to the National Science Foundation Act of 1950 express authority to support "social sciences," how does the Foundation contemplate expanding its present activities in the social science area? What subjects does the NSF consider to be "social sciences?"

Answer. Although the National Science Foundation Act of 1950 does not enumerate the social sciences among the fields it authorizes the Foundation to support, it contains the words "and other sciences". The legislative history makes it clear that the social sciences were to be included thereby if the Foundation found, upon study, that such action would be appropriate. Study of this question was begun soon after the Foundation began to operate, and support of social science research began on a limited basis in 1954. It has since grown in amount and scope until at present social sciences are eligible in every appropriate NSF program, including education, institutional development, planning, science information, and research.

At present, the Foundation supports numerous research projects in anthropology, economics, economic and social (human) geography, history and philosophy of science, political science, sociology and social psychology, archaeology, demography, and linguistics, and a few projects in history and law. Further, the Division of Social Sciences supports research in combinations of social sciences and of social sciences with other disciplines, in cooperation with other NSF divisions. Support is given to related research in physical geography, other environmental sciences, and psychobiology in other NSF divisions. A variety of research is encouraged, including research projects that are problem-oriented, so long as the research supported holds promise of yielding valid scientific generalizations, rather than being limited to finding solutions for problems peculiar to a particular time, place or event. Thus for research project support, it is the scientific nature of the work rather than the disciplinary category which determines eligibility.

Expansion of National Science Foundation support of the social sciences will depend on availability of funds, rather than upon explicit inclusion of the words proposed in the amendment under discussion. Nevertheless, entering the words explicitly will be a desirable recognition of the fact that the social sciences are presently included in the Foundation's programs and the Act will then more correctly describe the activities the Foundation has carefully and gradually developed, in accordance with the original intent of Congress and with its subsequent concurrence through the appropriations process.

In testimony before the Subcommittee on Government Research of the Senate Committee on Government Operations on February 7, 1967, I commented on Foundation plans for additional support of the social sciences if the new authority which is now contained in H.R. 5404 and S. 2598 were to be enacted. Certain of the comments made then are appropriate, and are summarized below.

If the Foundation were authorized to support applied research, there are several areas which would be appropriate for it to enter under such authority. One would be programs to stimulate the increased application of social science research. Officials dealing with social problems, such as police officers, housing

authorities and clergymen need to be provided with better means of performing their missions. This requires not only better informational and educational efforts, but also that social scientists do more than they now can do to link their basic research to means of applying it practically. The relevant fundamental findings of social, economic, political, and psychological theory should be brought to bear on problems that would help bridge the gap between the academic community and the "real world"—between theory and practice—and might result improved performance of our social institutions. This will require a program of research removed from the laboratory, where theory can be tested under conditions which while less controlled are more realistic. Less often then would programs begin *de novo,* nor would communities be so likely to repeat the errors of the past.

A second area of opportunity arises from the large number of action programs in the public welfare field which are being inaugurated by Federal, State, and local governments. Social science research is not often enough incorporated as a part of such programs, or if it is it usually is limited to the planning phase. Yet there are excellent opportunities for subjecting large-scale social programs to scientific analysis and for using the results in turn to advance social science. We need to be able to use these opportunities for independent and objective study of social change and what we learn can then be fed back into the planning of future programs.

Many of the most urgent problems facing our society are, however, technological in origin and remain problems because we have not developed the social technology with which to cope with the results of scientific technology. A combination of social science, engineering, and natural sciences is required to attack problems such as those arising from water and air pollution, population pressure, and the inadequacies of mass transportation systems. However, the time has come when we must move beyond the facile identification of promising research opportunities. Some beginnings have been made in this area including support by the Foundation's Division of Engineering for applying the techniques of operations research (developed initially for military and industrial problems) to the problems of the city and urban administration and planning.

We intend to establish special study groups with representation from the scientific and government communities to assist us in identifying areas where it would appear fruitful to sponsor work in the expectation that the results might contribute to the solution of specific problems. Other tasks we propose for these groups include recommendations on how fundamental research can be translated more effectively into useful ends for the betterment of society and advice as to which research areas require special stimulation.

In addition, the National Endowment for the Humanities and the Foundation have agreed to establish cooperative arrangements for the joint support of projects straddling the spheres of responsibility of the two agencies.

Question 2. How would the "applied research" provision be implemented, should it be added to the Act?

Answer. Under the proposed revision of the National Science Foundation Act, support of research is specifically authorized as follows:

"SEC. 3. (a) The Foundation is authorized and directed—

(1) to initiate and support basic scientific research * * *

"SEC. 3. (c) In addition to the authority contained in subsections (a) and (b) the Foundation is authorized to initiate and support scientific research, including applied research, at academic and other non-profit institutions. When so directed by the President, the Foundation is further authorized to support, through other appropriate organizations, applied scientific research relevant to national problems involving the public interest."

To implement these provisions, the Foundation plans to broaden its announced coverage to include proposals for support of "scientific research, both basic and applied." The existing policy of limiting support generally to academic institutions and closely related nonprofit institutes will be continued. Applied research at academic institutions will be supported when the research is compatible with the institution's academic program, and gives promise of being useful in its own right either by direct contribution to an important problem or through its potential of generally illuminating broad technological areas. Colleges and universities, however, will not be encouraged to go into the applied research business. Applied research which is not compatible with the over-all academic program would be more appropriately supported in some other type of institution. In supporting "other nonprofit institutions" the Foundation will continue to draw a line between institutions which are broadly considered part of the academic community, and which generate their own programs within a limited field, on the one hand, and

service-type institutions on the other, which exist to undertake research at a sponsor's request. The latter, more appropriately, will be supported only under circumstances arising from the necessity of making rapid progress on national problems as directed by the President under the provisions of Sec. 3(c) above.

Where Section 3(b) applies in "matters relating to international cooperation or national security" the Foundation would plan to utilize all types of institution, academic, non-profit, and profit, as appropriate to accomplish the objectives mutually agreed upon in any particular instance. Similarly, under Section 3(c) when the Foundation is "so directed by the President" the Foundation would support scientific research, both basic and applied as required, in all classes of institutions appropriate to the nature of the problems thus identified.

Question 3. What are NSF's views regarding the inclusion of profit-making institutions, along with academic and nonprofit institutions, in the authorization for research contracts in the pending legislation

Answer. The National Science Foundation's general authority for supporting basic research and education in the sciences includes the authority to make grants to or contracts with profit as well as nonprofit institutions and organizations. If S. 2598 is enacted, the Foundation will also have authority generally to support applied research subject, however, to a limitation with respect to the use of profit organizations. With respect to the Foundation's primary mandate in research and education, the proposed bill limits applied research authority to support of academic and nonprofit organizations, and we anticipate that this authority will be used generally to broaden support of research in areas where the line between basic and applied research is indistinct, where a basic research project must be continued into the applied sphere to provide meaningful results, or to provide support for academic research appropriately associated with educational activities.

Thus, the need to contract for applied research at profit-making institutions would probably only arise in the more special circumstances where the Foundation may be directed by the President to undertake a program of research "relevant to national problems involving the public interest." The limitation of the authority to support applied research by profit-making organizations to such special situations is appropriate. Inasmuch as there is now a wide spectrum of Federal agencies prepared to conduct or support research relevant to their specific missions, it is unlikely that the President would call upon the Foundation to perform this function, except in the rare instance where the work does not fall within the mission of another agency. In such a situation, it might well be desirable for the Foundation to contract with profit-making institutions in the interes of securing the best services available. The inclusion of the authorization to contract with or make grants to profit organizations for applied research in such situations is, therefore, an appropriate expansion of our legislative mandate.

Question 4. How many scholarships and fellowships did NSF issue in the last fiscal year? Please specify categories.

Answer. Tabulated below are NSF fellowship figures for FY 1967 and NSF Traineeships for FY 1966, broken out by program and by field of study.

FISCAL YEAR 1967 DISTRIBUTION OF NSF FELLOWSHIP AWARDEES,[1] BY FIELD

	Total	Graduate	Post-doctoral	Senior post	Science faculty	Senior foreign sciences
Engineering	430	345	10	8	59	8
Mathematical sciences	598	504	20	4	67	3
Physical sciences	960	782	67	25	62	24
Life and medical sciences	523	410	38	20	38	17
Social sciences and psychology	460	409	15	8	24	4
Total	2,971	2,450	150	65	250	56

[1] In contrast to traineeships, where the institution appoints the recipients, fellowships are awarded to individuals selected by the National Science Foundation, in accordance with sec. 10 of the NSF Act, as amended. It is for this reason that we are able to provide a distribution of fellowship awardees by field for fiscal year 1967.

FISCAL YEAR 1966 [1] DISTRIBUTION OF NSF TRAINEESHIPS, BY FIELD

	Graduate traineeships	Summer traineeships for graduate teaching assistants [2]
Engineering	1,789	88
Mathematical sciences	490	156
Physical sciences	1,114	322
Life and medical sciences	388	139
Social sciences and p.ychology	412	205
Total	4,193	910

[1] Comparable field data for the 5,077, fiscal year 1967, graduate traineeships and the 896 summer traineeships for graduate teaching assistants are not presently available. The reason for this is that traineeships are awarded to institutions and the institutions select the recipients. Reports of academic year 1967–68 appointees and their fields of study are still being received from institutions. A further complicating feature of the traineeship program relates to program design and the resulting field distribution. The graduate traineeship program began in fiscal year 1964 but was limited to awards in engineering only; in fiscal year 1965 traineeships were awarded in engineering, mathematics, and the physical sciences; in fiscal year 1966 the life, medical and social sciences and psychology were added to the eligible list for traineeships; in fiscal year 1967 and subsequent years graduate students in all fields of science are eligible for traineeship support and we can anticipate shift of support among the various fields.

[2] Formerly identified as summer fellowships for graduate teaching assistants.

Question 5: What stipends are given recipients of NSF scholarships and fellowships? How does the amount of these stipends compare with stipends given by the Office of Education under programs it administers? Please furnish similar figures for tuition payments to colleges and universities for scholarships and fellowships.

Answer.

A. NSF graduate fellowship program:

Stipend:	*Per calendar year*
First year	$2,400
Intermediate	2,600
Terminal year	2,800

Cost-of-education allowance: In lieu of tuition and fees, $2,500 per Fellow paid by NSF to fellowship institution located in the United States. For Fellows studying abroad only tuition and fees paid by NSF to foreign fellowship institution for Fellow.

Dependency allowance: $500 per year for each dependent (spouse or child).

Travel allowance: 8¢ per mile to fellowship institution. If going abroad, to institution and return to appropriate port of debarkation when U.S. flag carriers are used. No travel allowance between fellowship years for renewals or those beginning second year of two-year award at same institution.

Supplemental stipend: No allowances paid to Fellow by NSF but fellowship institution may supplement the stipend from its own funds to the extent of $750 for a 9-month tenure, $1,000 for a 12-month tenure.

Comparable OE Program: National Defense Graduate Fellowships (Title IV).

Stipend:	*Per academic year*
First year (9 months)	$2,000
Second year (9 months)	2,200
Third year (9 months)	2,400

Each fellow, whatever level, may receive an additional $400 stipend for summer study, thus making the calendar year stipends comparable to those of NSF.

Cost of education allowance: $2,500 per year to U.S. fellowship institution.

Dependency allowance: $400 for each dependent per academic year; $100 for each dependent per summer.

Travel allowance: None.

Supplemental Stipend: None from OE, but Fellow may undertake gainful employment by the institution if such employment is directly related to the doctoral training. Employment remuneration is limited to $1,000 per year.

B. NSF postdoctoral fellowships:

Stipend:	*Per year*
1st 12 months	$6,500
2d 12 months (prorated whenever less than 12 months)	7,000

Cost-of-Education Allowance: $1,000 to host United States institution for 9- or 12-month tenure; prorated according to schedule when institutional affiliation is multiple. $500 to host foreign institutions and non-academic U.S. institutions.

Special Allowance: $150 to Fellow for 9- or 12-month tenure for special fellowship costs and special travel to other laboratories or scientific meetings.

Dependency Allowance: $500 per year for each dependent (spouse or child).

Travel Allowance: 8c per mile for Fellows only to reach fellowship institution, if going abroad, to institution and return to appropriate port of debarkation when U.S.-flag carriers are used. Renewal Fellows continuing at same institution do not receive travel allowance between tenures.

No comparable OE program.

C. Senior postdoctoral fellowships:

Stipend: "Salary-matching", but NSF contribution not to exceed $1250 per month.

Special Allowance: $400 to Fellow on 9- or 12-month tenure, for special fellowship costs such as fees, unusual research expenses, and incidental travel to other laboratories or scientific meetings, pro-rated for longer of shorter tenures according to schedule.

Dependency Allowance: None.

Travel Allowance: Maximum of $2,000. Round trip to institution or between institutions at 8¢ per mile for Fellow, 4¢ for spouse, 3¢ for each dependent child accompanying Fellow. Same allowance for one round-trip abroad (except 8¢ per mile for Fellow only if stay abroad is less than six months), when U.S. Flag carriers are used.

No comparable OE program.

D. Science faculty fellowships:

Stipend: "Salary-matching," but NSF contribution not to exceed $1250 per month.

Cost-of-Education Allowance: $2,500 for predoctoral Fellows, $1,000 for postdoctoral Fellows attending U.S. institutions. Up to $500 (or tuition and fees, whichever is greater) to host foreign institution.

Special Allowance: $150 for Fellow, predoctoral or postdoctoral.

Dependency Allowance: None.

Travel Allowance: Maximum of $1,500. Round trip to institution or between institutions at 8 cents per mile for Fellow, 4 cents for spouse, 3 cents for each dependent child, accompanying Fellow. Same allowance for one round-trip abroad, (except 8 cents per mile for Fellow only if stay abroad is less than six months), when American (U.S.) Flag carriers are used.

No comparable OE program.

E. Senior foreign scientist fellowships:

Stipend: Comparable to faculty salaries at host institution but NSF contribution not to exceed $1,250 per month. Host institution may supplement stipend.

Special Allowance: $400 to Fellow for 8–12 months' tenure. $300 to Fellow for 5–8 months' tenure.

Dependency Allowance: None.

Travel Allowance: Round trip from home to U.S. host institution, at 8 cents per mile for Fellow, 4 cents for spouse, 3 cents for each of two dependent children.

No comparable OE program.

Question 6. Under what standards does NSF operate in granting funds for the erection of college and university facilities? How do these standards differ from those specified by the Higher Education Facilities Act?

Answer. The Foundation's major program for support of academic science facilities, the Graduate Science Facilities program, has as its primary standard the existing scientific merit of the group to be housed by the facility. Thus, the major thrust is toward maintenance of the Nation's presently existing strength in basic scientific research. The program supports only graduate-level facilities and is therefore comparable with the O.E. Graduate Academic Facilities Program, Title II of the Higher Education Facilities Act of 1963, since Title I supports undergraduate facilities. The Title II program, however, places greater emphasis on the institution's plans to expand enrollment and on the wider geographic distribution of funds—no more than 12½% of the appropriation in any year can be made available to projects in any one State. The NSF program supports scientific merit wherever it exists.

The NSF program can support all graduate-level research and research training space (excluding classrooms) whereas the O.E. Graduate Academic Facilities Program excludes space to house postdoctoral personnel but allows classroom space. Also, the Foundation's program supports only science facilities while Title II shares its funds also with the humanities, law schools, and other academic areas. In addition, NSF provides 50% of eligible costs whereas Title II provides 33⅓%. NSF excludes from eligibility the cost of land and of purchasing buildings while Title II supports these costs.

Several other Foundation programs also support academic science facilities, in all cases at the graduate level. The University Science Development Program provides substantial support by including funds for facilities in its grants. There is no fixed matching requirement but there must be an institutional contribution. The program's emphases are on increasing the number of institutions of recognized excellence in research and education in the sciences, and in attaining wide geographic distribution of support provided through the program. The Foundation also has various specialized facilities and equipment programs that provide support primarily for such facilities as nuclear reactors, accelerators, oceanographic vessels, telescopes, and research instruments. These programs also provide a small percentage of the Foundation's total support for academic buildings, usually as housing for a specific research activity the Foundation is supporting. In these programs the emphasis is on scientific merit and there is no fixed matching requirement; up to 100% of the costs can be provided.

Question 7. What is the current ratio of social scientists among doctorate recipients, and how does this ratio compare with the ratio over the past decade?

Social scientists [1] *as percent of all doctorate recipients*

Academic year:	*Percent*
1958–59	15
1959–60	15
1960–61	15
1961–62	15
1962–63	15
1963–64	14
1964–65	13
1965–66	13
1966–67	13

[1] Includes anthropology, economics, agricultural economics, psychology, sociology, linguistics, political science, and geography.

Source: OE degree survey data used through 1964–65. Data for subsequent years estimated by Science Education Studies Group, NSF.

Question 8: From time to time there have been reports regarding the tendency of academic and nonprofit institutions to "shop around" various Federal agencies in search of the most favorable grants. To your knowledge, what is the extent of this? Do you believe that differing standards between agencies may be a cause of such "shopping" and of the flowering of what has popularly been termed as "grantsmanship?"

Answer. It is not at all uncommon for the investigator, through his instituion, to submit the same proposal to several agencies. The extent to which this happens varies considerably among fields, being dependent on the extent of availability of funding for the field in one or more agencies.

The underlying reason for submission of duplicate proposals is the desire to assure funding for the project from some source. The reason for this desire for "insurance" is that it is well known that no agency has had sufficient appropriated funds to be able to activate all the worthwhile projects submitted to it. Accordingly, it is the hope of the investigator that if one agency is unable to fund his project, another might be able to do so. Therefore, not infrequently he submits the same proposal to two agencies, informing each that he has also applied to the other. In any case, the agencies, through exchange of information, are fully aware of this when it occurs. Likewise, agencies are aware of each other's actions with respect to such proposals. The usual outcome is that if one agency offers support, the proposal is withdrawn from the other agency. Or, if both offer support, the investigator chooses the one he prefers and withdraws his application from the other. Occasionally, neither agency can support the project to the extent necessary and, as a consequence, they collaborate, each offering partial support for the project.

The circumstances delineated above are the most usual. There is no real element of "shopping around" involved in this practice beyond seeking assurance for getting support for the project and, hopefully, as large a proportion as possible of the needed funding. Sometimes, because of its own budgetary situation or because of the relation of the proposed work to its own mission, one agency is able to offer a somewhat higher proportion of the needed funds than another. In this sense, the offered terms might be characterized as "more favorable." But otherwise, the terms provided by the different agencies are very similar and provide little basis for choice.

Only in one kind of instance is there a possibility for shopping around for better terms. This refers to support for construction of research facilities and results from the different restrictions, based on legislative mandates, placed on the grants for this purpose of the different agencies. Thus, as delineated in the answer to question 6, the National Science Foundation, since the inception of its graduate facilities program, has been willing to consider provision of up to fifty percent of the costs of construction of graduate research facilities. It requires that its grant funds must be at least matched by non-Federal funds. The National Institutes of Health, on the basis of the provisions of the Health Research Facilities Act, has followed the same practice with respect to "health-related facilities." However, the Office of Education, operating under the terms of Title II of the Higher Education Facilities Act, has been able to consider only 33⅓ percent of the cost of a similar building. In this situation, it is, of course, of some advantage to the institution if it may apply for and receive support from the National Science Foundation or the National Institutes of Health for construction costs of any building which is eligible under the terms of these programs. At the same time, wishing to protect all options, it may also apply to the Office of Education. Accordingly, not infrequently the same proposal is submitted to the programs of several agencies. At other times, the institution will apply to one program for support of one portion of the building and to another for support of another portion. In some instances, help may be obtained from several agencies. However, because there is very close interagency cooperation, all parties are aware of such submissions. Although the agencies have frequently cooperated by joining in support of a given construction project, there is no possibility of offering or providing duplicate support for the same items of a given project.

In short, then, although duplicate or related proposals may be submitted to several agencies, this is not based on differing standards, in terms of acceptable quality, of the different agencies. Rather, it is based on (a) the simple desire on the part of the investigator or the institution to obtain the needed help, (b) the differing missions of the several agencies, and (c) in the case of support of facility construction, the differing "matching" requirements which stem from legislative authorization. We feel that the common inference of the term "grantsmanship" does not really apply to these practices.

While the term "grantsmanship" is imprecise and may convey a variety of meanings to different individuals, we feel that it implies that skill in negotiating or facility in writing may have more bearing on the awarding of grants than the objective merit of projects for which support is requested. Without question, it is true that knowledge of Government programs and procedures is of value in obtaining Federal support for a variety of assistance. However, all Federal agencies welcome the opportunity to advise newcomers seeking assistance concerning how to apply so as to compete effectively, and where in the Government assistance relevant to the needs of an applicant may be obtained. Intercommunication among the agencies takes place continually and in those relatively infrequent

cases where applicants depend upon glibness rather than content, such an applicant's reputation for this approach becomes known quite speedily. For the most part, any temporary advantage which may on occasion be gained by such methods is thought to be of quite short duration. Actually, the acquisition of such a reputation probably would, in the long run, prove to be a liability. In short, program administrators try to see that this program supports worthwhile projects; good administrators seek to support on the basis of merit, and regard it as a reflection on their own ability to be taken in by "operators."

Question 9. The Senate Committee on Labor and Public Welfare, in its 1965 report on the Higher Education Act, observed:

"The committee has noted that there has been a tendency in recent years for college teachers to devote less time to classroom instruction and to personal counseling of students than previously, factors which have become more evident as institutions of higher education have become larger and more impersonal. While recognizing the importance of research—which this committee itself has encouraged in other legislation—we nevertheless are hopeful that this act will serve to encourage the expert and the teacher to devote more time to the classroom and the student. We look to an equitable balance between research and teaching and between the outside lecture platform or publishing house and the classroom."

Please comment on this. How do you think that this "equitable balance" may best be achieved?

Answer. The matter of an equitable balance between research and teaching is one to which all institutions of higher education are particularly sensitive as is is the National Science Foundation. In any discussion of the teaching function vis-a-viz the research function in an academic setting, one must recognize that in graduate education the research function has a large component of instruction associated with it. In fact, in the research laboratory the distinction between research and teaching disappears and is replaced by one activity—learning. The association of the graduate student with his research mentor is a true instructional situation which includes personal counseling as well as the acquisition of new knowledge. This association very frequently forms the basis of lasting intellectual relationships between scientists. The fact that graduate students and faculty are engaged in Research and Development activities on campuses cannot be interpreted as meaning that learning is not taking place nor that the researcher is not involved in a teaching role.

The Foundation, in administering its programs, seeks to promote an equitable balance between research and teaching. However, the Foundation recognizes that foremost it is the responsibility of the institution to allocate its resources, including manpower, to meet the varying needs its faces. To the extent possible within this general structure, the Foundation actively encourages the involvement of the research scientist in classroom teaching in addition to the instructional aspects of his research. The Committee on Academic Science and Engineering of the Federal Council for Science and Technology maintains the view (to which the Foundation subscribes) that only special and rare circumstances should exist to warrant full-time devotion to research to the exclusion of teaching responsibilities. On the other hand, if a university chooses to make such an exclusive assignment, the Foundation, in line with its basic belief in university autonomy, while not encouraging such an arrangement does not rule out the possibility of support.

The Foundation is not only concerned with an equitable balance between the research and teaching activities of present faculty; it is also vitally concerned with the need for more and better prepared college and university teachers. Accordingly, the Foundation has placed considerable emphasis on the importance of a teaching experience for graduate students during their fellowship and traineeship tenures. The language in the Graduate Traineeship program announcement will serve to illustrate the Foundation's position.

"Because a reasonable amount of teaching constitutes a valuable part of the education of many graduate students, a Trainee may include in his training program such teaching as is in the faculty's opinion contributing to his academic progress. As provided below, he may receive additional funds for such activities, up to a specified maximum."

Survey results show that an appreciable number of Graduate Fellows and Trainees avail themselves of a teaching opportunity during their tenure period.

Another indication of the Foundation's interest in rewarding individuals engaged in teaching is manifest in its support, during the summer months, of graduate students who during the academic year have served as full-time teaching assistants. This is the only Federal program devoted exclusively to meeting the specific

graduate training needs of this group of student-teachers. Formerly known as Summer Fellowships for Graduate Teaching Assistants, the Foundation now administers the program under the title "Summer Traineeships for Graduate Teaching Assistants."

We believe that these measures contribute towards an "equitable balance" between teaching and research.

Question 10. Please furnish the committee with a list of conferences and conventions attended by NSF personnel during the last fiscal year, their location, their duration and the number of NSF personnel attending.

Answer. Officials of the National Science Foundation attend conferences and conventions for two principal reasons. In the first place, the conference is a mechanism whereby the staff official of the Foundation is brought up-to-date on the current developments in the scientific discipline relevant to his official responsibilities. This is not only essential in order that the official can effectively evaluate proposals received in the context of new developments in his field but is also a valuable ingredient of career development. In the second place, conferences and conventions are a convenient meeting place for Foundation officials and grant recipients. At such meetings Foundation personnel review with grantees the status of projects, the progress of work, accomplishments, and problems being encountered. In many cases a single such meeting can take the place of several site visits which would be more expensive in terms of time and travel money.

The attached list furnishes the information you requested.

1966

Meeting attended	Location	Days duration	NSF personnel attending
JULY			
Meeting of Board of Directors of Engineering Index, Inc	New York	1	2
American Library Association Meeting	do	7	1
68th Meeting of Association of Research Libraries	do	1	1
Joint Commission on Union List of Serials	do	1	1
1966 Gordon Research Conference	New Hampton, N.H	6	1
National School Facilities Conference	Omaha	1	1
Commission on Engineering Education Meeting	Boulder	1	1
Meeting of Committee of Advisory Council on College Chemistry	USAF Academy, Colorado Springs.	2	2
Interuniversity Communication Counsel Conference EDUCOM	Boulder	6	2
Medical Equipment Display and Conference	Boston	3	1
Engineer Foundation Research Conference on the Role of Technological Change.	Andover	1	1
NAS–NRC Commission on the Alaska Earthquake	Stanford	4	1
AUGUST			
American Statistical Association Meeting	Los Angeles	6	1
Symposium on Radio Astronomy Glactic System	Noordwijk, Netherlands	5	2
Symposium on Solar Terrestrial Physics	Belgrade, Yugoslavia	4	2
The 11th Pacific Science Congress	Tokyo, Japan	15	4
The Laurentian Hormone Conference	Montreal, Canada	6	1
3d International Heat Transfer Conference	Chicago	4	2
Conference of Physics Teachers in 2-year Colleges	Stony Brook, N.Y	2	1
Annual Meeting of American Sociological Association	Miami	4	5
The Society of Experimental Social Psychology Meeting	New York	1	1
Low Temperature Calerisetry Conference	Helsinki, Finland	4	1
10th International Conference on Low Temperature Physics	Moscow, Russia	7	1
Symposium on Long-Range Forecasting and Planning	USAF Academy, Colorado Springs.	4	1
13th International High Energy Physics Conference	Berkeley	8	2
American Association of Geographers	Toronto, Canada	4	1
Engineering Foundation Research Conference	Santa Barbara	5	1
Association for Computing Machinery Conference	Los Angeles	5	2
Gordon Research Conference on Infrared Spectroscopy	Lebanon, N.H	6	1
Genetics Society of America Meeting	Chicago	14	1
3d International Congress of Human Genetics	do	14	1
Midwest Economic Association Meeting	San Francisco	4	1
American Statistical Association Meeting	Los Angeles	7	1
Meeting of the American Physical Society	Mexico City	3	1
5th Congress on the International Mineralogical Association	Cambridge, England	15	1
SEPTEMBER			
Medicinal Chemistry Symposium	New York	3	1
Mutational Genetics Conference	Bar Harbor	7	1
10th Annual Conference of the Association of College and University	Ann Arbor, Mich	3	2
Conference on Priorities at Columbia University	New York	2	1

1966—Continued

Meeting attended	Location	Days duration	NSF personnel attending
SEPTEMBER—Continued			
Intersociety Energy Conversion Engineering Conference	Los Angeles	1	1
152d National-American Chemical Society	New York	5	10
Conference of 100 Special Project Instructors of Biological Sciences Curriculum Study.	Chicago	3	1
Executive and General Meeting of the American Fisheries Society	Kansas City	3	1
Antarctic Oceanography Symposium	Santiago, Chile	4	1
The 9th SCAR Meeting	do	5	1
International Conference on Nuclear Physics	Gatlinburg, Tenn	4	2
Celebration of the 50th Anniversary of the Founding of the National Research Council of Canada Ceremonies.	Ottawa, Canada	3	1
Ohio State University Symposium Molecular Structure and Spectroscopy.	Columbus, Ohio	4	1
Research Committee Meeting of the National Association of Manufacturers.	New York	1	1
15th Annual Meeting of General Assembly of the International Scientific Radio Union.	Munich, Germany	15	3
74th Annual Convention of American Psychological Association Convention.	New York	4	4
6th World Congress of Sociology Meeting	Evian, France	21	1
American Meteorological Society (Conference on Marine (Oceanic) Meteorology).	Virginia Beach	3	1
15th General Assembly of International Scientific Radio Union	Munich, Germany	2	1
2d International Biophysics Congress	Vienna, Austria	5	1
1st International Symposium on Electro Sleep and Electro Anesthesia	Graz, Austria	3	1
1966 International Conference on Instrumentation for High Energy Physics.	Palo Alto, Calif	3	1
ASCE Conference on Electronic Computation	UCLA, Los Angeles	4	1
Special National Conference of the U.S. National Commission for UNESCO.	New Orleans	3	1
Water Pollution Control Federation Annual Conference	Manhattan, Kans	3	1
Conference on Higher Education	London, England	3	1
OCTOBER			
Conference on Turbulence and Collision Free Shock Waves in Plasmas	Cleveland	2	1
21st Annual Federal Safety Conference	Chicago	5	1
ACS Westernal Regional Meeting	San Francisco	1	1
Optical Society of America and the Society for Applied Spectroscopy	do	2	1
National Academy of Engineering Symposium	New York	2	1
American Sociological Association Committee Meeting	Ann Arbor	3	1
The Migration of Scientific and Technical Personnel	Paris, France	3	1
Seminar on Planning for College and University Facilities	New York	2	1
Public Expectations of Business Leadership in Social Progress	do	1	1
20th National Conference on the Administration of Research	Miami	4	2
Gaseous Electronics Conference	Atlanta	2	1
International Minerals Cooperation Symposium	Chicago	3	1
75th Anniversary Conference of the California Institute of Technology	Pasadena	8	2
American Psychnomic Society Meeting	St. Louis	3	1
3d United States-Japan Seminar on Paleomagnetism	Kyoto, Japan	10	1
Conference on Architectural Research	St. Louis	3	2
18th Annual Conference of the Association of Graduate Schools	New York	2	1
Research in the Service of Man, a conference on biomedical knowledge; research, development, and use.	Oklahoma City	4	1
American Documentation Institute Convention	Los Angeles	6	1
Joint Council on Economic Education	New Orleans	1	1
2d Conference on Undergraduate Chemistry Curriculum in the North Central State Region.	Fargo, N. Dak	3	1
New England Regional Conference of the National Science Teachers Association.	Hartford	1	1
Conference on Articulation and the Sciences Between Junior Colleges and 4-Year Colleges.	Des Moines	1	1
49th Annual Meeting of the American Council on Education	New Orleans	3	5
Meeting of Institute of Electronic Engineers Research Committee	Chicago	1	1
National Electronic Conference	do	2	3
13th Annual Symposium on Systematics	St. Louis	3	1
3d Systems Symposium	Cleveland	2	1
National Electronics Conference	Chicago	3	1
29th Annual Convention of the American Documentation Institute	Santa Monica	1	1
Operations Research Society of America Meeting	Durham	4	1
International Minerals and Chemical Cooperation Symposium on Photosynthesis.	Chicago	3	1
NOVEMBER			
American Society of Cell Biology	Houston	4	1
Southern Economic Association Meeting	Atlanta	3	1
The Council of Graduate Schools in the United States	Denver	4	1
Winter Annual Meeting of American Society of Mechanical Engineers	New York	4	3
The National Industrial Conference Board	do	1	1

1966—Continued

Meeting attended	Location	Days duration	NSF personnel attending
NOVEMBER—Continued			
The American Astronautical Society Conference on Management of Aerospace Programs.	Columbia, Mo	4	1
Annual Meeting of the Geological Society of America and Related Societies.	San Francisco	4	1
Convention on Society of Exploration Geophysicists	Houston	6	1
Conference on Condensation Nuclei and Warm Fog Dissipation	Cambridge, Mass	3	1
Communication in Science Symposium	London, England	3	1
Meeting on Scientific Information Activities in the United States	The Hague, Netherlands	1	1
Annual Meeting of the Entomological Society of America	Portland, Oreg	5	2
Annual Meeting of the American Anthropological Society	Pittsburgh	4	2
National Symposium on Stabilization of Engineering and Scientific Employment.	Los Angeles	8	1
Meeting of the Texas Psychological Association	Austin, Tex	3	1
Annual Joint Services Technical Advisory Committee	New York	2	1
National Superconductivity Information Meeting	Upton, N.Y	4	1
Fall Joint Computer Conference	San Francisco	3	4
41st Annual Meeting of the American Society of Parasitologists	San Juan, P.R	3	1
Symposium on Research on R. & D. Management Priorities	New Haven, Conn	1	1
5th Annual Eastern Theoretical Physics Conference	Providence, R.I	3	1
Annual Meeting of Pacific Coast Physical Plant Administrators of Colleges and Universities.	Los Angeles	6	1
Symposium on the Study of Personality	Houston	2	1
National Meeting of the Geological Society of America	San Francisco	3	4
Symposium on Basic Research by the Department of Defense	Detroit	2	1
DECEMBER			
SACS–SREB Conference on Higher Education for the Negro	Atlanta	2	1
Multiple Molecular Forms of Enzymes	New York	3	1
Conference on In-House Government Science Management Research Problems at Northwestern University.	Chicago	3	1
47th Annual Meeting of the Eastern Association of College Business Officers.	Boston	4	3
Conference for Federal Science Exchange	Williamsburg	6	1
8th Meeting of the Committee on Scientific and Technical Communication (SATCOM).	New York	2	2
59th Annual Meeting of the American Institute of Chemical Engineers	Detroit	5	1
Annual American Economics Association Meeting	San Francisco	4	1
SES American Physical Society	Nashville	1	3
American Astronomical Society Meeting, University of California	Los Angeles	11	1
Meeting of Linguistic Society of America	New York	2	1
American Economic Association Meeting	San Francisco	8	2

1967

JANUARY			
United States-Japan Program Seminar on Immochemistry and United States-Japan Program Seminar on Cell Biology.	Honolulu	5	1
International Symposium on Atomic, Molecular, and Solid-State Theory.	Sanibel Island, Fla	5	1
Symposium on Thermal Neutron Scattering Applied to Chemical and Solid-State Physics.	Atlanta	3	1
"Texas" Symposium on Relativistic Astrophysics	New York	11	2
Seminar on International Affairs and Federal Operations	Kings Point	14	1
Regional Conference on Current Problems in Science Education	Kalamazoo	4	1
4th Coral Gables Conference on Symmetry Principle at High Energy	Miami	3	1
American Society of Heating, Refrigerating, and Air Conditioning Engineers Committee.	Detroit	5	1
The 8th of the Fall Series of Industrial Liaison Symposia	Cambridge	3	1
Cell Biology Study Meeting	New York	4	1
Engineers Joint Council Meeting on "Future Planning for Primary Publications."	do	3	2
American Library Associations Midwinter Meeting	New Orleans	1	1
Conference on International Education Act	New York	2	1
Conference on Industrial R. & D. Management	Lafayette, Ind	5	1
Meeting of Program Committee for 1967 National Telemetering Conference.	New York	2	1
2d Annual National Conference on Industrial Research	Lafayette, Ind	4	3
73d Annual Meeting of the American Mathematical Society	Houston	6	8
American Library Association Conference	New Orleans	6	1
Meeting of the Government and Industrial Panel of the Conference Board of Mathematical Sciences Survey Committee.	New York	3	1
Annual Meeting of the American Meteorological Society	do	4	2
Conference on Research Management	Meriden, Conn	3	1
Industrywide Conference Relating to the Report of the President's Commission on the Patent System.	New York	2	1

1967—Continued

Meeting attended	Location	Days duration	NSF personnel attending
FEBRUARY			
1st Meeting of the American Institute of Physics Committee on Scientific Information and Technology.	New York	2	1
American Society of Civil Engineers Environmental Conference	Dallas	6	1
Conference on Social Science in the Schools	Lafayette, Ind	2	1
Annual American Physical Society Meeting	New York	2	10
Conference on the Present and Potential Contribution of the Social Sciences to Research and Policy Formulation in the Quality of the Physical Environment.	Boulder	2	1
American Mathematical Society and Association Meeting	New York	3	1
National Association for Research in Science Teaching Conference	Chicago	4	1
Conference on Engineering in the Civilian Economy	Lafayette, Ind	3	1
Conference on Contribution of Social Sciences to Research and Policy Formulation in the Quality of the Physical Environment.	Denver	2	1
Steering Committee Meeting of Engineering Foundation Research Conference.	New York	3	1
National Meeting of the American Institute of Chemical Engineers	Houston	9	1
Conference on Indian Education at Temple University	Philadelphia	2	1
Joint Services Technical Meeting at the University of Southern California.	Los Angeles	6	1
American Association of Physics Teachers Meeting	New York	2	2
Biophysical Society Meeting	Houston	3	1
MARCH			
Annual Meeting of the Western Association of Graduate Schools	Honolulu	9	2
National Convention of Institute of Electrical and Electronics Engineers	New York	4	1
Polar Research Glaciology Panel Conference	Tucson	6	1
APRIL			
153d National American Chemical Society Meeting	Miami	5	3
Task Group on Human Dimensions for Weather Modification	Santa Barbara	3	2
University Seminar on Higher Education	New York	1	1
Conference on the Future of Science in the Liberal Arts College	Norton, Mass	2	1
NCAR-Government-NAS Meeting Dealing With Global Atmospheric Research.	Denver	1	1
Organizing the Campus for the Administration of Sponsored Programs	Albany	2	1
National Conference on Higher Education and the International Flow of Manpower.	Minneapolis	3	1
American Philosophical Society Meeting	Philadelphia	3	1
11th Conference on Directors of Systematic Collactions	Chicago	4	1
Symposium on Combinatorial Mathematics and Its Applications	Chapel Hill	4	1
Association of Southeastern Biologists Meeting	Columbia, S.C	5	1
Midwest Economic Association Meeting	Houston	1	2
Federation of American Societies for Experimental Biology Meeting	Chicago	5	3
Spring Joint Computer Conference	Atlantic City	4	1
NSIA Meeting	Sunnyvalle, Calf	4	1
Symposium on the Development of Doctoral Programs by Small Liberal Arts Colleges.	Brunswick, Maine	3	2
Conference on Current Latin American Study	Houston	3	1
Conference on Electronic Information Handling	Pittsburgh	3	1
Faculty Seminar on Science and Government	Charlottesville	2	1
Conference on Higher Education in Tomorrow's World	Ann Arbor	5	1
Conference of College and University Business Officers	Albuquerque	4	1
MAY			
American Society for Microbiology	New York	2	1
Conference on Crisis in the Environment and the Scientists Responsibility to the Public.	do	2	1
4th Annual National Colloquium on Information Retrieval	Philadelphia	3	1
Meetings of the Midwest Psychological Association	Chicago	3	1
5th Annual Association for Educationa Data Systems Convention	Detroit	3	1
Conference of College Educators From State of Kansas and From Other Federal Education Agencies.	McPherson, Kans	3	1
Structural Engineering Meeting—Earthquake	Seattle	7	2
Meeting of U.S. National Committee of the International Scientific Radio Union (URSI).	Ottawa, Canada	5	1
Conference for Federal Executives on Business Operations	Cleveland	5	1
Do	New York	6	1
Annual Meeting of the Council of Biology Editors	do	2	1
55th Meeting of the Central Association of College and University Business Officers.	St. Louis	1	1
Annual Meeting of the Western Association of College and University Business Officers.	San Francisco	4	1
Symposium on Markov Processes and Potential Theory	Madison	3	1
Liberal Arts Seminar, Du Pont Experimental Station	Wilmington	2	1
Society for American Archeology	Ann Arbor	4	2
American Sociological Association Committee Meeting	Detroit	2	1

1967—Continued

Meeting attended	Location	Days duration	NSF personnel attending
MAY—Continued			
Annual Meeting of Education Commission of the States	Denver	3	1
Conference of United States-Japan on the Sciences and Chemists Program.	New York	3	1
69th American Ceramic Society Meeting	do	1	1
18th Annual Conference of Council on Foundations, Inc	Boston	3	1
Symposium on Origin and Distribution of the Elements	Paris, France	7	1
2d Radioecology Symposium	Ann Arbor	5	2
Council of Graduate Schools Committee on Uniform Application Forms	St. Louis	1	1
Conference on Higher Education	McPherson, Kans	3	1
Meeting of U.S. Section of the International Council for Bird Preservation.	New York	1	1
Navy League Seminar on Oceanography and Sea Power	do	1	1
JUNE			
Data Processing Management Association International Conference	Boston	1	3
Symposium at the Center for Visual Science	Rochester	3	1
20th National Organic Chemistry Symposium	Burlington, Vt	5	1
American Society of Ichthyologists and Herpetologists	San Francisco	8	1
Computers in Education	Palo Alto	5	1
Gordon Research Conference on Magnetic Resonance	Laconia, N.H	11	2
American Astronomical Society	Williams Bay, Wis	3	1
International Symposium on Eutrophication	Madison, Wis	7	1
Conference on Computers in Chemistry	San Diego	6	3
Planning Conference on Applied Undersea Research and Oceanography.	New London	2	1
Annual Meeting of American Engineering Education	East Lansing	2	5
American Society Pharmacognosy	Detroit	6	1
Symposium on Computer Research and Humanistic Studies	Pittsburgh	3	1
Conference on American Library Association and Association of Research Libraries.	Berkeley	3	1
Annual Meeting of the Midwest Section of the American Society of Plant Physiologists.	Ann Arbor	3	1
Programing for the Seventies	Chapel Hill, N.C	2	1
Population Biology Conference and Cold Spring Harbor Symposium	Syracuse	9	1
Council of Social Science Data Archives Meetings	San Francisco	6	2
20th National Organic Chemistry Symposium	Burlington, Vt	9	1
2d Conference of the Modern Language Association of America's Center for Editions of American Authors.	New York	1	1
American Society of Limnologists and Oceanographers Meeting	St. John's, Newfoundland.	7	1
International Conference on Systematics Biology	Ann Arbor	4	4
Conference on Graduate Academic and Research Programs in Computing Science.	New York	3	2
Symposium on Reactor Research	San Diego	10	1
Conference Exploring the Feasibility of Computer Utilization in the Field of Humanities.	Scranton	2	2
Executive Seminar on Administration of Public Policy	Kings Point, N.Y	13	1
Surtsey Research Conference	Reykjavik, Iceland	8	1
Conference on Poverty	Madison Wis	4	1
Developmental Biology Society Symposium	San Diego	5	1
Meeting of American Association of Physics Teachers at St. Lawrence University.	Canton, N.Y	5	1

Question 11. How much of the fiscal year 1967 NSF budget was devoted to travel? What is contemplated for fiscal year 1968?

Answer.

During fiscal year 1967, the following travel costs were incurred:

Staff travel	$380, 108
Consultants and panel members	348, 438
National Science Board	28, 487
	757, 033

The following travel costs are estimated for fiscal year 1968:

Staff travel	$418, 500
Consultants and panel members	394, 000
National Science Board	36, 000
	848, 500

Question 12. What were the NSF expenditures for printing during fiscal year 1967? How much of this was done by the Government Printing Office, how much by private contract, and how much through NSF facilities?

The following printing costs were incurred during fiscal year 1967:

Government Printing Office	$145, 790
Private contract	68, 312
NSF facilities (personnel and supplies)	94, 226
Total	308, 328

Question 13. During the House debate on H.R. 5404, it was pointed out (p. H3979) that NSF is relieved of the provisions in the law requiring advertising for bids. Please comment on this. What are NSF procurement policies with respect to bidding?

Answer. The comments referred to on page H3979 appear to pertain to construction performed by grantees under grants awarded by the NSF science development and departmental improvement programs. The restrictions of Revised Statutes 3709 do not apply to grants. Under NSF grants, we rely on the grantee organization for application of sound business practices.

In its own contracting, the NSF follows the Federal Procurement Regulations, i.e., it obtains bids whenever FPR would require it to do so.

Question 14. With further reference to the House debate, it was indicated (p. H3979) that NSF, unlike other agencies, can make payment before performance. Please comment on this.

Answer. Authority to make payments to grantees before performance under grant awards is contained in Sec. 11(d) of the National Science Foundation Act of 1950 (P.L. 507—81st Congress) as amended through August 15, 1963. This section reads as follows:

"SEC. 11. The Foundation shall have the authority, within the limits of available appropriations, to do all things necessary to carry out the provisions of this Act, including, but without being limited thereto, the authority * * *.

"(d) to make advance, progress, and other payments which relate to scientific research without regard to the provisions of section 3648 of the Revised Statutes (31 U.S.C., sec. 529);"

The legislative history supporting this concept recognizes that the Foundation is dealing primarily with educational institutions who generally do not have sufficient working capital for financing research and science activities. House Report 796 of the 81st Congress contains the following comment relating to this point:

"Since a large part of the research sponsored by the Foundation will inevitably be done by academic institutions; and since such institutions by and large lack freely available working capital, Sub. Sec. (d) of the bill provides that the Foundation may make advance and progress payments to finance the research."

Although Section 11(d) makes specific reference to "scientific research", there are a number of indications in the legislative history that the paragraph was intended to cover other science activities conducted by the Foundation in addition to basic research.

As a matter of practice, the Foundation furnishes advance payments to grantees covering no more than 30 days requirements and monitors cash on hand balances to assure that funds are not being requisitioned in larger amounts than required.

Question 15. What members of the National Science Board also serve on the President's Science Advisory Committee, advisory committees of the National Academy of Sciences, or other Federal advisory groups?

Answer.

AFFILIATIONS OF MEMBERS OF THE NATIONAL SCIENCE BOARD ON PRESIDENT'S SCIENCE ADVISORY COMMITTEE, ADVISORY COMMITTEES OF THE NATIONAL ACADEMY OF SCIENCES, AND OTHER FEDERAL ADVISORY GROUPS

Organization	*Board Member*
Atomic Energy Commission:	
Argonne National Laboratory	Goldsmith
Oak Ridge Associated Universities	Reynolds
Oak Ridge National Laboratory	Reynolds
Reactor Development Division	Brooks
Communications Satellite Corp	Hagerty

Organization	*Board Member*
Department of Commerce:	
Interagency Committee for International Meteorological Programs	Haworth
National Bureau of Standards	Eyring, Piore
Panel on Technology and the Economy	Brooks
Department of Defense:	
Air Force:	
Air Force Systems Command	Piore
Air University Board of Visitors	Hagerty
Army:	
Advisory Council, Chemical Corps	Eyring
Defense:	
Defense Industry Advisory Council	Piore
Defense Science Board	*Haworth (statutory)
Navy:	
Naval Research Advisory Committee	Brooks
Navy's Advisory Board on Education Requirements	T. Jones
Department of Health, Education, and Welfare:	
Health Sciences Advancement Award Panel	Thieme
National Institutes of Health:	
National Advisory Arthritis and Metabolic Diseases Council	McBride
National Institute of General Medical Science, general medical research program—project committee	Carter
Public Health Service, U.S.: National Advisory Dental Research Council	Thieme
Regional Advisory Committee on Manpower	Tyler
U.S. Office of Education:	
Advisory Committee on Graduate Programs	Heyns
Panel on Research and Development Centers	Tyler
Research Advisory Council	Tyler
Department of Housing and Urban Development: Interagency Working Committee on Science and Urban Problems	Haworth
Department of the Interior: U.S. Geological Survey	Goldsmith
Department of Labor: Regional Advisory Committee on Manpower	Tyler
Department of State:	
Agency for International Development:	
Advisory Committee for AID-University Relations	Sullivan
Research Advisory Committee	Haworth
Science Liaison Group	Haworth
Department of the Treasury:	
Interdepartmental Savings Bond Committee	Haworth
U.S. Coast Guard Academy Advisory Committee	Hagerty
National Academy of Education	Tyler
National Academy of Engineering	Piore
National Academy of Sciences:	
Ad Hoc Committee on Postdoctoral Study	T. Jones
Committee on Cyrus B. Comstock Fund	Piore
Committee on Marcellus Hartley Fund	Piore
Committee on Science and Public Policy	Brooks
Ad Hoc Panel on Applied Research	Brooks
Committee on Research in the Life Sciences	Handler
Committee on U.S. Steel Award	Handler
Council Member	Carter, McShane

*Leland J. Haworth, as Director of the National Science Foundation, serves as the NSF representative in those cases listed. As indicated in the list, several of these assignments result from statutory requirements or Executive orders.

Organization	*Board Member*
National Academy of Sciences—Continued	
Environmental Studies Board (jointly with National Academy of Engineering)	Morison
National Research Council:	
Advisory Committee on U.S.S.R. and Eastern Europe, Office of the Foreign Secretary	Carter
Committee on Kinetics of Chemical Reactions, Division of Chemistry and Chemical Technology	Eyring
Committee on Oceanography, Division of Earth Sciences	Spilhaus
Highway Research Board, Division of Engineering	T. Jones
Panel on Solid State Sciences, Division of Physical Sciences	Brooks
U.S. National Committee for the International Mathematical Union (IMU), Division of Mathematical Sciences	McShane
U.S. National Committee for the Scientific Committee on Oceanic Research of the International Council of Scientific Unions, Division of Earth Sciences	Spilhaus
National Advisory Commission on Health Manpower	Bunting
National Advisory Council on Regional Medical Programs	Bunting
National Aeronautics and Space Administration: Ad Hoc Science Advisory Committee	Heyns
National Council on Marine Resources and Engineering Development	Haworth (statutory)
Consultant	Brooks
National Foundation on the Arts and the Humanities: Federal Council on the Arts and the Humanities	Haworth (statutory)
Organization for Economic Cooperation and Development	Brooks
White House:	
Commission on Presidential Scholars	Hagerty
National Advisory Council on Education for Disadvantaged Children	Tyler
Office of Economic Opportunity: Advisory Committee, "Upward Bound"	Sullivan
Office of Science and Technology: Federal Council for Science and Technology	Brooks, Haworth (Executive Order 10807), Mar. 13, 1959
Committee on Academic Science and Engineering	Haworth
Committee on Federal Laboratories	Haworth
Coordinating Committee on Materials Research and Development	Brooks (consultant)
Interdepartmental Committee for Atmospheric Sciences	Haworth
International Committee	Haworth
President's Committee on Manpower	Haworth (Executive Order 11152), Apr. 15, 1964
President's Science Advisory Committee	Brooks, Handler

Question 16. How does NSF coordinate its educational activities with those of the Office of Education

Answer. It is clearly recognized in an area as important as education that the Federal Government has an opportunity and a responsibility to assist people, institutions, school systems, etc., in meeting national goals, such as—

Improving the subject matter competence of teachers at all educational levels and in all fields;

Improving course content and instructional materials for all educational levels and in all fields;

Improving instruction at all educational levels and in all fields by assisting institutions to acquire instructional tools;

Increasing the knowledge and experiences of students at the pre-college, college, graduate and post-graduate levels of study;

Supporting training of graduate students in all fields, with particular emphasis at appropriate times on certain specialized fields which are known to be, or will be in the foreseeable future, in short supply of well-trained manpower;

Providing support on a wide geographical base for the improvement to all educational levels and all fields, thus helping all areas in the United States to become stronger; and

Improving the literacy of the American public at large.

In carrying out its mandate "to strengthen the education in the sciences," the National Science Foundation seeks to improve the quality of science at all educational levels and in all fields of science. Such improvement is a complicated and long-range task, to be accomplished only through patience, persistence, and sensitivity to the needs of established scientists and of those young people, at all stages of education. who may some day achieve eminence in science. The attainment of national goals in science education also demands wholehearted collaboration between the Foundation and the educational institutions, with mutual understanding of each other's strengths and limitations. Another important aspect is that there must be a general advancement on all eductaional levels and in all fields of science and non-science, a role in which the Foundation can play only a part in achieving. In particular, this calls for a close collaboration between the National Science Foundation and the U.S. Office of Education.

The fact that close collaboration between these two agencies and their staffs does exist, and is increasing yearly, may be illustrated by the examples of formal and informal collaborative activities which follow.

Staff of the Foundation and Office of Education serve together on a variety of important committees and panels.

A. Interagency committees and panels

1. Federal Interagency Committee on Education (FICE).
   Subcommittee on University/Government Relations (FICE).
   Staff Coordinating Group (FICE).
   Student Support Study Group (FICE).
2. Federal Fellowship Administrators.
3. Committee on Scientific & Technical Information (COSATI), Panel on Education & Training.
4. Federal Council on Science and Technology.
   Committee on Academic Science and Engineering (chaired by NSF).
   Committee on Environmental Quality, Subcommittee on Information, Education, Manpower, and Facilities.
5. Special Committee on Educational Uses of Computers (chaired by NSF).

B. Advisory committees and panels

1. Advisory Committee, Division of Laboratories and Research Development OE (for policy development and evaluation as well as proposal evaluation). Title VII, NDEA.
2. Advisory Committee, National Center for Educational Statistics.
3. Advisory Panel, Division of Graduate Education, OE (for policy formulation for new fellowship program for persons planning teaching careers) Elementary and Secondary Education Act.
4. Advisory Panel, Division of Research Training and Dissemination, OE (policy and program formulation for new programs for training educational researchers). Elementary and Secondary Education Act.
5. Advisory Panel, Division of Educational Personnel Training, OE (for formulation of policy for new program of fellowships for experienced teachers) Elementary and Secondary Education Act.
6. Advisory Committee on New Educational Media, OE (development and evaluation of all OE activities involving devices used in instruction, including the review of individual proposals).
7. Advisory Committee on USOE Regional Educational Laboratories (The NSF Conference on Coordination of Curriculum Studies devoted its fall meeting to a joint meeting with leaders of the USOE Regional Educational Laboratories for information purposes about each other's programs and for the development of

useful interaction between the Laboratories and the Foundation's educational programs and projects).

8. Advisory Committee on Cooperative Research, OE.

9. Advisory Panel, Division of Elementary and Secondary Research, OE (for evaluation of proposals).

10. Advisory Panel, Developing Institutions (Title III of Higher Education Act of 1965).

11. Proposal Evaluation Panel, Developing Institutions (Title III, Higher Education Act, 1965).

12. Advisory Panel, Instructional Equipment (Title VI of Higher Education Act of 1965).

13. Advisory Discussions on Education Professions Development Act of 1967.

14. Working Group on Joint Publication Policy. Continuing activity involving CCI/NSF and OE staff.

15. USOE staff (6) served on NSF proposal evaluation panels in past year.

16. The former Commissioner of Education (Mr. Keppel) served as a member of the NSF Advisory Committee for Science Education.

C. Joint funding of projects, examples

1. Harvard Project Physics.

2. Conference for State Supervisors of Mathematics (impact of OE and NSF teacher education and CCI projects on local instructional programs).

3. Utilization of a Regional Educational Research Laboratory facility in a study to evaluate problems in the widespread adoption of new curricula.

4. Combining of OE Elementary and Secondary Education Act, Title III grants in local situations to implement adoption of new curricular materials in conjunction with NSF Cooperative College-School Science Program grants.

D. Less formal arrangements

1. USOE staff (10) served as field visitors to evaluate NSF institutes.

2. Joint meeting of Professional Staffs of Division of Education and Professional Training, OE and Teacher Education Section, PES/NSF.

3. Monthly meeting, Professional Staff of Bureau of Research, OE and Special Projects Program, UES/NSF.

4. Staffs of the two agencies meet frequently to share information and future plans so that their respective programs can complement each other to the maximum extent possible. Further, following the passage of the important educational legislation of 1965, Foundation personnel helped OE personnel develop many of the OE programs needed to implement that legislation.

5. USOE personnel have been invited by NSF to address meetings of NSF project directors in order to explain to college and university personnel the recent education legislation and other OE programs.

6. Close cooperation between NSF Fellowship staff and the OE/NDEA Fellowship staff.

7. OE personnel have attended NSF meetings for project directors.

8. OE observers at Course Content Improvement Coordination Conferences. Regular meetings at which directors of all CCI projects exchange information. Occasionally OE staff will address this group.

9. Perhaps *most significant* are the telephone contacts between program staff counterparts in the two agencies. They are too numerous to detail here but suffice it to say that particularly in the Fellowships Institutes, and CCI areas there is a continuing close personal contact. The benefits of this informal but substantive kind of coordination to the programs of the two agencies and education generally are immeasurable.

Question 17. How does NSF coordinate its health activities with those of the Public Health Service and the National Institutes of Health?

Answer. The Foundation has a responsibility to support basic research in the biological and medical sciences. In carrying out this responsibility support is provided for all fundamental aspects of biology, considering the support provided by other Federal agencies. Since almost all disease and health problems stem from malfunctioning biological mechanisms, a major portion of the Foundation's support of biology is either directly or indirectly health-related. It should be emphasized that Foundation support is intended to promote research designed to contribute to the pool of fundamental knowledge from which applied medical technology is derived; that is to say the effort is not directed toward solving specific problems of disease, or of contributing directly to clinical or applied medicine.

The Foundation, along with other Federal agencies, reports to NIH annually on the extent of support given to the area of medical and health-related research. This information is published in the Budget of the United States; in Special Analyses, Fiscal Year 1967, page 108, the Foundation's support is shown as:

Fiscal year:	*Millions*
1965	$25. 9
1966 (estimated)	35. 1
1967 (estimated)	35. 9

There exists between the Foundation and PHS/NIH a general agreement, developed when the Foundation was first organized, that support of clinical and applied medical research was the responsibility of PHS. Both organizations, of course, support basic research, and to a certain extent individual projects are suitable for consideration by either agency. Essentially duplicate proposals are submitted to NSF and NIH (or other agencies) rather frequently. A recent analysis indicates that approximately 12.5–17.7 percent of all proposals submitted to the NSF Biological and Medical Sciences Division were also submitted to NIH during the years FY 1964–1967. The percentage varies, but is not increasing. It should also be noted that duplicate submissions to PHS/NIH occur in only certain areas of biology, for that organization recognizes that certain non-medical fields of biology are rather distinctly the province of NSF.

If similar proposals are under review by two or more agencies at the same time, efficient and appropriate final actions require liaison and coordination between the agencies. The liaison between NSF and NIH takes these forms:

Each proposal is required to include a statement to the effect that it is also being submitted to the agencies named, or a statement that there is no duplicate submission. Quarterly tabulations of duplicate submissions are prepared in NSF's Biological and Medical Sciences Division.

Review and evaluation processes are carried out by the agencies separately and free from interaction. It is customary, however, for NSF Program Directors to invite proposal administrators from NIH (usually Study Section Executive Secretaries, but also higher officials) to sit as observers at their Advisory Panel review sessions. NSF Program Directors, in turn, frequently sit as observers in Study Sections.

In this fashion officers of the two agencies develop and maintain close personal working relationships. Because the agencies are differently structured and divide biological areas on quite different lines, the contacts between NIH and NSF staff members are not on a one to one basis. Generally each is required to deal with several, sometimes many, persons in the other agency. These multiple contacts and diverse relationships, we believe, enhance the rapport and effective liaison between the two staffs.

What has been said of the exchange of invitations and visits at the Advisory Panel-Study Section level applies also at the NIH Council level, though NSF has no re-review group of a comparable type. Our more senior staff do regularly attend Council meetings. Attached is a roster of NSF formal memberships on PHS and NIH groups.

At higher levels the liaison also continues. For example, at the fall 1967 meeting of the Biological and Medical Sciences Division's Advisory Committee, a policy recommending group, Dr. John Sherman, Associate Director for NIH's Extramural Programs presented a review of the reorganization of that agency and the support programs as they relate to NSF interests.

In addition to liaison, NIH and NSF (sometimes other agencies are involved) occasionally undertake joint consideration of a large proposal, usually for support of a facility, and joint support may be provided.

For each applicant additional information is derived from Science Information Exchange forms. These are routinely procured and reviewed in order to determine what other projects an investigator may have been involved in or now has, and what the scope of present and past support has been.

Through the means mentioned above, information is exchanged on a continuing basis. With respect to duplicate proposals under review, when one or the other of the agencies reaches a decision on whether support can be provided, this advice is passed on to the appropriate manager in the other agency informally, usually by phone. Though the information provided cannot help but affect the final decision of the second agency, appropriate care is exercised so as not to let it influence the evaluation and merit rating of the proposal. Beyond this point circumstances become so varied that no procedural pattern predominates. Each

case is treated on an individual basis. Fairness to the investigator and administrative efficiency are the key factors that primarily influence action. The applicant is advised by both agencies of the action each plans. If both are prepared to act favorably at approximately the same time, the applicant is invited to consider both offers of support and choose whichever he prefers.

The mechanisms employed in handling proposal-related liaison between the agencies is rather informal, but we believe this flexibility is desirable. A staff member in the Office of the Division Director of Biological and Medical Sciences is responsible for monitoring the process.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Committee	Staff member	Representative capacity
National Institutes of Health:		
Interdepartmental Advisory Panel for the National Center for Health Statistics.	Sanow, Kenneth	Alternate.
National Advisory Council on Health Research Facilities	Page, Howard E	Member.
	Carlson, Harve J	Alternate.
National Advisory Allergy and Infectious Diseases Council.	Tyler, David B	Liaison.
National Advisory Arthritis and Metabolic Diseases Council.	do	Do.
National Advisory Cancer Council	do	Do.
National Advisory Child Health and Human Development Council.	Lewis, Herman W	Do.
National Advisory Dental Council	Tyler, David B	Do.
National Advisory General Medical Sciences Council	Carlson, Harve J	Observer.
National Advisory Heart Council	Tyler, David B	Liaison.
National Advisory Neurological Diseases and Blindness Council.	do	Do.
National Institute of Mental Health: National Mental Health Manpower Studies Committee.	Levine, Milton	Member.
National Library of Medicine:		
Advisory Committee on Publications	Vacant	Observer.
Board of Regents	Carlson, Harve J	Ex-officio member.
Public Health Service:		
National Advisory Community Health Committee	do	Observer.
National Advisory Disease Prevention and Environmental Control Council.	do	NSF liaison representative.
National Advisory Health Council	do	NSF representative.

Question 18. What scientific disciplines are represented on the National Science Board?

DISCIPLINES OF PRESENT NATIONAL SCIENCE BOARD MEMBERS

Name	Present position	Field of academic specialization
Ex officio: Haworth, Leland J	Director, National Science Foundation (chairman, executive committee)	Physics.
Terms expire May 10, 1972:		
Hardin, Clifford M	Chancellor, University of Nebraska	Agricultural economics.
Jones, Charles F	President, Humble Oil & Refining Co., Houston, Tex.	Chemistry and chemical engineering.
Jones, Thomas F., Jr	President, University of South Carolina	Electrical engineering.
Morison, Robert S	Professor of biology and director, Division of Biological Sciences, Cornell University.	Biology (M.D.).
Piore, E. R	Vice president and chief scientist, International Business Machines Corp.	Physics.
Reynolds, Joseph M	Professor of physics and vice president for research, Louisiana State University.	Do.
Spilhaus, Athelstan F	President, the Franklin Institute, Philadelphia	Meterology and oceanography.
Sullivan, Richard H	President, Association of American Colleges, Washington, D.C.	English and education.
Terms expire May 10, 1970:		
Bunting, Mary I	President, Radcliffe College	Microbiology.
Carter, H. E	Vice chancellor for academic affairs, University of Illinois, Urbana.	Chemistry.
Goldsmith, Julian R	Associate dean, Division of the Physical Sciences, University of Chicago.	Geology.
Hagerty, William W	President, Drexel Institute of Technology, Philadelphia.	Mechanical engineering.
Heyns, Roger W	Chancellor, University of California at Berkeley	Psychology and education.
Picker, Harvey	President, Picker X-Ray Corp., White Plains, N.Y.	Administration.
Rees, Mina S	Dean of Graduate Studies, City University of New York.	Mathematics.
Thieme, F. P	Vice president, University of Washington, Seattle.	Anthropology.

DISCIPLINES OF PRESENT NATIONAL SCIENCE BOARD MEMBERS—Continued

Name	Present position	Field of academic specialization
Terms expire May 10, 1968: [1]		
Brooks, Harvey	Professor of applied physics and dean of engineering and applied physics, Harvard University.	Physics.
Eyring, Henry	Professor of chemistry and metallurgy, University of Utah.	Physical chemistry.
Handler, Philip	(Chairman, National Science Board), professor and chairman, Department of Biochemistry, Duke University Medical Center.	Biochemistry.
McBride, Katharine E.	President, Bryn Mawr College	Psyclology and education.
McShane, Edward J.	Professor of mathematics, Department of Mathematics, University of Virginia.	Mathematics.
Tatum, Edward L.	Professor, the Rockefeller University	Microbiology and biochemistry.
Tyler, Ralph W.	(Vice Chairman, National Science Board), director emeritus, Center for Advanced for Advanced Study in the Behavioral Sciences, Scientific Research Associates, Inc., Chicago.	Social science and education.

[1] Vacancy.

Question 19. How does NSF audit its grants?

Answer. The National Science Foundation uses a management-type audit for auditing its grants. The audits include a review of the effectiveness of grantees' systems of internal control over NSF grant activities to determine whether (1) grantees have adequate administrative and accounting control over NSF grant funds, (2) funds are used for the purposes for which the grants were made, and (3) fiscal reports submitted to NSF by the grantees are reliable and in agreement with the grantees' accounting records.

Additionally, selected NSF grants are audited in detail to determine whether (1) the administrative and accounting procedures are in effect, (2) there is consistency in the classification of costs between direct and indirect costs as applied to NSF grants and other projects of the grantees, and (3) instructions of NSF program offices to grantees were followed.

The Foundation also has instituted an audit plan whereby educational institutions with established internal audit offices may audit their NSF grants in accordance with audit guidelines furnished by NSF. Reports on the pilot audits under this "self-audit" plan have been received from several institutions and are being evaluated for extension of the "self-audit" plan to other institutions.

Question 20. How are indirect costs determined on grants?

Answer. Indirect cost rates used by NSF are based on the principles and standards contained in BOB Circular No. A–21. Where the Department of Defense has established indirect cost rates for educational institutions and other nonprofit organizations with which they deal, NSF uses these rates for its own grant awards.

NSF also has a working arrangement with the Department of Health, Education, and Welfare whereby HEW assumes responsibility for establishing rates with larger educational institutions not handled by DOD, with state and local agencies and with health-related nonprofit organizations. NSF assumes responsibility for establishing the rates for smaller educational institutions and for non-health-related nonprofit organizations. To minimize the administrative burden of the grantees and simplify processing of grants, indirect cost rates are fixed at the time awards are made and are not subject to adjustments during the period of the award.

Question 21. What are NSF policy and procedures on cost sharing? How does this differ from cost sharing policies followed by other Federal agencies?

Answer. The attached "Important Notice" dated January 24, 1966, provides a complete statement of NSF's policies on cost-sharing. These policies resemble those of other Federal agencies in that they are based on Government-wide guidelines issued in Bureau of the Budget Cirucular No. A–74 dated December 13, 1965. The unique feature in NSF cost-sharing policy relates to the requirements for university contributions based upon NSF support of faculty salaries as stated in items (1) through (4) on page 2 of the Important Notice under the heading, "Universities and Colleges."

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., January 24, 1966.

IMPORTANT NOTICE TO PRESIDENTS OF UNIVERSITIES AND COLLEGES, PRESIDENTS OF PROFESSIONAL SOCIETIES AND ACADEMIES OF SCIENCE, HEADS OF INSTITUTES AND OTHER NONPROFIT ORGANIZATIONS

Subject: Cost Sharing on research grants.

This Notice provides information on cost principles applicable to research grants and instructions regarding cost-sharing procedures to be followed on research grants made by the Foundation after March 1, 1966. The information in this Notice supersedes the NSF Important Notice of September 22, 1965, on Cost-Sharing on Research Projects and supplements information contained in the NSF brochure Grants for Scientific Research (NSF 63–27, as amended, December, 1963).

It is recognized that institutions contribute to the support of basic research in many ways, including the provision of faculty or other staff time and accumulated knowledge, and the furnishing of the institution's physical plant and organization. For the last several years the Acts of Congress providing appropriations for the Foundation limited overhead for research grants to a fixed percentage of the direct costs. This has had the effect, in most cases, of assuring another type of institutional contribution to research projects receiving Foundation support. However, the Independent Offices Appropriations Act for fiscal year 1966 (which applies to the National Science Foundation and became effective August 16, 1965), eliminates this limitation and stipulates that the Agencies may not reimburse any recipient of a grant for the full costs of a research project. This legislative change affects grants made by various government agencies. Consequently, the Bureau of the Budget has issued Circular No. A–74 dated December 13, 1965 (copy attached) which provides Government-wide guidelines governing cost-sharing on all research projects supported by Federal grants.

In determining the amount of NSF support for research grants awarded by the Foundation on or after March 1, 1966, full indirect costs, calculated in accordance with applicable cost principles, will be reimbursable. However, institutions will be required to share in the cost of each of their research projects supported by an NSF grant.

The provisions of this cost-sharing requirement will not apply to those grants awarded in support of research which are made solely for the purpose of providing funds for (a) conferences and symposia; (b) publication of manuscripts; (c) travel; (d) rehabilitation, construction, or purchase of equipment or facilities; or (e) logistic support activities.

The following principles will serve as guidelines in establishing degrees of cost sharing:

(1) A high level of cost-sharing by grantees is appropriate for those grants (a) which provide for relatively significant reimbursement of academic-year faculty salaries at educational institutions; or (b) where the grantee institution prefers substantial cost-sharing as a matter of institutional policy.

(2) A low level of cost-sharing may be appropriate for those grants which (a) include a relatively significant amount for the purchase, rehabilitation, construction or operation of major equipment or facilities for research; (b) provide principally for services to be made available on a regional or national basis; or (c) provide special stimulus for an area of research in the national interest.

Cost-sharing on projects supported by NSF research grants may be accomplished by the recipient institution by a contribution to any of the cost elements in the project, direct or indirect.

UNIVERSITIES AND COLLEGES

Research is one of the normal functions of institutions of higher education and is an essential component of graduate education. Therefore the National Science Foundation has always regarded NSF-supported research at colleges and universities as a joint enterprise of the institutions and the Foundation. Since the faculty is an intrinsic part of the educational institution and research a natural function of the faculty, it appears that the provision of faculty time is a particularly appropriate contribution of an educational institution towards the support of basic research.

In general, universities and colleges must share in the costs of each project as follows:

(1) For those research project grants in which NSF reimburses all or part of the academic year salary of faculty members, [1] the cost sharing requirement will be deemed to be satisfied if the grantee institution contributes to the the cost of the project from non-Federals ources an amount that at least *matches the NSF support of faculty salaries for the academic year (including applicable indirect costs)*, provided that such contribution constitutes more than a token participation.

(2) In institutions or major components thereof where *faculty appointment are on a calendar year basis*, the cost sharing requirements will be deemed to be satisfied if the grantee institution contributes to the cost of the project an amount that at least *matches half the NSF support of faculty salaries (including applicable indirect costs)*, provided that such contribution constitutes more than a token participation.

(3) Claims for reimbursement for faculty members of a major component of an institution must be treated in a consistent manner insofar as academic year and calendar year appointments are concerned.

(4) Those research projects in which the proposed institutional contribution, through faculty salary matching or otherwise, does not consistute more than a token amount will be subject to negotiation with respect to cost sharing.

Indirect costs will be calculated in accordance with the provisions of Bureau of the Budget Circular A–21, as revised March 3, 1965.

OTHER NONPROFIT RESEARCH ORGANIZATIONS

The appropriate level of cost sharing for nonprofit institutions other than universities and colleges will be determined on a case by case basis. Those research projects in which the Foundation considers that the proposed institutional contribution does not constitute a reasonable amount under the particulsr circumstances will be subject to negotiation with respect to cost sharing.

Indirect costs will be calculated in accordance with the provisions of Federal Procurement Regulations, FPR 1–5.2 except where NSF determines that the nonprofit institution is organized and functioning in a manner similar to colleges and universities, in which case Circular A–21 will be applied.

SUBMISSION OF PROPOSALS

As of March 1, 1966, budgets for all research proposals submitted to the Foundation should include the following:

(1) The amount requested of NSF for direct cost of each of the cost elements of the research proposed. Where applicable, faculty salaries should be separately allocated between academic year and summer salaries, unless salaries are claimed on a calendar year basis.

(2) The amount requested for indirect cost. Indirect cost will be requested only on applicable direct costs to be supported by NSF.

(3) The total requested from NSF.

(4) The amount proposed as the institution's cost-sharing contribution from non-Federal sources, itemized by the same categories of cost as above.

Where the institution's proposed contribution is not more than a token amount, the level of cost-sharing should be adequately justified.

INDIRECT COSTS

As stated above, the determination of indirect cost rates to be allowed each grantee on NSF grants will, in all instances, be made in accordance with principles prescribed by Circular A–21, or other applicable cost principles. Rates will be determined by one of the following methods:

(1) Department of Defense or other Federal agency audit rates established in accordance with Circular No. A–21 (or other applicable cost principles) may be used as the basis for the NSF rate determination.

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[1] As used in this important notice (a) the term "academic year" means the usual 2-semester school year of approximately 42 weeks, or its equivalent, such as three quarters if the institution is on a 4-quarter basis: and (b) the term "faculty member" includes "instructors" or equivalent members of the instructional staff, and individuals whose title includes the word "professor" in any form.

(2) If recent approved rates are not available, rates will be determined on the basis of an indirect cost proposal submitted by the institution, supported by the following:

(*a*) A statement indicating the method used in separating the component activities such as research, instruction, and other institutional activities.

(*b*) A statement indicating the basis for distributing indirect costs to such component activities.

(*c*) A computation of the indirect cost rate based on the principles outlined in Circular A–21 (or other applicable cost principles). (Where research activities are performed at an off-campus location, a separate indirect cost proposal applicable thereto should be submitted.)

(*d*) A copy of the institution's audited financial statements and other supporting information for the period covered.

(3) If the total direct cost of all Government-sponsored research and development work at a college or university does not exceed $500,000 a year, the abbreviated procedure as prescribed by Circular A–21, will be acceptable in determining the indirect cost rate.

Indirect cost rates established as indicated above will be considered "predetermined fixed rates," thus enabling institutions to earn overhead on an NSF grant at a definite rate. The rates will be effective for awards made on or after the date of the rate determination, and until new predetermined rates are established by NSF. They will not be made retroactive, and they will not be subject to adjustment during the period of a grant, or any amendment thereto.

In submitting research proposals, the approved rate for the institution will be used in computing estimated indirect cost amounts. Budgets submitted with research proposals may reflect items as direct cost only if such items are classified and consistently recorded as direct cost in the proposer's accounting system. The proposed budget must also: (a) identify the Federal agency establishing the rate; (b) show the date when the rate was determined; and (c) indicate the period covered by the audit on which the rate is based.

If approved rates are not available and if a current indirect cost proposal has not been submitted to NSF, an indirect cost proposal should be submitted simultaneously with the initial research proposal submitted under these guidelines. As a general rule, indirect cost rates will be based on salaries and wages, except that the rates for educational institutions having less than $500,000 research and development work annually sponsored by the Federal Government or otherwise qualifying under Section H of Bureau of the Budget Circular No. A–21, may be based on total direct cost. A new indirect cost proposal is required annually and should be submitted to the Foundation within four months after the end of the fiscal year.

All indirect cost proposals should be submitted directly to the NSF Comptroller, Attention: Indirect Cost (Rate) Determination Office.

Where audited or approved rates are not available and where sufficient data have not been submitted to enable the Foundation to make an indirect cost rate determination, awards will be withheld until the indirect cost rate is determined.

RECORDS AND REPORTS

Since it will be necessary to demonstrate that cost-sharing is fulfilled, institutions must maintain accounting records which will establish their contribution. If the expenditures for the research are less than originally contemplated, the relationship between the institutions contribution and the total cost should remain essentially the same as proposed in the approved application or in a subsequent approved revision.

LELAND J HAWORTH, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington D.C., December 13, 1965.

Circular No. A–74.

To the heads of executive departments and establishments.

Subject: Participation in the costs of research supported by Federal grants.

1. *Purpose.*—This Circular provides guidelines for Federal agencies concerning participation by colleges and universities and other institutions in the cost of research supported through Federal grants.

These guidelines take into account provisions in the appropriation acts for the fiscal year 1966 for the Department of Defense (P.L. 89–213), the Departments of Labor and Health, Education, and Welfare (P.L. 89–156), and the Independent Offices (P.L. 89–128), that prohibit Federal agencies from paying any recipient of a grant for the conduct of a research project an amount equal to as much as the entire cost of such a project. These guidelines also take into account the removal of statutory limitations on the payment of the indirect costs of research financed by Federal grants.

This Circular does not affect existing policies and practices of Federal agencies concerning cost participation in research financed through contracts.

2. *Effective date.*—The guidelines set forth in this Circular should be applied as soon as practicable to all research grants awarded subsequent to the issuance of this Circular and not later than March 1, 1966.

3. *Background of cost participation.*—The conduct of research is a significant function and important responsibility of institutions of higher education. In addition to contributing to the advancement of knowledge, academic research is an essential element in the advanced training of scientists and engineers. At the same time, the Federal Government relies heavily upon research conducted in non-Federal institutions, and particularly in colleges and universities, to assist in the accomplishment of the missions of Federal agencies. Thus, Federal research grants generally serve the objectives both of the institutions and of the Federal Government. Cost participation reflects this mutuality of interest.

In the past, cost participation by the grantee institution has been accomplished through: (*a*) cost participation as a consequence of legal limitations on the proportion of indirect costs payable by the Federal agencies under research grants; (*b*) cost participation through continued payment by grantee institutions of part or all the salaries of faculty members or professional personnel participating in sponsored research, and (*c*) payment by grantee institutions of a portion of other costs such as equipment.

4. *Guidelines for Federal agencies.*—(*a*) Agencies should generally continue their present policies and practices concerning the extent of cost participation by grantee institutions:

(1) Except for increased indirect cost allowances which may be paid as a result of the removal of statutory limitations on payment of such allowances; and

(2) Except that in cases where Federal agencies would otherwise pay all research costs, the applicant institution must share in such research costs on more than a token basis.

(*b*) The costs which may be charged to a research grant include direct costs and their associated indirect costs, as determined in accordance with Bureau of the Budget Circular No. A–21 (Revised), dated March 3, 1965.

(*c*) The extent of cost participation by grantees may vary in accordance with a number of factors relating to both the granting agency and the grantee institution, e.g.:

(1) A higher degree of cost participation should ordinarily exist when the cost of the research consists primarily of the efforts of senior faculty during the academic year, or when the grantee institution's long range interests are best served by substantial cost participation;

(2) Cost participation should generally be lower when a major portion of the research cost consists of equipment, when the grant provides for a large component of services to be made available on a regional or national basis, or when in the view of a Federal agency an area of research requires special stimulus in the national interest.

5. *Administration.*—(*a*) Federal agencies will require that proposals for each research grant include—

(1) The amount requested for direct expenses, by category of direct expense;

(2) The amount requested for indirect expenses related to the requested direct expenses;

(3) The *total* grant request; and

(4) The additional amount which the grantee institution proposes as its contribution from non-Federal sources to the planned research.

(*b*) Federal agencies will require each grantee institution to maintain records to demonstrate a total actual contribution by the grantee institution of an amount which is not less, in proportion to the actual charges against the grant, than the total amount proposed in the application, or any subsequent revision thereof, approved by the agency. The amount of the grantee institution's contribution will be subject to audit.

6. *Agency reports on cost participation.*—Each agency which awards research grants will report to the Bureau of the Budget by November 1 of each year on cost participation by grantee institutions in the immediately preceding fiscal year. This report should provide information on the overall amount obligated for grants in the preceding fiscal year and the overall additional amount which grantee institutions proposed to contribute to the research supported by these grants. (The report to be submitted by November 1, 1966, should cover grants awarded from the tate of implementation of this Circular through June 30, 1966.)

CHARLES L. SCHULTZE, *Director.*

Question 22. What is NSF policy regarding patents that might result from research it has financed?

Answer. Present NSF policy is to include in contracts and other arrangements that when an invention is made, the Foundation shall have the right to determine whether or not and where a patent application shall be filed and to determine the disposition of the invention and title to and rights under any application or patent that may result. In making such determinations all of the circumstances in each case are examined in the light of the principles enunciated in the President's Statement of Patent Policy issued October 10, 1963 (FR 28 No. 200 dated October 12, 1963). In essence these principles recognize that the public interest calls for the encouragement of private initiative to bring into use inventions made with Government financial support having due regard for governmental requirements and the need to protect consumers against restraint of trade and unreasonable pricing. To this end extensive privately funded background research accomplishments and demonstrable capability of making (or arranging to have made) the benefits of the invention reasonably available to the public are considered and in appropriate cases the grantee or contractor may be given the right to retain title to any patent which may issue subject to certain safeguards described below. Inventions which are of importance to the Government's activities or are of such a nature that Government control is necessary may be covered by a Government owned patent. Absent such special Government interest, when the invention is of such a nature that it is immediately useful without extensive further investment and when the invention is directly affected with the public interest or made in circumstances described in Section 1. (a) of the President's Statement, then it should be made freely available to the public.

A determination that exclusive rights in an invention may be retained by a grantee or contractor is in all cases subject to a royalty-free license in the Government for governmental purposes and to the right to require the grantee or contractor to grant licenses under the resulting patent in the event the invention is not worked within a reasonable time or is required for public use by Government regulations or to fulfill health needs.

One factor taken into consideration in determining patent rights is the established commercial position of the contractor. In practice, few of our grantees or contractors have established commercial positions or other equities within the meaning of Section 1.(b) of the President's Statement and inventions arising out of basic research are generally peripheral to the main purpose of that research. However, if the Foundation is authorized to engage in applied research we can expect this situation to change and if it does then the Foundation will follow the applicable provisions of the President's Statement, a copy of which is attached hereto.

FOLLOWING IS THE TEXT OF A MEMORANDUM FROM THE PRESIDENT ADDRESSED TO THE HEADS OF THE EXECUTIVE DEPARTMENTS AND AGENCIES ON GOVERNMENT PATENT POLICY, WITH STATEMENT ATTACHED

Over the years, through Executive and Legislative actions, a variety of practices has developed within the Executive Branch affecting the disposition of rights to inventions made under contracts with outside organizations. It is not feasible to have complete uniformity of practice throughout the Government in view of the differing missions and statutory responsibilities of the several departments and agencies engaged in research and development. Nevertheless, there is need for greater consistency in agency practices in order to further the governmental and public interests in promoting the utilization of Federally financed inventions and to avoid difficulties caused by different approaches by the agencies when dealing with the same class of organizations in comparable patent situations.

From the extensive and fruitful national discussions of government patent practices, significant common ground has come into view. First, a single presump-

tion of ownership does not provide a satisfactory basis for government-wide policy on the allocation of rights to inventions. Another common ground of understanding is that the Government has a responsibility to foster the fullest exploitation of the inventions for the public benefit.

Attached for your guidance is a statement of government patent policy, which I have approved, identifying common objectives and criteria and setting forth the minimum rights that government agencies should acquire with regard to inventions made under their grants and contracts. This statement of policy seeks to protect the public interest by encouraging the Government to acquire the principal rights to inventions in situations where the nature of the work to be undertaken or the Government's past investment in the field of work favors full public access to resulting inventions. On the other hand, the policy recognizes that the public interest might also be served by according exclusive commercial rights to the contractor in situations where the contractor has an established non-governmental commercial position and where there is greater likelihood that the invention would be worked and put into civilian use than would be the case if the invention were made more freely available.

Wherever the contractor retains more than a non-exclusive license, the policy would guard against failure to practice the invention by requiring that the contractor take effective steps within three years after the patent issues to bring the invention to the point of practical application or to make it available for licensing on reasonable terms. The Government would also have the right to insist on the granting of a license to others to the extent that the invention is required for public use by governmental regulations or to fulfill a health need, irrespective of the purpose of the contract.

The attached statement of policy will be reviewed after a reasonable period of trial in the light of the facts and experience accumulated. Accordingly, there should be continuing efforts to monitor, record, and evaluate the practices of the agencies pursuant to the policy guidelines.

This memorandum and the statement of policy shall be published in the Federal Register.

STATEMENT OF GOVERNMENT PATENT POLICY

Basic considerations

A. The government expends large sums for the conduct of research and development which results in a considerable number of inventions and discoveries.

B. The inventions in scientific and technological fields resulting from work performed under government contracts constitute a valuable national resource.

C. The use and practice of these inventions and discoveries should stimulate inventors, meet the needs of the government, recognize the equities of the contractor, and serve the public interest.

D. The public interest in a dynamic and efficient economy requires that efforts be made to encourage the expeditious development and civilian use of these inventions. Both the need for incentives to draw forth private initiatives to this end, and the need to promote healthy competition in industry must be weighted in the disposition of patent rights under government contracts. Where exclusive rights are acquired by the contractor, he remains subject to the provisions of the antitrust laws.

E. The public interest is also served by sharing of benefits of government-financed research and development with foreign countries to a degree consistent with our international programs and with the objectives of U.S. foreign policy.

F. There is growing importance attaching to the acquisition of foreign patent rights in furtherance of the interests of U.S. industry and the government.

G. The prudent administration of government research and development calls for a government-wide policy on the disposition of inventions made under government contracts reflecting common principles and objectives, to the extent consistent with the missions of the respective agencies. The policy must recognize the need for flexibility to accommodate special situations.

Policy

SECTION 1. The following basic policy is established for all government agencies with respect to inventions or discoveries made in the course of or under any contract of any government agency, subject to specific statutes governing the disposition of patent rights of certain government agencies.

(*a*) Where—

(1) A principal purpose of the contract is to create, develop or improve products, processes, or methods which are intended for commercial use (or which are otherwise intended to be made available for use) by the general public at home or abroad, or which will be required for such use by governmental regulations; or

(2) A principal purpose of the contract is for exploration into fields which directly concern the public health or public welfare; or

(3) The contract is in a field of science or technology in which there has been little significant experience outside of work funded by the government, or where the government has been the principal developer of the field, and the acquisition of exclusive rights at the time of contracting might confer on the contractor a preferred or dominant position; or

(4) The services of the contractor are—

(i) for the operation of a government-owned research or production facility; or

(ii) for coordinating and directing the work of others,

the government shall normally acquire or reserve the right to acquire the principal or exclusive rights throughout the world in and to any inventions made in the course of or under the contract. In exceptional circumstances the contractor may acquire greater rights than a non-exclusive license at the time of contracting, where the head of the department or agency certifies that such action will best serve the public interest. Greater rights may also be acquired by the contractor after the invention has been identified, where the invention when made in the course of or under the contract is not a primary object of the contract: *Provided*, the acquisition of such greater rights is consistent with the intent of this Section 1(a) and is a necessary incentive to call forth private risk capital and expense to bring the invention to the point of practical application.

(*b*) In other situations, where the purpose of the contract is to build upon existing knowledge or technology to develop information, products, processes, or methods for use by the government, and the work called for by the contract is in a field of technology in which the contractor has acquired technical competence (demonstrated by factors such as know-how, experience, and patent position) directly related to an area in which the contractor has an established non-governmental commercial position, the contractor shall normally acquire the principal or exclusive rights throughout the world in and to any resulting inventions, subject to the government acquiring at least an irrevocable non-exclusive royalty free license throughout the world for governmental purposes.

(*c*) Where the commercial interests of the contractor are not sufficiently established to be covered by the criteria specified in Section 1(b), above, the determination of rights shall be made by the agency after the invention has been identified, in a manner deemed most likely to serve the public interest as expressed in this policy statement, taking particularly into account the intentions of the contractor to bring the invention to the point of commercial application and the guidelines of Section 1(a) hereof, *provided* that the agency may prescribe by regulation special situations where the public interest in the availability of the inventions would best be served by permitting the contractor to acquire at the time of contracting greater rights than a non-exclusive license. In any case the government shall acquire at least a non-exclusive royalty free license throughout the world for governmental purposes.

(*d*) In the situations specified in Sections 1(b) and 1(c), when two or more potential contractors are judged to have presented proposals of equivalent merit, willingness to grant the government principal or exclusive rights in resulting inventions will be an additional factor in the evaluation of the proposals.

(*e*) Where the principal or exclusive (except as against the government) rights in an invention remain in the contractor, he should agree to provide written reports at reasonable intervals, when requested by the government, on the commercial use that is being made or is intended to be made of inventions made under government contracts.

(*f*) Where the principal or exclusive (except as against the government) rights in an invention remain in the contractor, unless the contractor, his licensee, or his assignee has taken effective steps within three years after a patent issues on the invention to bring the invention to the point of practical application or has made the invention available for licensing royalty free or on terms that are reasonable in the circumstances, or can show cause why he should retain the principal or exclusive rights for a further period of time, the government shall have the right to require the granting of a license to an applicant on a non-exclusive royalty free basis.

(*g*) Where the principal or exclusive (except as against the government) rights to an invention are acquired by the contractor, the government shall have the right to require the granting of a license to an applicant royalty free or on terms that are reasonable in the circumstances to the extent that the invention is required for public use by governmental regulations or as may be necessary to fulfill health needs, or for other public purposes, stipulated in the contract.

(*h*) Where the government may acquire the principal rights and does not elect to secure a patent in a foreign country, the contractor may file and retain the principal or exclusive foreign rights subject to retention by the government of at least a royalty free license for governmental purposes and on behalf of any foreign government pursuant to any existing or future treaty or agreement with the United States.

SECTION 2. Government-owned patents shall be made available and the technological advances covered thereby brought into being in the shortest time possible through dedication or licensing and shall be listed in official government publications or otherwise.

SECTION 3. The Federal Council for Science and Technology in consultation with the Department of Justice shall prepare at least annually a report concerning the effectiveness of this policy, including recommendations for revision or modification as necessary in light of the practices and determinations of the agencies in the disposition of patent rights under their contracts. A patent advisory panel is to be established under the Federal Council for Science and Technology to—

(*a*) develop by mutual consultation and coordination with the agencies common guidelines for the implementation of this policy, consistent with existing statutes, and to provide over-all guidance as to disposition of inventions and patents in which the government has any right or interest, and

(*b*) encourage the acquisition of data by government agencies on the disposition of patent rights to inventions resulting from federally-financed research and development and on the use and practice of such inventions, to serve as basis for policy review and development; and

(*c*) make recommendations for advancing the use and exploitation of government-owned domestic and foreign patents.

SECTION 4. *Definitions:* As used in this policy statement, the stated terms in singular and plural are defined as follows for the purposes hereof:

(a) "Government agency," includes any Executive department, independent commission, board, office, agency, administration, authority, or other government establishment of the Executive Branch of the Government of the United States of America.

(b) "Invention" or "invention or discovery," includes any art, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof, or any variety of plant, which is or may be patentable under the Patent Laws of the United States of America or any foreign country.

(c) "Contractor," means any individual, partnership, public or private corporation, association, institution, or other entity which is a party to the contract.

(d) "Contract," means any actual or proposed contract, agreement, grant, or other arrangement, or sub-contract entered into with or for the benefit of the government where a purpose of the contract is the conduct of experimental, developmental, or research work.

(e) "Made," when used in relation to any invention or discovery, means the conception or first actual reduction to practice of such invention in the course of or under the contract.

(f) "Governmental purpose," means the right of the Government of the United States (including any agency thereof, state, or domestic municipal government) to practice and have practiced (made or have made, used or have used, sold or have sold) throughout the world by or on behalf of the Government of the United States.

(g) "To the point of practical application," means to manufacture in the case of a composition or product, to practice in the case of a process, or to operate in the case of a machine and under such conditions as to establish that the invention is being worked and that its benefits are reasonably accessible to the public.

Question 23. What is NSF copyright policy?

Answer. The mission of the Foundation—to support basic research and education in the sciences—requires assuring the most effective dissemination of the findings from such research and of improved curricular materials. In addition, the Foundation is expressly charged by its organic act to foster interchange of scientific information and to develop improved methods for disseminating information. The Foundation's policy is basically to encourage the publication of research

results using established channels without disturbing the copyright practices of the journals and other publications involved.

With respect to textbooks and other curricular material developed with Foundation support, the objective is to secure the widest possible use based on the free choice of educational institutions throughout the country without giving undue competitive advantage to these materials. Exclusive publication rights for a limited period may be granted when necessary to assure publication and distribution and revisions subject to control of the copyright by the Foundation and subject to royalty arrangements designed to avoid as far as practical competitive advantage.

Similarly, to the extent that new techniques of dissemination developed with Foundation support produce desirable information, the data banks so produced may be covered by copyright where necessary to assure their availability subject to control by the Foundation to avoid undesirable practices.

Question 24. What are the estimated costs of new activities which NSF would undertake under H.R. 5404?

Answer. There are some uncertainties inherent in the new tasks that would be assigned to NSF if either H.R. 5404 or S. 2598 were to be enacted; therefore it is not at this time possible to do more than give rough estimates of the additional costs which would be incurred as the result or the passage of either bill.

We have attempted to determine possible cost-ranges for each of the Sections which imply additional cost and these are given in the paragraphs below.

The most significant potential cost would result from the authority to support applied research as contemplated in the proposed version of Section 3(c) of the Act. It is difficult to make meaningful estimates of increased costs for this function.

We estimate crudely, however, that, if funds are made available, support for applied research at academic and appropriate non-profit institutions might in the first few years increase the total research support by the Foundation at such institutions by from 10 to 20 percent. Our total support of research at such institutions in FY 1967 was approximately $235 million.

The funds required to implement the authority proposed in Section 3(c) when so directed by the President, to support "applied scientific research relevant to national problems involving the public interest" would depend entirely upon the specific nature of the problems assigned.

The following table shows our estimates of the cost-ranges for each of the other Sections of the Act which imply additional costs. Estimates can be made with somewhat greater certainty for in-house increased expenditures for staff compensation (as noted below for appropriate portions of Sections 4, 5, 6, and 15).

ESTIMATED ADDITIONAL ANNUAL COSTS

[Excludes applied research]

	Minimum estimate	Maximum estimate
Secs. 3(a) (4) and 4(g): Evaluation of status of science	$1,000,000	$2,600,000
Sec. 3(a) (5): Register of scientists and engineers	(1)	[2] 4,500,000
Sec. 3(a) (6):		
Studies of research fund allocations:		
NSF	[3] 100,000	[4] 350,000
Other agencies	[3] 200,000	[4] 1,000,000
Subtotal	1,300,000	8,450,000
Sec. 4(h): National Science Board increase in staff (S. 2598 does not provide for Board staff)	130,000	130,000
Sec. 5(a): Director's compensation increase	1,600	1,600
Sec. 6(a): Deputy director's compensation increase	2,675	2,675
Sec. 6(b): 4 assistant director's compensation (and secretarial assistance)	144,000	144,000
Sec. 15 (new sec. 14(d)): National Science Board increase in compensation	29,000	29,000
Subtotal	307,275	307,275
Grand total	1,607,275	8,757,275

[1] Assuming that approximately 10 percent of engineers are registered.
[2] Required to achieve the maximum feasible coverage of engineers.
[3] Assuming that reporting on fund allocations only to universities and nonprofit organizations is required (S. 2598, 3(a)(6)).
[4] Assuming that reporting on fund allocations to all performers is required (H.R. 5404, 3(a)(6)).

SUPPLEMENTAL QUESTIONS AND ANSWER

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., December 8, 1967.

Mr. ROY MILLENSON,
Minority Clerk, Committee on Labor and Public Welfare,
U.S. Senate,
Washington, D.C.

DEAR MR. MILLENSON: The attached answers are provided in response to the questions you put to me following your initial review of the answers transmitted formally to Senator Griffin on November 30, 1967, by the Director of the Foundation in response to the Senator's questions on H.R. 5404 and S. 2598.

Please note that information adding to our earlier response to the Senator's question number 5 does recommend one clarifying editorial change in the first part of the Director's response to question 5. The attached material is intended for use with the responses transmitted by the Director on November 30.

Let me know if we can be of further assistance.

Sincerely yours,

THEODORE W. WIRTHS,
Congressional Liaison Officer.

Question 5. The additional question re item 5 was, "With respect to the answer provided for question 5, why does NSF use a calendar year and OE use an academic year? Why the difference in dependency allowances?"

Answer. Before answering the additional questions, it will perhaps be helpful to explain that Federal agencies administering fellowship programs have worked together for many years on an informal basis. Periodically, "Fellowship Administrators" representing, NSF, NIH, AEC, NASA, OE, and Departments of Defense, Agriculture, Interior and State, have met to discuss programs and problems relating to graduate student support and the means for achieving a higher degree of uniformity of administrative guidelines. This informal approach has been very successful in bringing about desired changes. With the establishment of the Federal Interagency Committee on Education (FICE), this previously informal activity now is handled as a formal subcommittee function of FICE.

The following discussion supplements information provided in the answer to Question 5, provided to Senator Griffin on November 30, 1967, and should be used in conjuction with the earlier answer.

Why does NSF use a calendar year and OE use an academic year? In the case of NSF, it is an administrative decision; in the case of NDEA Title IV fellowships, it is a matter of law. NSF, in arriving at its decision, took into consideration the fact that the average tenure of NSF Graduate Fellows is in excess of 11 months in "calendar" year ("calendar" year here being defined as 12 consecutive months, beginning with either the summer school or the academic year term) and that, therefore, "academic year" was an inappropriate term and would tend to slow up attainment of the Ph. D. degree.

In order to avoid any misunderstanding regarding information to be included in the record, in the answer to Question 5 submitted to Senator Griffin on November 30, 1967, "*calendar*" should be deleted and "(12 months)" added after "year", as follows:

"A. NSF graduate fellowship program:

Stipend:	*Per year (12 months)*
1st year	$2,400
Intermediate year	2,600
Terminal year	2,800"

Thus, the 12 month stipend *rate* is the same for the NSF Graduate Fellowship Program, and the OE National Defense Graduate Fellowships (title IV).

In further explanation of stipend determinations it may be helpful to note that if a "first year" NSF Graduate Fellow, with one dependent, chooses the academic year (9 months) tenure option available under the fellowship program his stipend would be reduced to $1800 and the dependency allowance to $375 for that period; this adheres to the same *rates* as those established by NSF for 12 month tenure. These points are fully explained to the applicant in the program announcement. The stipend *amount* for 9 month tenure is lower under the NSF

program than the comparable OE program. Discussion of this difference appears below, as well as mention of possible steps to bring about greater uniformity between programs.

Why the difference in dependency allowance? NSF administratively established a dependency allowance of $375 for 9 months and $500 for 12 months; NDEA Title IV, by law, provides $400 for 9 months and by administrative decision the dependency allowance was increased to $500 for 12 months.

A decision to equalize NDEA Title IV fellowship stipends and their dependency allowance for 12 month tenures, with those of fellowships provided by other Federal agencies (NSF, AEC, NIH) was made by OE, after consultations with other Federal agencies and the Bureau of the Budget. An alternative considered was to increase the 9 month stipends and the dependency allowance for NSF AEC and NIH fellowships by $200 and $25, respectively. This step was rejected primarily because of the increased costs that would result and the fact that seemingly the Federal government would be encouraging 9 month tenures for all fields of study, which—in many instances—could result in an unnecessary and inefficient prolongation of the time required to complete graduate studies. Of course, this disparity still exists in the NDEA Title IV fellowship because the levels are specified by law. Another alternative was considered and rejected, for the time being, because it would have been even more costly to the Federal government, namely, to establish, for example, all "first year" stipends at $2,000 for 9 months as provided by NDEA Title IV fellowships and to continue to support individuals for 12 months at the same rate ($2,667 for 12 months) and dependency allowance at $400 and $533, respectively.

It seems to a number of Federal agency representatives that perhaps an alternative to the NDEA Title IV fellowship stipends and the dependency allowance being specified by law would be to leave responsibility to the Federal Interagency Committee on Education and the Bureau of the Budget for establishing stipends and dependency allowances for comparable fellowships administered by various Federal agencies.

Question 6. The additional question re item 6 was, "Why the difference in provision by NSF of 50 percent of eligible costs and by OE of 33⅓ percent?"

Answer. At the time the Graduate Science Facilities program was established by NSF in 1960 there was one comparable program in Government—the Health Sciences Facilities program of NIH. The legislation establishing this program called for 50% matching. NSF, therefore, by administrative action, established a similar requirement which, it should be noted, excludes land and purchased buildings. OE legislation, with the provision of 33⅓% matching of eligible costs (which include land and purchased buildings), was not enacted until later (Higher Educational Facilities Act of 1963).

It should be noted that the proportion of matching funds provided by NSF is negotiated in each case according to the unique aspects which prevail. In actual practice, the NSF proportion very often is considerably lower than the 50% limit, and it is felt that retention of maximum flexibility to facilitate such negotiation is highly desirable.

Question 12. The additional question on item 12 was, "Why does NSF have so much printing done under private contract?"

Answer. The Foundation's Enabling Act (Section 11(g)) permits printing of scientific and technical information without reference to the Government Printing Office. NSF has followed the practice of contracting for printing outside of GPO when it is more economical or expeditious to do so. Although the Foundation does not undertake a prescribed cost analysis of each printing job, our experience shows that most of our privately contracted printing is undertaken when it is obvious that GPO printing would be either more costly or would not meet required deadlines.

Question 13. The additional question on item 13 was, "Why are grantees not required to advertise for bids? Does NSF practice correspond to that of other agencies in this regard?"

Answer. In many cases NSF-granted funds supplement funds provided by the grantee institutions, often from State resources, and NSF has sought to avoid special restrictions on its granted portion. The Foundation, therefore, does not require grantees to advertise for bids because reliance is placed on the normal sound business practices of grantee institutions—usually colleges and universities—rather than on the imposition of special procedures which might differ from those practices. To the best of our knowledge, this is similar to the practices of other agencies, such as the Public Health Service, in their grants to educational institutions.

Question 14. The additional question on item 14 was, "How does NSF's practice in making payments before performance compare with practices of other agencies?"

Answer. The practice of making advance payments is common among Federal agencies, such as Office of Education and NIH, which deal with educational institutions and other nonprofit bodies. This is necessary inasmuch as these organizations do not have sufficient working capital of their own to finance the federally sponsored activities and must receive funds in advance to meet disbursement requirements.

(Whereupon, at 12:20 p.m., the hearing was recessed, subject to the call of the Chair.)

(The House report that was previously ordered printed in the record follows:)

Union Calendar No. 528

89th Congress, 2d Session - - - - - - House Report No. 1236

THE NATIONAL SCIENCE FOUNDATION

ITS PRESENT AND FUTURE

REPORT

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
EIGHTY-NINTH CONGRESS

SECOND SESSION

Serial M



FEBRUARY 1, 1966.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

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WASHINGTON : 1966

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LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., February 1, 1966.

Hon. JOHN W. MCCORMACK,
Speaker of the House of Representatives,
Washington, D.C.

DEAR MR. SPEAKER: I am submitting herewith a report entitled "The National Science Foundation—Its Present and Future." This report followed more than a year of inquiry and hearing by the Subcommittee on Science, Research, and Development. It has been adopted unanimously by the full committee, and we expect it to serve as the basis for legislation later in this session of the Congress. I commend the report to the attention of all Members of the House.

Sincerely yours,

GEORGE P. MILLER, *Chairman.*

LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., December 30, 1965.

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

DEAR MR. CHAIRMAN: I am submitting herewith a report of the Subcommittee on Science, Research, and Development entitled "The National Science Foundation—Its Present and Future." This report is a critical evaluation of the Foundation, its functions and operations, not only as they appear today but as the subcommittee views them against the needs of tomorrow.

This report was undertaken pursuant to your instructions for a thorough review of the Foundation. The subcommittee and its staff, with the important assistance of the Science Policy Research Division of the Library of Congress, began work on this review late in 1964. The report represents a consensus of the subcommittee following extensive hearings and other investigations since that time.

It is my belief that this report should serve as a basis for amendatory legislation, in 1966, of the Foundation's organic act. With this in mind, I commend it to the attention of the full committee.

Sincerely,

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

Union Calendar No. 528

89TH CONGRESS, 2d Session } HOUSE OF REPRESENTATIVES { REPORT No. 1236

THE NATIONAL SCIENCE FOUNDATION

ITS PRESENT AND FUTURE

FEBRUARY 1, 1966.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. MILLER, from the Committee on Science and Astronautics, submitted the following

REPORT

CONTENTS

	Page
LETTER OF SUBMITTAL	III
LETTER OF TRANSMITTAL	IV
SUMMARY	IX
CHAPTER I. BACKGROUND	1
Purpose of the subcommittee report	1
Role of the Subcommittee on Science, Research, and Development	1
Purpose and conduct of this inquiry	4
CHAPTER II. CONTEMPORARY ROLE OF THE NATIONAL SCIENCE FOUNDATION	7
Federal objectives for science and technology	8
Research and development	8
Authority of the National Science Foundation	9
Mission of the Foundation	11
Implementation of its mission	11
1. Basic research	13
(a) Project grants	13
(b) National research programs	13
(c) National research facilities	15
2. Science education	15
(a) Fellowships and traineeships	15
(b) Teacher training	16
(c) Course improvement	16
(d) Research participation	16
(e) Instructional equipment	16
3. Institutional development	17
4. Science information	18
National science policy	18
1. National science policy—What is it?	19
2. NSF and science policy	19
(a) Legislative assignment	20
(b) Executive Order 10521	20
(c) Executive Order 10807	21
(d) Reorganization Plan No. 2	21
(e) NSF response to the reorganization	23
(f) Further thoughts from the hearings	24
(g) Studies of science resources	26
CHAPTER III. CONTEMPORARY PERFORMANCE OF THE NATIONAL SCIENCE FOUNDATION	27
General appraisal	27
Identification of weaknesses and deficiencies	29
Specific problem areas	31
1. Organization	32
(a) Strengthening the Office of the Director	32
(1) Strengthening senior staff	32
(2) The Director's salary	33
(b) The National Science Board	33
(1) Composition	34
(i) Overlapping membership	34
(ii) Membership and size	35
(iii) Compensation	35
(2) Functions and operations	35
(i) Contact with the scientific community	36
(ii) Greater responsibility for the National Science Board	36
(c) Division of authority	37
(1) Delegation of authority	39
(2) Possible alternatives	39
(d) Staff for the National Science Board	40
(e) The divisional committees	41

CHAPTER III.—Continued

Specific areas—Continued

	Page
2. Leadership in science policy	42
(a) The Federal superstructure for science and technology	42
(1) The President's Special Assistant for Science and Technology	43
(2) The President's Science Advisory Committee	43
(3) The Federal Council for Science and Technology	43
(4) The Office of Science and Technology	44
(b) Relation of the National Science Foundation to the Superstructure	45
(c) Problem areas	47
3. Research programs	47
(a) Support of meritorious proposals	48
(b) Different leagues for competition	49
(c) Engineering and social sciences	49
(1) Engineering Research	50
(2) Social sciences	51
(d) Opportunities for small colleges	53
(1) Freezing out small colleges	53
(2) View from the small colleges	54
(3) Opportunities for small colleges	55
(e) Broadening geographic distribution	55
(f) Applied research	59
(g) Interdisciplinary research	61
4. The NSF and "Big Science"	61
(a) NSF funding of "Big Science"	62
(b) Management of NSF projects	63
(c) Weather modification	63
(d) Project Mohole	64
(e) Computers for universities	65
5. Strengthening institutional support	67
(a) Federal emphasis upon project grants	67
(b) Institutional development	68
6. Educational programs	69
(a) Graduate training of engineering students	69
(1) Estimates of needs and supply	69
(i) The Gilliland report	70
(ii) Current thoughts about the Gilliland report	71
(iii) The need for engineers	72
(iv) American Society for Engineering Education forecast	72
(2) Role of the National Science Foundation	73
(b) Public understanding	74
7. Science information	76
(a) The national science information network	76
(b) Interagency coordination	77
(c) Residual role of the NSF	78
(d) What of the future?	79
8. The balance-wheel function	80
(a) Origins of an idea	80
(b) Funding the balance wheel	84
(c) Using the 15 percent	85
(d) Appraisal and evaluation	86
(1) Evaluation of other agency programs	86
(2) Evaluations of basic research	88
9. Science policy planning	88
(a) Statistics for science policy	89
(b) Manpower information	90
10. Science and foreign policy	92

CONTENTS IX

	Page
CHAPTER IV. THE CONGRESSIONAL VIEW	97
Congress and national science policy	97
Legislative oversight of the National Science Foundation	100
Long-term commitments	101
Information for Congress	102
CHAPTER V. EMERGING ROLE OF THE NATIONAL SCIENCE FOUNDATION	103
Some specific thoughts	103
1. Academic research	103
(*a*) Funding academic research	103
(*b*) Balancing	104
(*c*) "Big Science"	104
(*d*) Social science	105
(*e*) Engineering	105
(*f*) Multidisciplinary studies	105
2. Regional and institutional development	105
3. Science education	106
4. Application of science	106
5. Information for science	106
6. International scientific undertakings	106
7. Statistics and information	107
8. Science policy	107
CHAPTER VI. CONCLUSIONS AND RECOMMENDATIONS	109
Amending the National Science Foundation Act of 1950	109
Nonlegislative recommendations	113
Observations	116

87-071 O - 68 - 14

SUMMARY

This report is the result of study and comprehensive hearings by the Subcommittee on Science, Research, and Development in a critical review of the operations and functions of the National Science Foundation. More than a year of preparation and effort has gone into it.

It follows that the report is, and is intended to be, a critical one.

The subcommittee does not mean critical in the sense of pointing fingers at failure, mismanagement, or nonfeasance, but critical in the sense of evaluating a major ongoing operation of government against the backdrop of the future and the needs of the Nation.

The subcommittee's inquiry has, inevitably, disclosed some shortcomings of the first type. On balance, however, their effect has been so far submerged by the main positive thrust of the Foundation's usefulness that concentration on them by the subcommittee could not be considered warranted at this point.

Shortcomings of the second type are something else again. Still, these stem less from personal aptitudes, or lack thereof, than from the swift tempo of contemporary living and the unparalleled growth of science and technology. The moment and impact of each is having a highly significant effect upon the other, to the point of much mutual dependence. Put another way, the problems of current government, as well as everday life, clearly depend upon science and technology for at least a part of their solution—an important part. Correspondingly, science and technology, which today more than ever cannot afford to become stagnant, must rely to a large extent upon government and the motives provided by the pressing difficulties of modern society to induce a satisfactory rate of evolution.

It is within this context of scientific, political, and social interaction that the subcommittee evokes its cardinal criticism; namely, that the Foundation is operating, and is largely organized to operate, in a manner which was satisfactory a decade ago but which does not appear adequate for either today or tomorrow.

The Foundation's approach and attitude toward its mission, its relationship with the Executive Office and other agencies of Government, and its legislative machinery all—in varying degree—appear to be in need of overhaul.

It is the subcommittee's hope and belief that appropriate executive and legislative action in accord with the findings of this report will help facilitate that overhaul.

Background for NSF Review

The National Science Foundation was created in 1950 in the wake of extensive congressional debate and some controversy over its mission and form. It was largely the result of public realization of the values of research and development in connection with World War II, plus the war's technological aftermath. Fundamentally the Foundation was charged with the duty of fostering good basic research

throughout the United States, together with promoting adequate education and training of those needed to do the research and engage in engineering practice.

For the most part, once organized and functioning, the Foundation carried out its programs in an atmosphere of relative quiet and moderate growth. Its contacts with Congress were, and until recently have remained, casual and generally confined to an annual inspection of the NSF budget.

A significant change began to take place in the post-Sputnik era. From a technological point of view, public opinion crystallized around the concept that basic science was no longer an ancillary, but a primary, instrument needed to guard the public safety, health and economy. From an organizational point of view, Congress responded to the new emphasis on science in a variety of ways—including the establishment of the House Committee on Science and Astronautics, which was given legislative jurisdiction over the Foundation as well as scientific research and development in general, space exploration, and other matters.

The committee began its operations in 1959. While it has not had authorization authority in regard to the NSF budget, it has continually endeavored to educate itself to the workings and growth of the Foundation—both of which have lately accelerated rapidly in scale and, to some extent, in scope.

INQUIRY BEGINS

Late in 1964 pursuant to a directive from the full committee chairman, Mr. Miller, the subcommittee began a comprehensive review of the Foundation and its operations.

At that time the subcommittee arranged with the newly formed Science Policy Research Division of the Library of Congress for a complete background report on the Foundation. The report was completed and submitted to the subcommittee in May 1965.[1] Shortly thereafter the subcommittee met in executive session over a period of time to familiarize itself with the contents of the study—which is a factual one and makes no effort to evaluate NSF performance. The purpose was to assimilate a still more detailed working knowledge of the Foundation, its operations and place in the scheme of the executive family.

In June the subcommittee began its public review of the Foundation in hearings which ran through the first week of August. More than 40 witnesses, government and nongovernment, testified [2] and a broad base of additional statements and pertinent information was solicited for subsequent analysis.[3]

In September and October the subcommittee resumed its executive sessions. Testimony and data were reviewed and analyzed, findings and conclusions worked out. Preliminary instructions for the drafting of legislation to amend the Foundation's organic act were delineated.

[1] "The National Science Foundation: A General Review of Its First 15 Years," a report of the Science Policy Research Division, Library of Congress, to the House Committee on Science and Astronautics, May 1965.

[2] Government and Science: A Review of the National Science Foundation, hearings before the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, vol. I.

[3] *Ibid.*, vol. II.

It is expected that legislation designed to effect the recommended changes will be introduced early in the second session of this Congress.

Congress Must Take the Lead

Any evaluation of the status or destiny of the National Science Foundation must be considered in the light of a number of limitations. Among these, two stand out.

First, the Foundation cannot be measured standing alone as an independent entity, but only within and as a member of the total executive organization for research and development. The Foundation must be assessed not merely for its internal operations, but in its relations with the Office of Science and Technology, as a member of the Federal Council for Science and Technology, and vis-a-vis the many other Federal departments and agencies with scientific interests and programs. Basic research, science education and science information which are major interests and responsibilities of NSF, extend also across the board to other Federal departments and agencies, and across the boundaries of Federal activities into the realms of State and local governments, industry, and education.

Second, no matter how much time is spent on a review such as this, some phases or issues may be shortchanged due to difficulties in securing adequate and accurate information. The Federal science complex is at once broad and intricate; it also shifts and fluctuates rapidly. Data and situations which are now reliable may not long remain so.

The subcommittee has been aware of these difficulties. It has sought to hear representatives from all Federal agencies whose activities may interrelate with those of the Foundation, and it has endeavored through both formal and informal channels to acquire data and information which are as current as possible.

The subcommittee is therefore confident that its findings and recommendations rest upon reasonably solid ground.

A revealing note to the theme of the subcommittee's inquiries, however, is the lack of original suggestion from Executive branch officials for specific legislative action which might improve the Foundation's role or position in the scheme of things scientific.

In its invitations for testimony, the subcommittee solicited any recommendations for legislative revision which might be necessary or useful. While a number of Government witnesses testified as to programs which might be improved or problems which might be alleviated, apparently all felt that such improvement could be handled administratively. None asked for legislative assistance.

The subcommittee does not agree that the steps necessary to a vitalized and forward-looking Foundation can all be taken without congressional action—or that, in the absence of such legislation, they will all be taken administratively. This, then, is an area of the government-science relationship in which Congress should provide a large share of the leadership essential to significant improvement in the Nation's resources and development.

To recite this situation is not to deplore it. Legislative initiative is a crucial part of the political system by which our National Government functions. If, in recent years, it has been relegated to the sidelines—as some contend—perhaps the issue at hand is an indication of a reverse trend.

What Is Wrong?

Before discussing what appears to the subcommittee to be wrong with the Foundation and its current or projected position in the pattern of Federal affairs, it is important to reemphasize that a very great deal is right with them. Almost without exception witnesses and other communicants were strong in their support of the Foundation, its work and its value as a national asset. None suggested a reduced or markedly altered NSF role.

Moreover, the subcommittee is appreciative of the unwavering cooperation, effort and candid testimony provided to it by the Foundation and its representatives.

But the fact is that the Foundation has not kept pace with the demands of society nor adequately oriented itself within the shifting machinery of government. The detailed analysis of this situation is set out in the body of the report, and specific areas which appear to need strengthening, correction or further study are itemized in chapter VI. Nonetheless, a few general observations are appropriate here.

Fundamentally it may be said that the Foundation has functioned, and still does, in a manner that is largely passive. It has not itself put a sustained effort into developing substance, form, and direction of the programs it supports. Once granted its annual budget, NSF has to a large extent followed a practice of waiting for talented outsiders to suggest appropriate projects on which to spend it.

There have been at least three reasons for adhering to this procedure. One is that so far as effectively supporting basic research is concerned, the system has generally worked well; it has been a boon to the scientific community and particularly to the science-minded colleges and universities. Without fluid NSF support, the state of basic research in the Nation—and the quantity and quality of American scientists and engineers—would be far less satisfactory than they are. A second reason is that by waiting for proposals from private sources, the Foundation has been able to tap a vast reservoir of ingenuity, imagination and scientific competence which it could not itself begin to duplicate. A third reason is that the legislative charter of the Foundation does not generally permit in-house research or technological activity.

Nonetheless, the time is past due for the Foundation to assume a more positive, dynamic stance. And there are at least three good reasons for this, too.

The first is that the problems of living in today's environment are reaching proportions which are truly monumental. It is conceded that they will not be solved without an equally monumental lift from science and technology. Foundation guidance in focusing upon allied areas of appropriate research and education could be a major factor in maintaining the stability of a civilization which is today seriously threatened by the surfeit and concentration of people and their problems. Such guidance, whether pragmatic, empirical or simply intuitive, should be a welcome beacon to the ship of state—and, in the opinion of the subcommittee, need not water down the original NSF mission of supporting basic research.

Secondly, the Federal Government's interest in and support of R. & D. has become so broad and pervasive that the development of national policy concerning it has become correspondingly difficult.

We see this on every hand, not merely in the allocation and use of our scientific resources but in identifying and producing them in the first place. The Foundation's input toward the evolution of national science policy, never strong, seems to have weakened further in recent years. This has been particularly true since the establishment of the Office of Science and Technology with all its organizational overlap with the Federal Council, the President's Science Advisory Committee and the Presidential science adviser himself. There should be, and is, a scientific and technological stature about the Foundation sufficient to warrant an extraordinary voice in the science policy chambers of the administration. NSF is the only Federal agency with an exclusive scientific mandate. It should make itself heard, and should be listened to, accordingly. While the Foundation's mission may be less tangible or focused than those of other government agencies, it is equally as real. If there is a disposition on the part of either the Executive or the Foundation to regard NSF viewpoints as less significant vis-a-vis the so-called "mission oriented" agencies, that disposition should be erased.

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.

What Needs To Be Done

It is not clear from the record to date whether the Foundation is yet visualizing and preparing for the dynamic role which circumstances seem to be thrusting upon it. It appears doubtful.

There are, however, a number of changes and/or innovations which the subcommittee believes should take place in order for the Foundation to assume the responsibilities described. In general, they are as follows:

1. The Foundation needs to supplement its traditional philosophy with positive, forward-looking plans and programs. Its position within the executive family should be upgraded and its influence increased. In relation to the Office of Science and Technology and the President's Science Advisory Committee, the Foundation should take the initiative and be held broadly responsible for the Nation's science resources, disengaging OST and PSAC from their detailed oversight in this area. OST and PSAC would thus be enabled to devote more time to national issues of applied science and development and to marshaling the resources of science and technology toward security problems such as coping with certain international difficulties. NSF

obviously should continue its cooperation with and assistance to the OST, but as a senior partner of Federal research and development concerned with science resources rather than merely in a staff capacity.

In correlation with these goals, NSF might well assume responsibilities for:

- Evaluating the state of the various scientific disciplines and their needs;
- Evaluating the condition of national scientific and technological resources, including adequately trained manpower;
- Directing, where indicated, some research—basic or otherwise, and including engineering—to help bring the scientific base for new and emerging technologies required in the national interest to the point where their development can proceed through other Federal agencies and industry. This may be especially important in regard to the major physical problems of urban living—such as transportation, pollution, water supply, housing and population growth;
- Channeling more effort into promising areas of the social sciences;
- Accelerating support and liaison in connection with international science activities and U.S. policies abroad;
- Emphasizing support for the development and refinement of institutions as such, with an eye for special help to those geographical areas presently at the low end of the academic spectrum.

2. The character and functions of the National Science Board should be strengthened so as to give it a more lubricated and flexible position in governing NSF affairs. At the same time, the Board should also develop a more potent and utilized capability as a national advisory body available to both executive and legislative councils, with particular reference to science resources and policies governing them.

Among the improvements which might be assayed are:

- Streamlining the functions of the Board so as to relieve it of routine administrative duties;
- Encouraging both Congress and the Executive Office of the President to make use of the Board as an important added source of capable advice and independent viewpoint;
- Providing the Board with a small staff from the roster of Foundation personnel which would devote full time to the Board's needs and activities:
- Additional broadening of membership characteristics of the Board in order to foster more equal representation from all segments of the scientific community.

3. The authority of the Foundation's Director should be widened so as to give him power to administer NSF affairs with a minimum of protocol or the necessity of going through pro forma routine. He should be empowered and encouraged to delegate administrative authority in order to facilitate and improve the managerial quality of the Foundation's performance; the increasing pressure of future demands on the Foundation will make this essential. The Director's prestige and influence within the executive family should be enhanced.

Toward this end a number of steps might be taken, including these:

- The Director should be empowered to pass on all proposals for NSF support, subject only to Board restraint in exceptional cases;

- Additional high-level staff with managerial as well as scientific background should be made available;
- Legislative authority permitting the Director to delegate such decisionmaking functions as he deems appropriate should be provided;
- The Director's pay grade should be elevated to place him on a par with the highest official of any of the independent offices of the Federal Government.

4. In addition, it is submitted that a number of other contemporary questions and issues involving NSF deserve further scrutiny. These are matters which have been, or are being, discussed around the conference tables of both government and the scientific community. Administrative or legislative action on them may be required in the not-too-distant future.

These include:

- The appointment and tenure of the Director—should his present fixed 6-year term be traded for a contemporary post to be held at the pleasure of the President?
- The danger of limited viewpoint which may arise from too much in-breeding within the Government's science advisory bodies. This is a worrisome point provoked by the fact that a number of the same people often serve simultaneously on the National Science Board, the President's Science Advisory Committee, advisory committees of the National Academy of Sciences or other Federal advisory groups.
- The proper balance in the Foundation's support of education and teaching as opposed to its support of research. How should this balance be reached? What criteria should be employed? Should there be increased emphasis on teaching and, particularly, efforts to draw good people into that profession? What relationship should evolve between NSF and the Office of Education?
- The proper balance in the Foundation's support of engineering vis-a-vis the physical sciences. Similar questions arise here.
- The methods and emphasis of NSF support of new curricula for the teaching of science and technology. Are the Foundation's present activities gaged to assure strong, competent, and sufficiently varied inputs into the drafting of such curricula?

A Final Word

In view of the demands which the future promises to make on the Foundation and the importance which science and technology hold for government and for our national well-being—it may be appropriate to suggest that the Foundation abandon any remnants of past aloofness in dealing with Congress and, to a lesser degree, with certain Executive offices and agencies.

Both branches will need the Foundation's help as they attempt to come to grips with the increasingly complex problems of tomorrow.

The fact that many of the issues will be political in nature does nothing to obviate this need. On the contrary, it perhaps makes the need more pronounced.

It is the subcommittee's belief, with due respect for the merits of keeping basic science in the pure atmosphere of "pursuit of knowledge for its own sake," that science has nonetheless matured a great deal in recent years. We believe it can play in the political leagues without being corrupted or even unduly influenced by the character of the other players.

CHAPTER I

Background

PURPOSE OF THE SUBCOMMITTEE REPORT

This report deals generally with the Nation's science resources of knowledge, manpower and facilities, and specifically with the functions, performance and future of the National Science Foundation. Its purpose is to focus attention upon what the Foundation has done during the past 15 years of its existence to strengthen and develop our national science resources to meet private and public needs. It poses the essential question: How well prepared is the Foundation to meet the challenge of the 1970's and the demand of the coming decade for augmentation of our science resources in quality and quantity?

Testimony received by the subcommittee has begun to highlight the future form and shape of the Foundation's purpose and responsibilities. For 15 years it has worked to foster basic research and science education. Now it is time to make the Foundation into a broader instrument for forging and shaping, in company with the Federal mission-oriented agencies, the national policies to foster the national resources for science and to focus and direct them toward the attainment of great national goals. Full employment, a clean world to live in, a population in balance with resources, swift and ready transportation and communication, pure water to drink, education of the citizenry, discovery of new resources—all of these and other needs of the Nation must depend in part upon thorough, deliberate, and positive efforts to learn more about our physical world, its creatures and its peoples, and their relations to one another; to apply this knowledge skillfully and with judgment; and to have ready for application the requisite science resources. The future of the NSF is bound up with the cultivation and development of intellectual, personal and physical resources for science and engineering throughout the country. Brought together by this common purpose, its future programs should reflect the interests and requirements of industry and government as well as the academic community. The NSF will carry a far larger share of the responsibility for bringing the understanding of and data for new fields of science to the state where engineers and technologists can proceed effectively with their task of applying the results of science to new public and private purposes.

ROLE OF THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

Since it was established in 1959, the Committee on Science and Astronautics has been mindful of its responsibilities relating to science. Despite the great demands upon time and attention of the committee for oversight of the national space activities, Mr. Miller, as chairman

of the committee, in 1963 established the Subcommittee on Science, Research, and Development. The subcommittee undertook a series of hearings inquiring into fundamental problems existing in the overall government-science relationship.[1] It also held a special seminar with 15 of the Nation's prominent scientists.[2] As a result of this initial inquiry, the subcommittee concluded that it would require expert outside assistance to seek answers to such questions as the appropriate level of basic research in this country, important scientific areas that might be neglected, the status of science education, and the establishment of criteria for Congress to apply when considering big, new research programs. The subcommittee's first hearings also disclosed two problems which warranted its immediate attention. These were the geographical distribution of Federal funds for research, and the allowance of indirect costs for federally sponsored basic research. While not directly related to each other, both were parts of the fundamental financial picture for Government research and development. These subjects became the theme of further hearings before the subcommittee in May and June of 1964.[3]

From these and other sources emerged a picture of basic research, science education and science information as important functions of many Federal departments and agencies, but functions that, aside from the National Science Foundation, were incidental to their scientific and technical missions. Federal leadership in shaping national policies relating to these functions and in experimenting with new approaches seemed a natural responsibility for the Foundation. Among all of the agencies, it was the only one concerned with the condition of our science resources, as distinguished from their application to public purposes. In such a leadership role, the Foundation could help to bring a coherence, consistency and purposefulness to agency functions which impinged upon science resources.

With the benefit of these initial efforts, the subcommittee laid the groundwork for carrying out an extensive review of the Foundation.

Turning to Foundation history, it is important to recall that in his first annual report in 1951, Dr. Alan T. Waterman, the original Director of the NSF, outlined the following questions which needed to be answered in developing a national policy for science:[4]

> What is the total financial support now being provided for scientific research?
>
> What is the distribution of this support among the three major sources—Government, industry, and educational institutions?
>
> What amount of financial support can and should be provided and what is the most desirable distribution from among the available sources of support?
>
> What is the division of research effort among the various natural sciences?
>
> What areas need greater emphasis and what less?

[1] "Government and Science," hearings before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, 88th Cong., 1st sess.

[2] The proceedings of the Government and Science Seminar appear in "Government and Science," above.

[3] "Government and Science: Distribution of Federal Research Funds; Indirect Costs re Federal Grants," hearings before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, 88th Cong., 2d sess.

[4] National Science Foundation, "First Annual Report," 1951.

What means can be developed to shorten the period between discovery and practical application?

What are the present and future needs for trained scientific manpower?

What is the impact of Government support of research programs on the educational process in universities and colleges?

What is the effect of Federal research programs on the financial stability of universities?

Many of these questions remain unanswered today, and others are only partially answered.

In keeping with its interest in the Nation's science resources and their deployment, the subcommittee, in March 1964, contacted the National Academy of Sciences and posed to it the questions: (1) What level of Federal support is needed to maintain for the United States a position of leadership through basic research in the advancement of science and technology and their economic, cultural, and military applications? (2) What judgment can be reached on the balance of support now being given by the Federal Government to various fields of scientific endeavor, and on adjustments that should be considered, either within existing levels of overall support or under conditions of increased or decreased overall support?

The Academy assigned these questions to its Committee on Science and Public Policy, then chaired by Dr. George B. Kistiakowsky. The report of this Committee, which already has become a landmark for science and public policy, was submitted on March 19, 1965.[5]

The report consists of 15 individual papers written by members of an ad hoc advisory panel plus a summary of principal groupings of these papers. The principal group of eight is concerned broadly with the questions posed by the House committee. It tries to lay down general themes and to examine specific tactical questions arising in connection with the support of science A second group of three papers is primarily focused on the relation between education and research. The remaining four papers depict the state of certain particular fields of science and give the flavor of the substance of science by showing their intellectual challenge, the material requirements and the relevance to our society of some specific scientific activities.

The NAS report appears to have been well received within the scientific community. It certainly illustrates the complexity of the two questions posed for advice, and the difficulties in the way of substantial agreement among the various disciplines of the scientific community on specifics of these questions. Viewed in this light, it is understandable that simple, clear-cut answers to these questions are not likely to appear. Nonetheless answers must be sought. Our resources are not without limit and their limitations do present the public and Congress with difficult decisions in choosing programs and courses of action.

[5] "Basic Research and National Goals: A Report to the Committee on Science and Astronautics, House of Representatives, by the National Academy of Sciences, U.S. Government Printing Office, Washington, D.C., 1965.

PURPOSE AND CONDUCT OF THIS INQUIRY

Throughout the years since 1959, the Committee on Science and Astronautics has been aware that its responsibilities for legislative oversight of general science specifically included the programs and activities of the National Science Foundation, and the committee's early work helped to prepare it for this role. Now, 15 years after passage of the National Science Foundation Act of 1950 and following the Foundation's transition through its first major change in leadership, it appeared advisable and timely to make a complete and thorough, critical and constructive review of the Foundation. Chairman Miller designated the Subcommittee on Science, Research, and Development, under the chairmanship of Mr. Daddario, to undertake this task.

In opening the hearings on June 23, 1965, Mr. Daddario stated, the subcommittee hoped to produce useful information about:[6]

1. How well had the National Science Foundation performed the tasks which Congress set out for it in the act of 1950?
2. What roles, responsibilities and missions should the National Science Foundation assume in the future?
3. What tools would the Foundation need in the years ahead to accomplish its work?

The inquiry was motivated, not by any presumption of agency mismanagement, but by a recognition that new problems were developing in assuring adequate levels of basic research and scientific manpower to meet the national security, economic and social needs of the Nation, and in satisfying the educational needs of a growing student population. It also recognized a current of scientific opinion that visualized the Foundation as occupying an even more significant role in the future if it is to carry out its legislative mandate to promote the progress of science.

By way of advance preparation for the hearings, the subcommittee requested the Legislative Reference Service of the Library of Congress to prepare a general review of the first 15 years of the Foundation's operations. The objective of this report, undertaken by the recently established Science Policy Research Division, was to survey the purpose and concepts underlying establishment of the Foundation, and to document its statutory authority and its subsequent evolution in terms of programs and budgets. The resulting report is a valuable source of facts about the Foundation which also shows the NSF in the context of the whole of Federal activities for basic research and science education.[7] The report includes an historical digest of legislative origins and consideration of scientific and public policy which put the Foundation's past, present and future role into perspective. It analyzes organization and funding for the NSF and gives details of program components, showing budget trends with particular attention to the last 10 years of the Foundation's existence. It also covers NSF basic research project grants, national research programs, support of research facilities, science education and institutional

[6] "Government and Science: A Review of the National Science Foundation," hearings before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 89th Cong., 1st sess., 1965, p. 2.

NOTE.—These hearings hereafter will be cited as Hearings.

[7] "The National Science Foundation: A General Review of Its First 15 Years," Report of the Science Policy Research Division, Legislative Reference Service, Library of Congress, to the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, House of Representatives, 89th Cong., 1st sess. (committee print).

programs, science information services, and support of science policy planning.

Beginning on June 23, 1965, the subcommittee heard testimony from more than 40 witnesses during 7 weeks, beginning and ending with Dr. Leland J. Haworth, Director of the National Science Foundation, and his staff. It heard also from Dr. Donald F. Hornig, Director, Office of Science and Technology; Dr. Alan T. Waterman, NSF's first Director; Dr. Eric A. Walker, Chairman of the National Science Board; several Board members; an NSF laboratory director, and an AEC national laboratory director. In addition, it heard from representatives of 10 Federal departments and agencies, 9 colleges and universities, an economic planning organization, a not-for-profit research institute, and the head of a principal NSF project in science curriculum revision. It also sent follow-up questions to all witnesses, exploring further their ideas about the Foundation.

The testimony furnished fresh insight and understanding of the Foundation and its activities, and of the related attitudes of the Nation's scientific community. The subcommittee appreciated in particular the response of the National Science Foundation and its staff to the lengthy series of questions and requests for information.

The one main question in the mind of the subcommittee throughout the hearings was: "Are changes needed in the NSF to strengthen its capabilities to fulfill its future responsibilities?" Specific, individual questions were directed toward this end, and were intended also to provide the basis for future public discussion and debate.

Through this approach, the subcommittee is endeavoring to generate discussion about basic research and technology. That it has had some results was noted by Dr. Wiesner, former Director of the Office of Science and Technology, who said: [8]

> I know that this committee on many occasions, and other committees of the Congress, too, has spent a great deal of time looking into the question of basic research and of technology in relation to our national security and economic development. As a matter of fact, this committee has stimulated discussions during the past 2 or 3 years with the result that there has been a tremendous increase in the understanding of the role of basic research to the technical development programs in this country and, as a matter of fact, I believe that as a result there has been a very great improvement in the understanding of this problem.

[8] Hearings, p. 652.

CHAPTER II

Contemporary Role of the National Science Foundation

World War II conclusively proved that science and technology had become a cardinal element of national strength, that they held the potential to radically change our national way of life. This realization owes a great debt to the effort by the scientific community in the late 1940's to demonstrate that healthy national progress requires an expanding basic scientific knowledge. Congress responded to the consensus that there was a national need to promote scientific research by establishing, in 1950, a novel and unusual agency, the National Science Foundation, to foster basic research and science education. During the 15 years since then, the agency has grown and increased its activities in scale and diversity from the initial appropriation of $225,000 for fiscal year 1951 and an early statutory annual budget ceiling of $15 million, to $480 million for fiscal year 1966. Its programs have grown from the initial, small individual project grants and fellowships to an entire panoply of grants, contracts, fellowships, traineeships, national research programs, national laboratories, science information and data collection and analysis. As Dean Price [1] pointed out, "I do not think anyone would have expected 20 years ago that the Foundation, which was created to support basic research and forbidden by law to operate its own laboratories, would be in charge of the national program of weather modification and actually running a project like Mohole." [2]

NSF growth since 1950 is a measure of the success of the scientists and engineers who set out to inform the public and the government about the critical importance of science in our modern world. It is also a measure of the response of the Director of the Foundation, its staff, and the National Science Board to advice and proposals from the academic community, and to generous financial support by the Congress.

Fifteen years ago, scientists feared that the attractiveness of short-term returns from applied research and engineering and development would dry up funds and interest in basic research. This fear was well expressed by Dr. Vannevar Bush in his landmark report, *Science: The Endless Frontier* [3] and, more officially for the Government, in the Steelman report.[4] These and the great educational drive of the scientists raised basic research to an unprecedentedly high level of prestige. Indeed, there is some thought that the pendulum then set in motion has swung so far that engineering and applied science may

[1] Don K. Price, dean of the Graduate School of Public Administration, Harvard University.
[2] Hearings, p. 251.
[3] Vannevar Bush, "Science: The Endless Frontier," a report to the President on a program for postwar scientific research, July 1945. Reprinted July 1960 by the National Science Foundation in its report NSF-60-40.
[4] The President's Scientific Research Board, "Science and Public Policy, a Program for the Nation," vol. I (John R. Steelman, Chairman), 1947.

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have become subordinate in the public esteem, even though they are the vehicle which brings many of the benefits of science to the public and the Nation.

FEDERAL OBJECTIVES FOR SCIENCE AND TECHNOLOGY

The National Science Foundation is one among many Federal departments and agencies concerned with research and development. It is a part of the complex network of Federal agencies active in science and technology in pursuit of the three objectives described, as follows, in the Foundation's latest annual report: [5]

> A primary objective of the Federal Government should be and is to make sure that our capabilities in the areas of science and technology are the very best the social structure can produce. This means that leadership must see to it that we have a vigorous and healthy scientific and technological base which will lead to continued social and economic advance. Scientific and technological progress must be viewed as dependent, in the long run on two factors:
>
> 1. The need to maintain and constantly augment a fund of scientific knowledge derived through research, particularly basic research.
>
> 2. The need to strengthen science education, especially higher education, to be sure that we produce adequate numbers of young scientists and engineers qualified to do the things our national goals require.
>
> A second Government objective is to develop, or have developed, the hardware, materials, and processes required for national programs conducted by the Government itself such as those in military defense and space.
>
> A third Federal objective is to foster and encourage developments that will react to the direct benefit of the people. Here, the distinction lies in the fact that the public rather than the Government is the "customer." Improvements in public health; better practices in agriculture; improved transportation; development of energy, water, and other resources; and conservation. These and many other applications of the sciences are properly the concern of the Federal Government since private elements of our society cannot be expected to assume sole or even primary responsibility.

RESEARCH AND DEVELOPMENT

Because the terms basic and applied research and development have been defined many times, it is pertinent to note the definitions used by the National Science Foundation during its testimony and in collecting data about research and development. The scientific activities as defined by Dr. Haworth at the outset of the hearings, cover the broad range of basic research, applied research and development. However, the boundaries between them are not sharply defined, nor subject to neat compartmentation. The definitions he gave are the following: [6]

[5] National Science Foundation, "Fourteenth Annual Report, 1964."
[6] Hearings, pp. 5-6.

Basic research seeks an understanding of the laws of nature without regard for specific utilitarian value. The real objective of basic research is not merely to discover a collection of separate facts by weighing this and measuring that, but to develop an understanding of nature by seeking out the why and how of nature's behavior. Basic research is important in several senses: it has very great intellectual and cultural value, it is the foundation upon which rests all of our technological advances, it is intimately involved in the education and training of first-class scientists and engineers.

Applied research is carried out with practical and, usually, but not necessarily, specific objectives in mind. Such research may involve special measurements to yield data needed for some engineering purpose. It could be a broad study of high-temperature materials for application to many purposes. Much applied research seeks detailed information regarding a specific situation for which the general laws are known from basic research.

Development is the systematic use of knowledge directed toward the design and production of useful prototypes, materials, devices, systems, methods, or processes. This includes the construction and testing of "hardware," including military weapons systems, space vehicles, nuclear reactors, and many other items great and small. This is the costliest aspect of the research and development spectrum, both in Government and in private industry. It is distinct and separate from research in that it applies the results of research to the production of end products.

All three areas of activity are important. Applied research builds on the results of basic research. Development builds on both. The more complete our underlying knowledge, the easier the task of applied research and of development. In the broad sense, research is in this era the foundation upon which rests all technological development.

AUTHORITY OF THE NATIONAL SCIENCE FOUNDATION

In the National Science Foundation Act of 1950,[7] the Congress made clear its judgment that basic research was of such national importance as to warrant a new agency and to authorize explicit Federal expenditures for this purpose. Among other things, the Foundation was authorized and directed—

1. to develop a national policy for the promotion of basic research and education in the sciences;
2. to support basic scientific research and to appraise the impact of research upon industrial development and the general welfare;
3. at the request of the Secretary of Defense, to support specific defense research activities;
4. to award scholarships and graduate fellowships in the sciences;
5. to foster the interchange of scientific information;

[7] Public Law 81-507, 60 Stat. 149, 42 U.S.C. 1861-1881.

6. to maintain a register of scientific and technical personnel and to serve as a central clearinghouse for information covering such personnel;

7. to evaluate scientific research undertaken by Federal agencies and to correlate the Foundation's research programs with other such programs; and

8. to cooperate in international scientific research activities.

Since its establishment in 1950, the authority of the Foundation has undergone few amendments. The initial limitation on annual appropriations was removed in 1953. Responsibilities in weather modification and also in the science information area were added in 1958. The most significant and far-reaching change, however, occurred in 1962 when, under Reorganization Plan No. 2, elements of Government-wide policymaking and program evaluation (items 1 and 7 above) were transferred to a new Office of Science and Technology within the Executive Office of the President.

Some 42 other Federal departments and agencies with interests in science and technology are engaged in or supporting research and development to fulfill their missions. The Foundation is one of them, and its growing contribution to the overall Federal scientific effort is indicated by the appropriations data shown in table I. Among these different agencies the Foundation is unique for only the NSF—and, in certain respects, the Smithsonian Institution—has an explicit mandate to sponsor basic research in science unrelated to a specific agency mission.

TABLE 1.—*National Science Foundation appropriations related to Federal obligations for research*

Fiscal year	NSF appropriations [1] [2] (millions)	Total Federal obligations for basic research (millions)	Total Federal obligations for research (millions)	Total Federal obligations for basic research in educational institutions (proper) (millions)
1951	$0.225	[3] $75		
1952	3.5	[3] 71		[4]
1953	4.75	[5] 113		[4]
1954	8.0	[6] 118		[4]
1955	14.25	[6] 130		[4]
1956	53.0	157	$844	[4]
1957	40.0	210	916	[4]
1958	51.75	331	1,034	$125
1959	138.5	543	1,390	165
1960	152.773	741	1,900	237
1961	175.8	803	2,300	280
1962	263.25	1,085	2,977	385
1963	322.5	1,359	4,070	455
1964	353.2	1,808	[7] 4,571	535
1965	420.4	[7] 2,118	[7] 5,087	605
1966 [8]	530.0	[7] 2,272		[4]

[1] Including IGY.
[2] Approximately 50 percent in recent years is devoted to research and facilities support.
[3] Basic research *only at nonprofit institutions*—"Federal Funds for Science, vol. I (presumably "obligations").
[4] Not available.
[5] "Federal Funds for Scientific Activities in the Federal Government." Fiscal years 1953 and 1954, NSF 58-14, p. 105.
[6] "Federal Funds for Science," vol. V, p. 10.
[7] Estimated.
[8] Requested.

Source: National Science Foundation "Federal Funds for Science" and Federal Funds for Research Development and other Scientific Activities."

MISSION OF THE FOUNDATION

Any idea that the Foundation exists without a central mission to give coherence and force to its operations is incorrect. The eight functions set out in the National Science Foundation Act of 1950, comprise and outline a mission of great current and future importance, one that can affect the future of the country as dramatically as missions which leave more visible results, such as highways, dams and hospitals. Dr. Haworth described it as "the advancement of science in the national interest." [8] Dr. Hornig said it was "* * * to strengthen American science per se, * * *",[9] that "* * * the National Science Foundation, is, of course, the only agency which has as a fundamental responsibility the health of basic American science and science education." [10] [11]

Dr. Waterman called it a "national program for the advancement of science.[12]

This mission extends to and impacts upon the whole of the Nation's scientific and engineering community wherever it is found: on campus, in industry and in government. As this report has said before, and will say again, the Foundation has the potential to become a powerful instrument of national policy for science, shaping it, interacting with it, and helping to carry it forward. The mission of the Foundation concerns the very science resources of the Nation to the end that no part of the country, no segment of its industry, no sector of its higher education should be closed off from the resources requisite to realize the promise of this scientific age.

IMPLEMENTATION OF ITS MISSION

Considering that the principal mission of the Foundation is to help maintain a vigorous and healthy scientific and technological base for the country as a whole, it is not surprising that its first years were devoted more to organizing and carrying out its support for basic research and science education than to influencing the shape of national science policy. NSF's early years were marked by a disparity between goals and resources. By virtue of its broad, comprehensive legislation assigning responsibility "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences," and the desire by its first Director to adhere to congressional intent, the Foundation started to plan and organize initial programs in support of the three primary components of a scientific capability: Research, manpower development, and communication. From a variety of options, the Foundation chose to support research through grants for individual projects rather than for programs or general institutional support. Most of these grants represented the undirected interest of the proposing scientists. Some, however, were attracted by the emphasis given by the Foundation to special areas of science selected for particular attention through the national research programs such as the International Geophysical Year.

[8] Hearings, p. 5.
[9] Hearings, p. 102.
[10] Hearings, p. 106.
[11] See also hearings, vol. II, question 4 to Dr. Hornig, p. 1103.
[12] Hearings, p. 156.

The Foundation began to support both small and large-scale facilities in universities to meet growing enrollments and changing needs of science. Support for students was undertaken at a relatively high-level, focused on graduate and post-doctoral fellowships awarded through competitive examination, rather than undergraduate scholarships. In recognizing that science students poorly prepared at high school levels could not meet college scholastic standards, the Foundation initiated support for improved science teaching primary and secondary schools and at college levels, as well as for studies to improve curriculum at pre- and post-college levels. The NSF also undertook a modest effort to foster and improve the scientific literacy of the Nation as a whole. Finally, it instituted support to improve the dissemination and communication of the results of scientific research.

With such enormous tasks, but with limited funds, it was clear that during NSF's early years only a start could be made. Yet, a start was made in all of these areas, and NSF activities have grown to the point where funding has approached the half-billion-dollar level. This increase reflects more an expansion in size and scope of existing program elements than the creation of new ones. For example, the fraction of the total budget for basic research and supporting facilities has remained relatively constant since 1957.

Over the years the NSF's initial activities have grown so that today a number of activities can be counted in support of science and policy development. As indicated schematically in figure 1, presented by Dr. Haworth at the hearings, these include: research, science education, facilities and institutional science programs, science information, surveys and analyses, policy development, and agency management and staff functions.

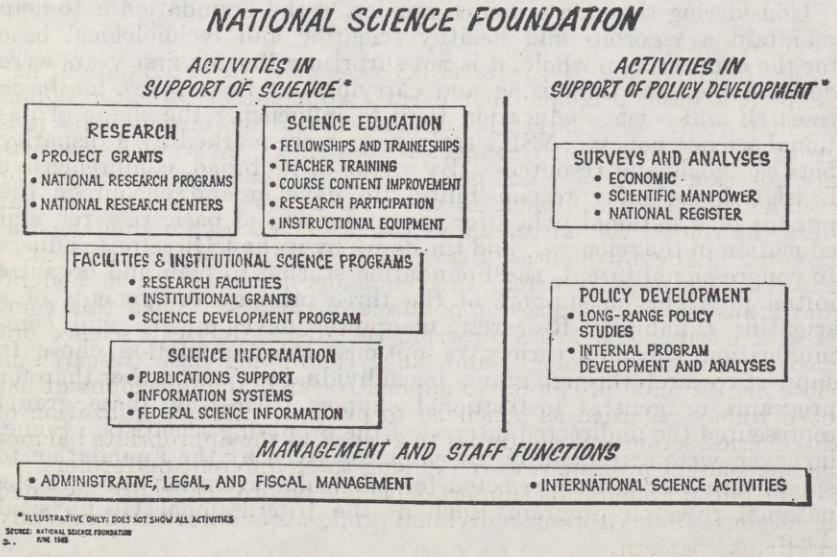

FIGURE 1

The four principal NSF mechanisms of support of science are highlighted in detail of scope and funding in figure 2, also presented by Dr. Haworth. These are: support of basic research, science education, facilities and institutions, and science information.

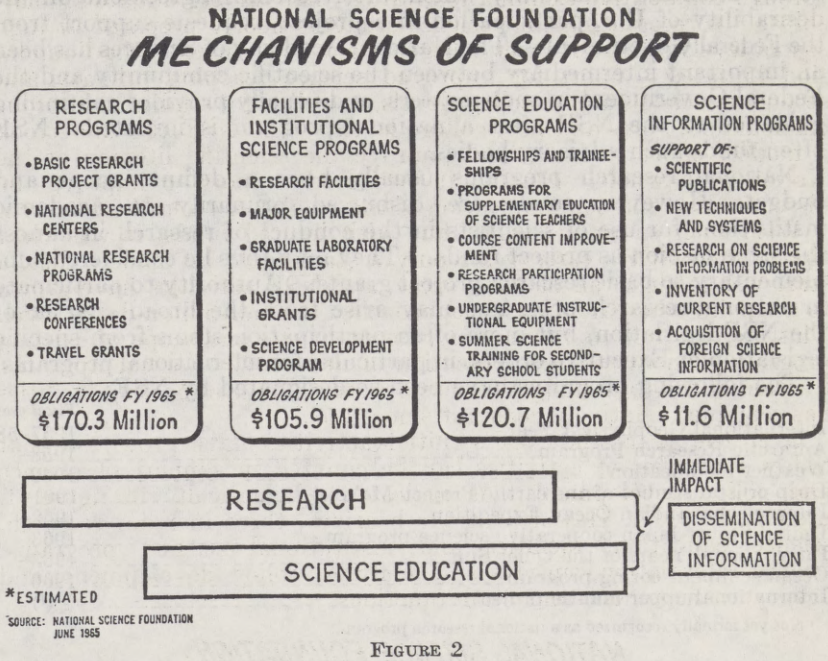

FIGURE 2

1. Basic research

(a) *Project grants.*—In fostering research, the Foundation has adopted a basic principle that every competent investigator should be supported. How large this number should be, at what rate it is growing, and how much support is needed by individual scientists are questions that have not been subject of quantitative analysis or recommendations. Implicit in the Foundation's approach also has been the role of the university as the primary host for fundamental research. The universities, incidentally, conduct about 50 percent of the Nation's basic research; the remainder is conducted in Federal and industrial laboratories or nonprofit institutes. Since this complex of institutional types underpins not only American science but also American technology, and since conducting basic research in close institutional proximity to applied research and development has been widely regarded as beneficial to prompt, effective utilization of discoveries, a question continues to arise as to the appropriate balance in the conduct of basic research among these different performers.

The initial Foundation support depended on project grants, awarded in response to meritorious individual proposals and not fitted into any particular pattern.

(b) *National research programs.*—Apart from its support of basic research through individual projects, the Foundation assumes responsibility for broad scientific programs in which a number of departments and agencies of the Federal Government participate, along with nongovernmental entities, and often in cooperation with other nations on an international basis. As the Federal agency

uniquely concerned with basic research, the Foundation has come to be regarded as the most appropriate "delegated agent" to coordinate and handle the financial aspects of NSF "national research programs."

National research programs are usually undertaken at the initiative of the scientific community which, after reaching agreement on the desirability of U.S. participation in a project, requests support from the Federal Government. The National Academy of Sciences has been an important intermediary between the scientific community and the Federal Government in such matters, and usually provides continuing guidance to the NSF after a national program is initiated. NSF often funds such advisory bodies.

National research programs usually have a definite scope and budget. However, funds are disbursed primarily to academic institutions for use of scientists in the conduct of research in almost the same fashion as project funds. They may thus be considered supplementary to basic research project grants. Authority to participate in national research programs may arise from the broad charter of the NSF legislation, but more often participation stems from specific legislation or Executive orders, in particular for international programs.

The following programs have been so designated by NSF:

	Fiscal year
International Geophysical Year	1957–58
Antarctic Research Program	1958–
Weather modification	1960–
Deep crustal studies of the earth (Project Mohole)	1961–
International Indian Ocean Expedition	1962–
United States-Japan cooperative science program	1963–
International Years of the Quiet Sun	1963–
Ocean sediment coring program	1966
International upper mantle project	(1)

[1] Not yet formally recognized as a national research program.

The subcommittee notes there may be some confusion about the meaning of national research programs. As indicated above, the Foundation itself has been given responsibility for two general categories of national research programs:

1. Those programs in which the United States participates as a component of an international program under auspices of intergovernmental or multinational science organizations. Examples are the International Geophysical Year, the Antarctic Research Program, International Indian Ocean Expedition, United States-Japan cooperative science program, and the International Years of the Quiet Sun program.

2. Those programs which are entirely domestic and of a non-mission-oriented basic research nature, such as Project Mohole, the ocean sediment coring program, and weather modification.

There is a third category of national research program designated by the Federal Council for Science and Technology comprising those scientific fields which depend substantially on Federal support, which are not the primary responsibility of any one agency, and whose scientific merits or promise in relation to public interest warrant acceleration. Among this category of national research programs are the following:

Atmospheric sciences.
High-energy physics.
Materials research.
Oceanography.
Water resources research.

Several of these were designated by President Kennedy as warranting such status; others were selected by the Council. The National Science Foundation participates in all of these programs but only as one among the several agencies with primary interests. The development of Government-wide goals and programs, and the designation of agency responsibilities including that of the National Science Foundation, are thus established through appropriate interagency committees operating under the aegis of the Federal Council for Science and Technology.

These three categories of national research programs do, however, result in ambiguities of meaning that make analysis difficult.

(c) *National research facilities.*—The Foundation has also moved to establish major research centers such as those for radio and optical astronomy and for atmospheric research where such facilities are needed to preserve U.S. leadership in science.

Today NSF funds pay for the operations of the National Radio Astronomy Observatory at Green Bank, W. Va.; the Kitt Peak National Observatory in Arizona; the Cerro Tololo Observatory in the mountains of Chile, South America, and the National Center for Atmospheric Research at Boulder, Colo. These national centers provide modern facilities for visiting university scientists, graduate students and the regular staff, and constitute effective extensions of academic research. They are operated for the Foundation under contract with nonprofit corporations sponsored by groups of universities.

2. Science education

A major concern of the Foundation, in addition to the health of science, has been the adequacy of U.S. manpower to meet both present and future needs. In adopting the concept of investing in people, and in placing a premium on academic excellence, the Foundation emphasized quality ahead of quantity. Accordingly, it took steps to assure an adequate future supply of scientists and engineers by improving their preparation in high school, thus helping to reduce the number of students who might want to choose a technical career but would find that option denied them because of inadequate precollege preparation. A similar concern also developed with regard to undergraduate teaching. As a consequence, the Foundation also has supported institutes for science and mathematics teachers, programs to aid high school and undergraduate college students, and improvement of course content for all levels of education.

Although the Foundation has sought not to emphasize any special fields of science by categorical support, this policy changed in 1962 when the Foundation mounted a special program of training grants for graduate study in engineering, thereby responding to the allegation of manpower shortage by the President's Science Advisory Committee.

The threefold objectives of the Foundation's support of science education are to assist qualified individuals to pursue their scientific training, to improve the quality of the material taught and the methods of teaching, and to improve the teachers. Five activities support these objectives:

(a) *Fellowships and traineeships.*—The Foundation's original graduate fellowship program has been and is regarded as one of its most effective efforts. Awards of these fellowships are made directly to

students based on merit in open national competition, with the student free to choose the institution for his training. The Foundation introduced its cooperative graduate fellowships in 1958 which are awarded to students who apply through the universities they attend.

Two postdoctoral fellowship programs provide for advanced training and study for especially able individuals. In addition NSF science faculty fellowships enable university and college science teachers to do scientific research and thus enhance their teaching of undergraduates. While not designated as a fellowship, the NSF's undergraduate research participation program provides promising students, who are thought likely to continue into graduate school, with opportunities to become junior colleagues of competent scientists.

A recent innovation is the NSF trainee program which seeks to increase the number of qualified individuals working toward advanced degrees by more fully employing the graduate training capabilities in existence. Trainees are supported through grants to universities which can accommodate more graduate students, as selected by the institution.

The training grants take on additional significance as a means to more fully utilize and strengthen the capabilities of many academic institutions. By placing responsibility for selection of students at the institution, this program also serves to counterbalance some of the effects of central selection in Washington of students for fellowships.

(b) *Teacher training.*—Over the past 12 years the Foundation has sponsored "institutes" which are group training activities in science, mathematics and engineering to upgrade teachers from elementary and high schools and from colleges and universities, with special emphasis on secondary school teachers. Institutes are conducted in the summer and during the school year. A smaller number of "academic year" institutes give training to teachers who can take leave of absence for a year. The NSF pays stipends to teachers enrolled in the summer and the academic year institutes.

(c) *Course improvement.*—The Foundation has also mounted an effort to improve the content of science courses. Through grants, outstanding scientists and teachers can work together to modernize and improve science course content for precollege and undergraduate instruction. To capture the excitement of modern science, and to help foster a deep understanding and appreciation of its principles, they have prepared much new instructional material—laboratory equipment, textbooks, teachers guides, films, supplementary reading and examinations.

(d) *Research participation.*—The purpose of this NSF program is to increase the competence of high school and college teachers through opportunities to gain actual research experience by working with active and productive scientists. An "academic year extension" begun in fiscal year 1962, gives money to selected college teachers to help them continue at their home institutions the research they began during the research participation program. This program has shown how it may be possible to bolster faculty research in smaller colleges.

(e) *Instructional equipment.*—A closely related NSF program provides colleges and universities with equipment for instruction of undergraduates through grants. The Foundation matches funds with an institution for the purchase of equipment for laboratory training.

This support activity has had widespread influence and has helped many small colleges.

3. Institutional development

In the beginning the Foundation was more concerned with individual scientists, engineers and students than it was with the scientific and engineering capabilities of whole institutions. Then, as the NSF's activities continued to grow and as the results of concentration of Federal funds for academic research began to appear, the Foundation began to give attention to strengthening and improving the capabilities of colleges and universities for basic research and science education. In response to the 1960 report, "Scientific Progress, the Universities and the Federal Government," of the President's Science Advisory Committee, and its 1962 report, "Meeting Manpower Needs in Science and Technology," the Foundation began to make funds available to strengthen individual institutions and to improve their capabilities as a source of our future trained scientists and engineers.

The four components of the NSF's "Institutional Science Programs" are:

(a) The graduate science facilities program, initiated in fiscal year 1960. Through it the Foundation matches institutional funds for construction of new, or renovation of existing research laboratories, and for acquisition of apparatus for advanced training and for research. Facilities and equipment thus supported are used for the biological sciences, including oceanography; the physical sciences; engineering; certain social sciences; and for university computer facilities.

(b) The institutional base grants program, initiated in fiscal year 1961. Through this program the Foundation makes grants to institutions based upon the NSF's research support to projects. The annual grant of funds is based on a variable formula related to the research support received by these institutions from the Foundation. The formula is set to favor those institutions receiving the least support. Under present NSF policy, the formula matches the first $10,000 of total NSF research grant payments for a year, and adds 5 percent of the remainder up to a maximum of $150,000. The average grant has increased from $6,035 in 1961 to $30,690 in 1964. These grants may be used for any purpose which directly supports academic science and thus provide funds for items such as rental of computers, equipping shops and libraries, student stipends and other purposes.[13]

(c) The instructional equipment grants program, started in fiscal year 1962, which provides funds for equipment for undergraduate science education.

(d) Science development grants, begun during fiscal year 1964, which are the latest addition to NSF means of fostering development of scientific centers of excellence. The science development grants are a significant innovation in NSF institutional support, although similar grants have been made for some time by the National Institutes of Health. These new NSF grants are devoted to the objective of developing those colleges and universities which, through their own initiative and efforts, show promise of maturing into first-rate centers of scientific research and education, but lack funds to do so.

[13] In addition to information about base grants contained in the testimony, a detailed discussion of these grants appears in an article by J. Merton England, director of the NSF's institutional grants program, in the June 25, 1965, issue of *Science*, pp. 1693–1696.

Of all the NSF grant programs, the science development grant program appears best suited to help alleviate some of the consequences of the concentration of Federal research funds in a few institutions.

Congressional enthusiasm for the science development grants is illustrated in the action of the House Appropriations Committee which, although reducing the Foundation's budget proposals for fiscal year 1966, instructed the agency not to cut its proposed level of support for this program.

4. Science information

Although the Foundation is thought of primarily in terms of basic research, it has a specific mission, assigned by section 3(a)(5) of the National Science Foundation Act of 1950, "to foster the interchange of scientific information among scientists in the United States and foreign countries." Such an assignment calls for an outlook and attitude more promotional than would seem appropriate for basic research activities.

Because scientific progress is cumulative, in that one individual builds on the findings of his predecessors, progress in science depends on a prompt and effective exchange of information among its participants. Information exchange was cited in the first annual report as the "circulatory system of a healthy and vigorous scientific body." The free dissemination of scientific results is also of prime importance to engineers, technologists, and managers who would seek to apply scientific discoveries to public or private purposes—of defense, health, transportation, communication, etc.

Since its origin, the Foundation has sponsored research into the process of information transfer, to improve methods of abstracting, to study use of mechanical and electronic means for compiling statistical and other material, to provide assistance in the preparation and processing of research results, to speed the appearance of papers in the scientific literature and to foster the translation of foreign scientific information. In addition, because of its responsibilities for coordinating scientific information, the NSF has undertaken a number of administrative steps to provide some coherence to the growing and often uncorrelated matrix of Federal information sources and dissemination systems. Finally, the Foundation has recognized the existence of "science intelligence" as apart from scientific information—intelligence about "who is doing what research, where, and with what funds." The Foundation has thus sought to support such activities as the Science Information Exchange at the Smithsonian Institution to provide information for scientists, and more particularly for administrators both in and outside of Government. The Science Information Exchange activity at the Smithsonian has not yet met congressional expectations and has been of some concern on the part of this subcommittee and of the House Select Committee on Government Research.

NATIONAL SCIENCE POLICY

When speaking of science policy and of the National Science Foundation, one may mean either the Foundation setting those internal policies that govern its activities, or the pursuit of national policy for basic research and science education which extends also to other Federal agencies. It is the latter with which we are concerned.

1. National science policy—What is it?

One would look in vain for a single, comprehensive, all encompassing national science policy. It does not exist as such. Instead, Federal research and development and science education activities are governed by a collection of more or less related policies that originated from different sources for various reasons at separate times. Dr. Haworth described the situation graphically saying: [14]

> National science policy is a constellation of interrelated policies. These policies may be grouped together under this singular term because they affect, directly or indirectly, the level, substance, and conduct of scientific activities in the United States, the opportunities for and content of education in the sciences, and the utilization and development of the Nation's resources for science. Science policies are also shaped by State and local governments and by nongovernmental institutions, enterprises, and organizations. It is appropriate, therefore, to speak of a constellation of both public and private science policies.

Dr. Hornig emphasized the absence of any single, monolithic policy for science, in his statement that: [15] "* * * I should like to make clear that there is no such thing as a single national policy for science. National science policy is composed of a mosaic of related segments."

From the standpoint of the subcommittee, science policy is taken to mean the collection of explicit and implicit policies and programs by which science is employed in the public interest to meet specific needs. Science policy embraces the allocation of funds, manpower, facilities and organizations, and the continuing development of our science resources. The decentralized, even fragmented character of national science policy deserves attention because it is possible that changes in constituent policies, made for special or narrow reasons, do affect the state and quality of resources for science, and thus become the concern of the National Science Foundation.

2. NSF and science policy

In its initial act, the Foundation was given the responsibility to develop and encourage pursuit of a national policy for the promotion of basic research and education in the sciences, to evaluate scientific research programs by agencies of the Federal Government, and to appraise the impact of research upon industrial development and upon the general welfare. These three passages form the Foundation's policy forming responsibilities.

Because the Foundation wished to gain internal operating experience before embarking on broader issues of policy planning for national science resources and because of the intrinsic difficulty that any agency has in evaluating scientific research programs of other agencies that are organizationally equal, and often more affluent, the Foundation did not exercise this responsibility.[16] As a result, initiative was taken for broad policy planning at the White House level with the establishment by President Eisenhower of the Office of the Special Assistant to the President for Science and Technology.

[14] Hearings, vol. II, NSF question A-1.
[15] Hearings, vol. II, question 5 to Dr. Hornig, pp. 1103–1104.
[16] Dr. Waterman's testimony explicitly stated why he did not think it proper for the NSF to evaluate the research programs of other agencies, see Hearings, p. 148.

Then, in 1962, Reorganization Plan No. 2, which established the Office of Science and Technology, changed the Foundation's responsibilities for national science planning. This plan downgraded the NSF from its previous special position to one coordinate with the other science-minded agencies under the aegis of the new Office of Science and Technology. Under the plan, however, the Foundation continued its responsibility to originate policy proposals and recommendations concerning research and education in the sciences and to provide information to OST on which sound policies can be based. Congress acceded to this plan and so shares responsibility for it with the executive branch. The results of the plan are now visible. In establishing the OST, the Foundation had taken from it part of the responsibility assigned to it by Congress in the National Science Foundation Act of 1950, "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." Such responsibility is now vaguely divided between the Foundation and the OST in a way that does not prohibit, but certainly appears unlikely to encourage initiative by the NSF.

Because of the importance the subcommittee attaches to the effect of Reorganization Plan No. 2, it is pertinent to review the background of NSF authority in science policy formulation.

(*a*) *Legislative assignment*

In section 3(a) of the National Science Foundation Act of 1950, we find that Congress authorized and directed the Foundation:[17]

> (1) to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;
>
> (2) * * * to appraise the impact of research upon industrial development and upon the general welfare;
>
> * * * * *
>
> (6) to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups;

(*b*) *Executive Order 10521*

In 1954 the President focused attention on the policymaking function through his Executive Order No. 10521. It broadened the scope of NSF interests to the national scientific effort and scientific research. It specifically provided:[18]

> The National Science Foundation * * * shall from time to time recommend to the President policies for the Federal Government which will strengthen the national scientific effort and furnish guidance toward defining the responsibilities of the Federal Government in the conduct and support of scientific research.
>
> The Foundation shall continue to make comprehensive studies and recommendations regarding the Nation's scientific research effort and its resources for scientific activities, including facilities and scientific personnel, and its foresee-

[17] Public Law 81-507, 60 Stat. 149, 42 U.S.C. 1862.
[18] Executive Order No. 10521, Administration of scientific research, Mar. 17, 1954—19 F.R. 1499.

able scientific needs, with particular attention to the extent of the Federal Government's activities and the resulting effects upon trained scientific personnel. In making such studies, the Foundation shall make full use of information and research facilities with the Federal Government.

* * * * *

The head of each Federal agency engaged in scientific research shall make certain that effective executive, organizational, and fiscal practices exist to ensure that the Foundation is consulted on policies concerning the support of basic research, * * *

Note that this order again spoke of policies to "strengthen the national *scientific* effort * * * and support of *scientific* research," it also directed attention to science resources, and put an obligation on agency heads to consult with the Foundation.

(*c*) *Executive Order 10807*

This expanded vision of the Foundation was pulled back to the original congressional specification of basic research and science education in 1959 when the Federal Council for Science and Technology was established by the President. His Executive order creating the Federal Council amended the earlier 1954 order to read:[19]

The National Science Foundation * * * shall from time to time recommend to the President policies for the promotion and support of basic research and education in the sciences, including policies with respect to furnishing guidance toward defining the responsibilities of the Federal Government in the conduct and support of basic scientific research.

(*d*) *Reorganization Plan No. 2*

The creation of the Office of Science and Technology in 1962 accounted for most of the discussion about Reorganization Plan No. 2. It is difficult to find much evidence of attention at that time to the long-term effect of the change upon the National Science Foundation's role.[20] Emphasis at the time was focused on the OST as a new organization with little explanation of the effects of the plan on the Foundation's functions. Dr. Waterman and the Budget Bureau appeared at the hearings on the plan and supported it unequivocably. Most of the congressional questions were aimed at the dual responsibility of the Director of OST as a personal Presidential adviser and as head of a unit within the executive branch. A staff study for the House Committee on Science and Astronautics at the time did note that the proposed transfer of functions would weaken the NSF and that it might have been better to strengthen the Foundation so that it would be able to perform these functions, rather than to create a new agency to undertake them.[21] However, no objection was raised and the plan was approved.

The plan transferred from the National Science Foundation to the Director of OST so much of the functions conferred upon the Founda-

[19] Executive Order No. 10807, Mar. 13, 1958.

[20] For background material on this plan, see the review report of the Science Policy Research Division and also the staff study, "Creation of the Office of Science and Technology" prepared for the Committee on Science and Astronautics, House of Representatives, 87th Cong., 2d sess., 1962 (committee print).

[21] "Creation of the Office of Science and Technology," a staff study prepared for the House Committee on Science and Astronautics, 87th Cong., 2d sess., 1962 (committee print), p. 3.

tion by the provisions of section 3(a)(1) of the National Science Foundation Act of 1950 as would enable the Director to advise and assist the President in achieving coordinated Federal policies for the promotion of basic research and education in the sciences. It also transferred the functions conferred upon the Foundation by section 3(a)(6) of the act "to evaluate scientific research programs undertaken by agencies of the Federal Government."

The plan specified also that the Director of OST should assist the President as he may request with respect to coordination of Federal scientific and technological functions and agencies.

In explaining the proposed reorganization, President Kennedy reported in his message to the Congress on March 29, 1962, that:

> The ever-growing significance and complexity of Federal programs in science and technology have in recent years necessitated the taking of several steps for improving the organizational arrangements of the executive branch in relation to science and technology:
>
> (1) The National Science Foundation was established in 1950. The Foundation was created to meet a widely recognized need for an organization to develop and encourage a national policy for the promotion of basic research and education in the sciences, to support basic research, to evaluate research programs undertaken by Federal agencies, and to perform related functions * * * . The National Science Foundation has proved to be an effective instrument for administering sizable programs in support of basic research and education in the sciences and has set an example for other agencies through the administration of its own program. However, the Foundation, being at the same organizational level as other agencies, cannot satisfactorily coordinate Federal science policies or evaluate programs of other agencies. Science policies transcending agency lines, need to be coordinated and shaped at the level of the Executive Office of the President drawing upon many resources both within and outside of Government. Similarly, staff efforts at that higher level are required for the evaluation of Government programs in science and technology.

and further:

> The Foundation will continue to originate policy proposals and recommendations concerning the support of basic research and education in the sciences, and the new Office will look to the Foundation to provide studies and information on which sound national policies in science and technology can be based.

With this transfer of authority to the Office of Science and Technology by Reorganization Plan No. 2, it was nonetheless understood that the Foundation would continue to originate policy proposals and recommendations concerning the support of basic research and education in science, and to provide studies and information to OST on which policies could be based. Also unchanged was the Foundation's responsibility to detect and, where possible, correct imbalances. This function was implicit in its responsibility to correlate

its programs with those sponsored by other Federal agencies, public and private groups.

(e) *NSF response to the reorganization*

No immediate effect of this reorganization appeared in the Foundation's report for the year ending June 30, 1963. After posing some broad questions of public policy, Dr. Waterman commented on the NSF's function of analysis for and formulation of policy: [22]

> The National Science Foundation aids such an analysis in two important ways, both specifically set forth in its enabling legislation. The one is a systematic data-gathering operation, together with factual analysis and periodic reporting. This was begun in 1953. The other is that of developing national science policy, with special reference to the role of the Federal Government as it relates to the health and progress of science—particularly basic research—and to the education and training of scientists and engineers.

Dr. Haworth, in his first annual report as Director, discussed the reorganization plan at some length, emphasizing future NSF surveys of research and development expenditures, manpower and other matters susceptible to statistical treatment, and the NSF's central responsibility for special analyses to help all those concerned with policymaking. In the introduction to this report Dr. Haworth wrote as follows: [23]

> The second sense in which such questions can be viewed as particularly relevant to the Foundation's role derives from the charge given NSF by the Congress to develop and encourage the pursuit of a National policy for the promotion of basic research and education in the sciences. In carrying out this assigned responsibility (which, by virtue of Reorganization Plan No. 2 of 1962, it shares with the Office of Science and Technology), the Foundation must of necessity take into account the activities and procedures of other Federal agencies and all other public and private groups that are concerned with improving the Nation's scientific potential. This means that NSF must inform itself and others concerning the actualities of Federal and other support of science and technology. This is accomplished by means of comprehensive and thoroughly detailed surveys of research and development expenditures, scientific and technical manpower, and other related matters that lend themselves to statistical treatment. Moreover, NSF has a central responsibility for presenting special analyses which will help all those concerned with policymaking in this domain to base their decisions on the most accurate and significant information available. Therefore, while it is obvious that the search for solutions of these problems is important in terms of the Foundation's own programs and procedures, it is necessary to remember also that these efforts must take into account our statutory responsibilities as they relate to policy formulation.

[22] National Science Foundation. Thirteenth annual report for the fiscal year ended June 30, 1963.
[23] National Science Foundation. Fourteenth annual report for the fiscal year ended June 30, 1964, pp. XX-XXII.

However, the body of the report was noticeably silent on the NSF's role in shaping national policy.

(f) Further thoughts from the hearings

In his opening testimony Dr. Haworth called attention to the President's statement that the Foundation would continue to originate policy proposals and recommendations for support of basic research and education in the sciences. He explained the effect on the Foundation, saying: [24]

> The Foundation has, therefore, not only put a great deal of effort into serving the needs of the Office of Science and Technology and the Federal Council for Science and Technology, but has also continued to consider and make recommendations, when appropriate, on policy matters; in order to accomplish these ends, it has also expanded its factfinding and analysis function, and has recently given this function a greatly enhanced organizational position.

As for the future, he said: [25]

> Now that we have gathered and have at hand a more nearly adequate base of information, we believe we can launch a major effort to isolate particular roadblocks and problems in the path of the Nation's scientific development—and thus assist more effectively in the development of policies to assure healthy scientific progress for the country.

In response to a question about science policy responsibility remaining with the Foundation following the reorganization, Dr. Haworth said: [26]

> A little of that is left over. There is both the question of how much—and it is somewhat intangible I have to admit—is an assigned responsibility in the legal sense, in the formal sense, and how much takes place just by tradition and relationships and so forth. I think it is fair to say that OST, Dr. Hornig and his office, look unusually strongly to the NSF for assistance in helping them develop information and policy both for OST and for the Federal Council; so, we are simply more engaged in this than are other agencies.

In his response to subsequent questions, Dr. Haworth said that he believed the Foundation had a responsibility not only involving the science policies of the Federal Government, but also those of the non-Federal public and private sectors of the Nation. He reaffirmed the policy role for the Foundation, pointing to its statutory responsibility "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." As for how the Foundation shared this responsibility with other Federal agencies, levels of government, and organizations and institutions in the private sector, he proposed active leadership by the Foundation, saying: [27]

> I believe that what NSF does directly through its own operations it should complement by an active leadership role

[24] Hearings, p. 13.
[25] Hearings, pp. 12—13.
[26] Hearings, p. 15.
[27] Hearings, vol. II, question A-1 to NSF.

> in developing, evaluating and proposing alternative policies by which the Federal Government as a whole, the State and local governments, and private institutions and organizations could contribute to the realization of these primary objectives.

Dr. Hornig testified that the realinement of functions by Reorganization Plan No. 2 had enabled the Foundation to participate more effectively in the science policymaking process and to develop stronger programs of support than would have been the case otherwise. He emphasized that "the Foundation continues to have full intellectual responsibility to examine, make policy recommendations, and take actions with regard to enhancing the health of American science which * * * is a unique responsibility of the Foundation." [28] In response to a later question he said: "The NSF is expected to and does generate policy proposals for the entire Government which are given particular weight because of the unique position and mission of the agency." [29]

He testified further that: [30]

> In recognition that the development of science policies affecting several agencies and evaluating agency programs can only be performed at a higher level, Reorganization Plan No. 2 was based on a transfer of two functions from the National Science Foundation to the Office of Science and Technology. First, it split the function of developing and encouraging the pursuit of a national policy for the promotion of basic research and education in the sciences by transferring to the Office of Science and Technology as much of that function as would enable the Director of the Office to advise and assist the President in achieving coordinated Federal policies for these purposes. The National Science Foundation retained the balance of the authority, including explicit responsibility for developing policies to govern NSF programs for the promotion of basic research and science education.
>
> The reorganization plan also transferred to the OST the 1950 function of the National Science Foundation to evaluate scientific research programs undertaken by other agencies of the Federal Government. It left in the Foundation statutory responsibility for correlating its scientific research programs with those undertaken by individuals and by public and private research groups.

This statement would indicate Dr. Hornig's thought that most of NSF's policy function would be limited to its own activities.

Dr. Waterman, on the other hand, did not believe the plan had a substantial effect upon the NSF's responsibility as he conceived it. In response to a question about the transfer to OST of the evaluation function, he said: [31]

> I should say that what this really did was to transfer the evaluation of agency programs to the OST. It still leaves to the Foundation the development of national policy with respect to science, in particular as a help to OST.

[28] Hearings, p. 110.
[29] Hearings, vol. II, question 5 to Dr. Hornig, pp. 1103—1104.
[30] Hearings, p. 107.
[31] Hearings, p. 167.

We have discussed Reorganization Plan No. 2 at some length, for it would appear that the original congressional instructions "to develop and encourage the pursuit of a national policy" were not meant to be limited to the Foundation's own programs and activities. Surely Congress did not create a National Science Board of 24 distinguished leaders of science, education and public affairs solely to settle issues arising out of the normal operations of the Foundation itself.

Congress, the subcommittee believes, originally expected the Foundation and the Board to play a larger role, to go beyond the confines of the Foundation's own operations, and to establish certain *national*, as contrasted with *Foundation* policies. The instructions to evaluate the programs of other agencies and to appraise the impact of research on industrial development and general welfare support this interpretation.

As for Reorganization Plan No. 2, with the benefit of hindsight, it appears that its effect on the NSF's policy function could have received more attention at the time to show more of the implications of the transfer. For this reason, more of its effects will be explored in chapter III.

(*g*) *Studies of science resources*

Although the above discussion of national science policy contains numerous references to the Foundation's activities in the collection and analysis of statistical and analytical data, the full range of its responsibilities may not be generally realized. The following summary from the Foundation's justification statement for its budget submission for fiscal year 1966 may prove helpful as a backdrop against which the discussion of these activities in chapter III, pages 88–92, can be considered:

Statistical surveys, are conducted nationwide on research and development in industry and in government; on funds allocated for scientific and technical information activities; on scientific and technical manpower; and on science education. These surveys are conducted or coordinated and supported by the Foundation, which has been designated as the focal agency for scientific and technical manpower and related economic information. Many are continuations of periodic surveys which have provided extensive historical background.

Detailed information is obtained every two years for the *National Register of Scientific and Technical Personnel* directly from individual scientists and engineers concerning their education, employment, and specialization. This information is particularly valuable for making detailed analytical studies of the status of and interrelations among the many factors involved in the education, work, and mobility of scientific and engineering manpower. The Register also serves as a source for identifying and locating individual specialists and—in the event of national emergency—would become a mobilization asset of vital importance.

Analytical studies of the economic and manpower implications of science and technology are made, either directly by the Foundation staff or with Foundation coordination and support. Such studies deal with scientific and technical manpower and science and engineering education; science organization, management, and facilities; the relationship or research and development to economic growth; government-university relationships; and science and technology in foreign countries, including the Soviet Union.

CHAPTER III

Contemporary Performance of the National Science Foundation

Having considered the contemporary functions of the National Science Foundation, the subcommittee next considered the testimony it had received and attempted to evaluate how well the Foundation has done its job. In doing so, the subcommittee looked for indications of the capability of the Foundation to meet its present responsibilities. It looked also for indications of the Foundation's ability to extend its scope to include the full range of developing the Nation's resources for science—both basic and applied—and to lay the foundation for the substantial application of science to major needs and problems of our time.

GENERAL APPRAISAL

A principal question before the subcommittee throughout the hearings was: "How well has the National Science Foundation performed the tasks which Congress set out for it?" It was evident that the administration believes the Foundation has done a good job. Dr. Hornig, as the spokesman for Federal science and technology, testified that the Foundation had achieved a brilliant record in strengthening American science and science education. He said that—[1]

> Its programs have measured up to and have come to symbolize the highest standards of excellence. Its policies and practices have been characterized by imagination and creativity in forging relations between the Government and our educational institutions that have been of unquestionable benefit to both.

The Foundation can indeed point to impressive achievements it has registered together with the academic community during the past 15 years. Building upon the earlier work of the Office of Naval Research, the Atomic Energy Commission and the Public Health Services, NSF has increased basic research while sustaining the concept of excellence in science. Superior new scientists and engineers have been trained. The tone and quality of science education has been improved. Laboratories have been built and special equipment purchased for science education and basic research. Emerging centers of academic excellence in science have been bolstered. Information systems have been demonstrated to supply facts about governmental research and about interests of individual scientists. A stream of reports has supplied data previously unavailable about money and manpower for research and development. NSF national laboratories have been established and national research programs organized enabling scientists to turn their attention to significant scientific matters.

[1] Hearings, p. 101.

These accomplishments have brought new dimensions to basic research and science education in America, raising these pursuits to new heights in the public esteem.

In carrying out its functions, the Foundation has had the advantage of broadly defined authority from Congress which has permitted unusual flexibility in planning and introducing new programs. Undertakings of the scale and importance of Project Mohole and the great radio telescope, recently dedicated at Greenbank, W. Va., have been mounted under the NSF's general authority without further specific congressional authorization. Few other agencies have so wide ranging a charter.

During its life, the Foundation has been able to concentrate its time and energies upon developing its programs without diverting attention to seeking authorizations and supporting them along the often long and arduous path from introduction to enactment. However, the very broadness of this charter may have been a disadvantage for the Foundation has not had to link together its several programs and direct them deliberately toward specific national purposes. This may be one reason why the Foundation sometimes appears fragmented, responding to individual, unrelated academic interests as they arise.

Dr. Haworth himself was mindful of this, for at the end of his third day of testimony, he remarked on the opportunistic, reactive approach of the Foundation, saying:[2]

> More generally, as time moves on, I see NSF assuming a more active role of leadership. Its traditional role has been an essentially receptive one—one which leads us to react to and support, to the extent we can, meritorious ideas of active scientists. Such a role may be described as one of enlightened opportunism. Thus we stand ready to receive and support good ideas, but only in a limited number of cases do we initiate activities.

The Foundation has been relatively free from the pressures that can be experienced by Federal agencies as the national political process reconciles different interests of national regions, States and the districts. NSF decisions have been based upon the needs of the academic community without having to consider the needs and interests of other sectors of our society.

The Foundation has enjoyed substantial financial support from the Congress. After a few early lean years, the $15 million statutory limit upon its appropriations was removed and Congress has since increased the amount of its funding to recent annual appropriations of half a billion dollars. However, not all NSF requests for funds have been granted. Some ideas and programs have been held back by delayed and reduced appropriations. Part of this holdback reflects the responsibility of Congress to test and temper the enthusiasm of the executive branch for new ventures. Part of it reflects the failure of the Foundation and the Chief Executive to inform the Congress early enough, or to present new ideas with sufficient clarity and emphasis. The subcommittee realizes that a more aggressive stance by the

[2] Hearings, p. 97.

Foundation would make some of its ideas vulnerable to congressional criticism. But introducing new ideas is a principal responsibility of the Foundation. Some of these may not be accepted, but others will survive; certainly none will be accepted if none are proposed. Those proposals which are accepted may be susceptible to less criticism if they have been critically examined beforehand. The rigors of the political process being what they are, the Foundation might profitably show more aggressiveness in the future.

The subcommittee, in its appraisal, has uncovered what it believes to be some weaknesses and problems which, if left uncorrected, may seriously hamper the Foundation in realizing its primary objective to develop and encourage the pursuit of a national policy for promotion of basic research and education in the sciences. Even more important, such failings could stand in the way of extending the Foundation's responsibilities to the scientific resources of the Nation.

IDENTIFICATION OF WEAKNESSES AND DEFICIENCIES

The subcommittee sought commentary on tangible deficiencies of the Foundation with somewhat indifferent results. There were few suggestions for change from the Federal witnesses, and most of what was proposed was keyed to executive rather than legislative action. The subcommittee, however, does not view this absence of suggestion as evidence that all is well and that legislatively no changes are in order.

Dr. Hornig, as a leading witness for the executive branch, did not identify any, but said instead that there was no evidence known to him to indicate variations in quality among NSF programs. Whatever weaknesses might exist he attributed to the state of national planning for research and science education, and to insufficient personnel and lack of sufficient quality staff to carry out the Foundation's assigned functions.[3]

Dr. Shannon, Director of the National Institutes of Health, while declining to comment on specific deficiencies, did say that he thought value judgments of program *objectives* were possible and probably even appropriate, saying:[4]

> From the point of view of the NIH, we see one imperative function for NSF: that is, providing for the stability, vigor and balanced growth of academic science. NSF—alone among Federal agencies supporting science—has the broad statutory role in science and science education that makes feasible the successful carrying out of that function. Those programs that contribute to this end—and the great majority of NSF programs certainly do—are the ones that NIH would like to see strengthened and expanded from year to year with the overall objective of assuring continued world leadership for American science capabilities.

He did, however, express his concern about[5]—

> * * * the tendency of NSF to pick up responsibility for direction and management of certain large-scale projects such as Mohole, radio astronomy, and weather modification.

[3] Hearings, vol. II, question No. 24 to Dr. Hornig, p. 1116
[4] *Ibid.*, question No. 17 to Dr. Shannon.
[5] *Ibid.*

He warned that because of their complexity, these major science projects must be expected to exact a fairly high proportion of top management and scientific attention and perhaps might limit NSF's ability to expand its pivotal role in support of academic sciences. Thus from the viewpoint of the National Institutes of Health, he thought it more sensible to consider alternative management arrangements for these major projects, so that NSF could be free to direct maximum energy and resources to the strengthening of academic science.[6]

Dr. Glenn Seaborg, Chairman of the Atomic Energy Commission, likewise did not speak to the NSF's strengths and weaknesses. But he did observe that there are certain types of projects which the Foundation might not be adequately equipped to handle at present. Based on his experience, he believed that to manage very large projects, an agency must have experience and depth in construction procurement, practical engineering, legal and fiscal matters. He concluded that if it is expected of the National Science Foundation to have the capability for all programs that might come within its charter, it should be provided with additional in-house technical and administrative capability.[7]

Dr. Waterman, while noting the difficulty in attempting evaluation of NSF programs, did express definite opinions. He saw the objectives of the NSF programs as having been consistently sound and so regarded them. He noted with approval the change of NSF programs in the light of experience and experimentation. Speaking first of better NSF programs, he said: [8]

> * * * generally speaking, the most effective thoroughly established programs of the NSF and the ones receiving widest approbation from the scientific community have been: the regular programs of grants in support of basic research by the project system; the fellowship programs for graduate students, postgraduates and science faculty (including teachers); summer institutes for teacher improvement; and science course content studies.

He said other NSF programs that had been well received included the national research centers; certain national research programs, support of research facilities—especially for graduate research and university computing, ecology and atmospheric research; and the NSF's data collection and analysis for research and development.

According to Dr. Waterman, programs which have lagged concern NSF participation in basic science affairs and science education abroad, apart from the international programs. Progress in solution of science information problems has been slow and awaits the successful outcome of research. Progress also has been relatively slow in the NSF's weather modification program.

The scientific leaders who represented the Federal Government and the academic community were all cooperative. Nonetheless there may have been some constraints to the extent that a witness

[6] *Ibid.*, question No. 17 to Dr. Shannon, pp. 1257–1258.
[7] *Ibid.*, question No. 21 to Dr. Seaborg, pp. 1180–1181.
[8] *Ibid.*, question No. 20 to Dr. Waterman, pp. 1138–1140.

experienced a conflict between his responsibility to inform the Congress frankly of possible weaknesses in NSF programs and activities and his responsibility to the President or to his academic superiors not to be critical nor to call attention to potentially embarrassing issues.

Any such reticence by scientists who occupy key positions in science-oriented Federal agencies or who are directly or indirectly interested in Federal funds for their projects or institutions points up a real although not new problem: How can Congress obtain objective observations from the scientific community when the Federal Government finances so much of academic research? This close financial tie is indicated by NSF's analysis of funds available to colleges and universities for research and development. For fiscal year 1963, of $1,175 million for research and development at these institutions, $775 million, or 66 percent, came from Federal sources—and this did *not* include $525 million more to colleges and universities as payment for their operation of Federal research centers.[9]

It should be emphasized that throughout the hearings the subcommittee sought to get to the bottom of specific issues and to make sure it understood what was involved. When one considers the full range and magnitude of NSF activities, it is apparent that the subcommittee could not delve into all issues to the same depth. Thus some matters considered last spring will necessarily be the subject of further inquiry during the hearings which the subcommittee expects to hold in connection with future legislative proposals.

SPECIFIC PROBLEM AREAS

Before proceeding from a general appraisal to existing or potential problems, it should be clear that the subcommittee recognizes the fine contributions made by the Foundation over the past 15 years toward the strengthening of American basic research and science education. Even with the benefit of hindsight, it is not evident that the Foundation should have evolved other than it did. We do, however, live in a rapidly changing age of the scientific revolution, and there is no reason to expect the Foundation to escape the challenges that follow new discoveries in science and their application.

In identifying certain problems, the subcommittee seeks to call attention to matters that it thinks will merit the attention of Congress and the public as the Foundation continues to evolve, and in so doing to preserve the advantage of acting in anticipation and recognition of a need for change rather than reacting to that need under conditions which demand immediate action.

1. Organization

The first issue deserving special attention is the organization of the Foundation and its relations with other Government agencies. In this section, the subcommittee looks at the office of the Director of the Foundation and the National Science Board, from the viewpoint of strengthening them, to more forcefully assert themselves in formulating national policy for basic research and science education.

[9] Hearings, p. 21.

(a) Strengthening the Office of the Director

The expansion of the Foundation from 1950 to the present has greatly increased the demands on the Director's time for internal affairs. In addition to his managerial responsibilities for support to individuals in basic research and science education, he is responsible for the national research programs, for the Foundation's national laboratories, and its large and complex projects—such as Mohole. Next he is an ex-officio, voting member of the National Science Board and is also an ex-officio voting member and Chairman of its Executive Committee, which imposes a special obligation to prepare for and attend the meetings.

Turning to his functions external to the Foundation, the Director is the principal, indeed the only formal contact of the Foundation with the Congress. A quick sampling of congressional demands shows that the Director has appeared before eight committees of the House, seven committees of the Senate, the Joint Committee on Atomic Energy and the Joint Economic Committee, plus his regular appearences before the House and Senate Appropriations Committees.

As a member of the Executive Branch, the Director is a member of the Federal Council for Science and Technology, the Defense Science Board and the President's Committee on Manpower. He is expected to maintain close relations with the OST and to maintain relations with the scientific community through the National Academy of Sciences and other bodies.

This catalog of the Director's personal responsibilities convinces the subcommittee that, of necessity, some of these functions must receive more attention than others, and some are insufficiently attended. It is unrealistic to impose upon the Director responsibilities that he cannot personally fulfill and still perform effectively as the head of an important agency.

(1) *Strengthening senior staff.*—In considering how the Director might be better equipped to deal with these responsibilities, the subcommittee concluded that there are real advantages in staffing the second level of the Foundation's organization with a Deputy Director and Associate Directors, appointed by the President and by and with the advice and consent of the Senate. To do so would yield several real advantages:

It would provide senior staff enjoying the stature of a Presidential appointment to take up some of the Director's relations with the Congress and with other Federal departments and agencies. Relative rank always has been important in a bureaucracy and there is no reason to think this does not affect the Foundation's staff in dealing with other departments and agencies.

It could open the way to greater delegation of the Director's authority, thus relieving him of close personal supervision of major Foundation programs and projects while increasing senior management attention to these activities. It would provide an extra attraction for recruiting additional high quality senior personnel who will be more necessary than ever as the NSF moves into the late 1960's.

Presidential appointments with congressional participation for second and third echelon personnel in independent agencies are not

without recent precedent. By Public Law 87–297 of September 26, 1961, Congress in establishing the Arms Control and Disarmament Agency provided for a Deputy Director and as many as four Assistant Directors appointed by the President by and with the advice and consent of the Senate. A similar provision appears in Public Law 88–452 of August 20, 1964, which established the Office of Economic Opportunity. It specifies a Deputy Director and three Assistant Directors appointed in this fashion. The Deputy Director of the U.S. Information Agency [10] and the Deputy Administrator of the Federal Aviation Agency [11] also are appointed by the President by and with the advice and consent of the Senate.

(2) *The Director's salary.*—While the Director's personal standing among top Federal executives depends upon his reputation as a leading scientist and administrator, it is also partly fixed by his grade in relation to other Federal executives, and may influence his effectiveness in interagency relations. At present the Director is at Level III of the five levels established by the Federal Executive Salary Act of 1964. The annual compensation for this level is $28,500.[12] He shares this grade with under secretaries of the principal departments, the Administrator of General Services, the Administrator of the Small Business Administration, the Director of Defense Research and Engineering, Department of Defense, the Deputy Administrator of NASA, the Deputy Director of the Bureau of the Budget and members of the Atomic Energy Commission. At Level II, at $30,000 annually, are officials such as the Deputy Secretary of Defense, the Under Secretary of State, the Administrator of NASA, the Chairman of the Atomic Energy Commission, the Chairman of the Council of Economic Advisers, the Director of the Office of Science and Technology, the Director of the Arms Control and Disarmament Agency, and the Director of the United States Information Agency.

It is the opinion of the subcommittee that the activities of the National Science Foundation are sufficiently important to warrant raising the Director to Level II. This would also accommodate a Deputy Director and possible Associate Directors at appropriate levels.

(*b*) *The National Science Board*

The National Science Board occupies a unique position among the many boards, commissions, committees, and other advisory groups of the Federal Government. Its uniqueness lies in its combination of a variety of policymaking, operation, and advisory functions. These it shares in a still evolving way with the Director of the Foundation, so that neither the Board nor the Director has undivided authority and responsibility for the Foundation.

The change of the Board away from the original concept of a body of eminent scientists who collectively would make the grants, thereafter to be administered by the Director and his staff, toward a policymaking and overseeing function was the subject of many differing views among the witnesses.

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[10] Reorganization Plan No. 8 of 1953.
[11] 49 U.S.C. 1341–1342.
[12] Public Law 88–426, 5 U.S.C. 2210–2213.

Dean Price highlighted this change, through his observation that—[13]

> As the workload of the Foundation has increased, its structure has been adjusted to let it get its job done, and deal with its policy issues, and less attention has been paid to the original conception that 24 eminent scientists on the Board should themselves make the grants, and that the Director and his administrative staff should be kept in the background.

(1) *Composition.*—The National Science Board is the policymaking body of the National Science Foundation. It consists of 24 members who are appointed by the President by and with the advice and consent of the Senate. In addition, Reorganization Plan No. 2, made the Director "an additional member of the Board * * * coordinate with other members, with full voting privileges." The National Science Foundation Act provides that persons nominated for appointment to the Board—

> (1) shall be eminent in the fields of the basic sciences, medical science, engineering, agriculture, education, or public affairs; (2) shall be selected solely on the basis of established records of distinguished service; and (3) shall be so selected as to provide representation of the views of the scientific leaders in all areas of the Nation.

Recommendations for nominations of Board members may be submitted to the President by the National Academy of Sciences, the Association of Land Grant Colleges & Universities, the National Association of State Universities, the Association of American Colleges, or by other scientific or educational organizations.

The term of office of each Board member is for 6 years, unless appointed to fill the unexpired portion of the term of a predecessor. The anniversary of a Board member's term is May 10, the date of the approval of the National Science Foundation Act of 1950. At that time, terms of the first members were staggered, one-third each to end in 2 years, 4 years, and 6 years, respectively, so that at the present time the terms of one-third of the Board members end on May 10 of every even-numbered year. Members may be reappointed for a second term; however, after a person has served for 12 consecutive years, he is ineligible for reappointment during the next 2 years.

The Chairman of the Board is elected by the Board from among its members, and is not designated by the President.

(i) *Overlapping membership.*—The subcommittee asked the opinion of many witnesses whether members of the Board should at the same time belong to other science advisory bodies such as the Committee on Science and Public Policy of the NAS, or the President's Science Advisory Committee. The reason was the close linkage observed between recommendations of such groups and subsequent changes in NSF programs. Dr. Waterman, based on his long experience, saw no serious problem, if membership on other bodies was part time and

[13] Hearings, p. 243.

advisory only. In these circumstances, some overlapping of membership could be a real asset, providing broader background and minimizing duplication and possible differences caused by inadequate communication. He thought a limitation on membership in other bodies might restrict the availability of good future candidates.[14] Dr. Brooks[15] saw no evidence of confusion due to overlapping membership. Dr. Seitz [16] thought it natural that most of the members of the Science Board and the President's Science Advisory Committee should also be members of the National Academy of Sciences, and said he was not aware of any significant tendency to bias in recommendations of the National Academy of Sciences advisory committees: on the contrary, persons serving in several different capacities can give valuable advice.[17]

(ii) *Membership and size.*—Although the Board is somewhat large to work as a body, testimony generally indicated no great need to reduce it in size. There was some thought that its present members were too heavily weighted in favor of physical scientists from the big universities. Scientific and engineering interests of small colleges, industry and nonprofit research institutes may not be adequately represented, and the balance of representation among scientific disciplines may need adjustment if the Board is to be adequately representative of national science interests in forming national policy for science resources. On the other hand, with a greater number of potentially divergent interests represented on the Board, common agreement on new ideas might be more difficult to achieve. Testimony indicated Board proceedings have been harmonious with no major unresolved differences.

In the opinion of the subcommittee, the Board's present size is satisfactory. As for its future composition, the criteria of selection for nomination to membership on the Board should emphasize scientific stature and competence, field of science, institutional affiliation, and region of the country. The Board must continue to be a gathering of outstanding scientists. It should be representative of the leading fields of science, with members drawn from industry and other areas as well as the academic community.

(iii) *Compensation.*—A marked difference presently exists in per diem compensation between members of the Board and members of NSF advisory panels. The former are limited to $50 per day, while the latter normally are paid $75 per day and some have received $100. The subcommittee sees no reason for this disparity to continue and believes the statutory limit on the Board members should be increased to $100 per day.

(2) *Functions and operations.*—The National Science Foundation Act specifies that the Foundation shall consist of the National Science Board and the Director. It does not divide the NSF functions, set out in section 3(a), between these two. While describing the general functions of the Board, Director Leland J. Haworth said: [18]

> In addition to establishing general policies for the Foundation the Board must either approve, or delegate authority

[14] Hearings, vol. II, question 6 to Dr. Waterman.
[15] Dr. Harvey Brooks, member of the National Science Board.
[16] Dr. Frederick Seitz, President, National Academy of Science.
[17] Hearings, vol. II, question 1 to Dr. Seitz.
[18] "Government and Science." Hearings before the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, 88th Cong., 2d sess., May-June 1964, 888 pages at p. 63.

to the Director of Executive Committee to approve such actions except with respect to very large awards, or where policy issues are involved. Although the Board must also take action on such matters as setting up new divisions within the Foundation, it is not a day-to-day operating body.

The Executive Committee as established by Reorganization Plan No. 2 of 1962. is composed of five members, consisting of the Director who serves as Chairman, and four other Board members, elected by the Board from its membership. The Board may assign to the Executive Committee such of its powers and duties as it deems appropriate; except that the Board may not assign to the Executive Committee the establishing of policies. The Executive Committee reports annually to the Board concerning its activities and may make such recommendations as it feels are appropriate; minority views and recommendations are to be included.[19]

Despite the importance of the Board's functions, it has issued no public reports concerning its operations or policy. While the Foundation's annual reports through 1959 included a statement by the Chairman of the Board, there has been none since then.

The material and testimony received by the subcommittee did not illuminate the relationship of the statutory Executive Committee to the full National Science Board. It is not clear from the legislation and Reorganization Plan No. 2 what is the division of responsibility between the Board, its Executive Committee—of which the Director is Chairman—and the Director himself. One clarifying approach would be to authorize the National Science Board to delegate its functions, including its policymaking function, to the Executive Committee or to the Director as it sees fit. This would have the advantages of increasing flexibility in actions and speeding up the Board's business between its meetings, while still retaining to the Board the power to recall the delegations if necessary.

(i) *Contact with the scientific community.*—A real, although nonstatutory, function of the Board was pointed out by its present Chairman, Dr. Eric Walker. This is to provide close and strong coupling between the Foundation and the scientific community, although "* * * the Board has a great deal of difficulty making this coupling a useful one." [20]

On the other hand, both Dean Price and Dr. Brooks took the view that the Board itself could not really bridge all of the necessary paths to the scientific community, and that this function in reality is carried on by the many subordinate advisory panels which review applications for support of projects.[21] [22] Dean Price identified these panels as the great safeguard for independence of scientific institutions from political control.

(ii) *Greater responsibility for the National Science Board.*—Increased use of the National Science Board as a distinguished policymaking body in the area of research was proposed by Dr. Waterman.[23] Since the Board includes not only research experts, but academic presidents,

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[19] A detailed description of the internal organization of the Board was given by its Chairman, Dr. Eric Walker, during the appropriations hearings for fiscal year 1966. See "Independent Offices Appropriations for 1966." Hearings before a subcommittee of the House Committee on Appropriations, 89th Cong., 1st sess., pt. 2, at pp. 549–550.

[20] Hearings, p. 566.

[21] Hearings, p. 247.

[22] Hearings, vol. II, question 12 to Dr. Brooks, p. 1236.

[23] Hearings, p. 160.

leaders of industry and men of affairs, Dr. Waterman viewed it as a unique body capable of dealing with many policy matters in the councils of the Government.

Dr. Eric Walker, as Chairman of the Board, observed that the Board had not seized its opportunities to deal with policy and that its guidances had been few and far between.[24] Dr. Philip Handler, as Vice Chairman of the Board, thought the Board represented a wider cross-section of background and experience than does the President's Science Advisory Committee and was better able to recognize the "* * * impact on, and contributions to, Federal policies for science on the part of industrial organizations, small liberal arts colleges, the great universities, and the scientific community generally."[25] He was satisfied with the present policy role of the Board and thought the Board was wise in adjuring a larger national science policy role.

Dr. William V. Houston, a member of the Board, thought the Board's authority should extend only to the Foundation's own activities, and that any influence outside the NSF should be accomplished only through the President.[26] Dr. Robert S. Morison, also a Board member, supported Dr. Waterman's recommendation for a greater role, although he noted the Board had never been seriously consulted on scientific policy external to the Foundation. He suggested experimentation with the Board in shaping national science policy.[27]

It appears to the subcommittee that the National Science Board is a distinguished body representative of the scientific community and is capable of greater and more important contributions than thus far have been required of it. Because the formulation of national policies for science can have such far-reaching effects on the future of the country, the Board should be a valuable source of considered opinion and recommendations to the President and to the Congress.

(c) *Division of authority*

At the heart of the division of functions and responsibility between the Director and the Board is the question of who is really running the Foundation. Does the National Science Board occupy the same relative position to the Director as do members of the large private foundations to their directors, or is the Director of the Foundation the focal point of authority and responsibility with the Board acting as overseer or policymaker or adviser? Or is the relationship somewhere in between?

At present the relationship is one of dual responsibility. The Director looks to the Board for policy and program guidance and approval, but nonetheless, it is he, rather than the Chairman of the Board, who answers to the President. It is the Director, not the Board Chairman, who represents the Foundation on the Federal Council for Science and Technology and in continuing dealings with the Office of Science and Technology. The Director and the Chairman and/or other Board members usually appear before the Appropriations Committees, but it is the Director who answers most of the questions.

Just how the responsibility for the Foundation should be divided in the future between the Science Board and the Director is an important

[24] Hearings, vol. II, question 1 to Dr. Walker, p. 1328.
[25] Hearings, vol. II, question 1 in Dr. Handler's letter, pp. 1417-1418.
[26] *Ibid.*, question 1 in Dr. Houston's letter, p. 1416.
[27] *Ibid.*, question 1 in Dr. Morison's letter, p. 1412.

open question that depends in part upon the changing workload of the Board, the success of its delegations of authority to the Director, and the effectiveness of the Board's recent internal reorganization. The testimony before the subcommittee did not show common agreement.

Dr. Hesburgh,[28] as a member of the Board, traced in detail the evolution of relations between the Board and the Director. He thought Congress had acted wisely when it amended the act to change the Director from an ex-officio, nonvoting member to a full voting member of the Board and statutory chairman of its Executive Committee.[29]

Dr. Haworth recognized the trend toward concentrating NSF executive functions in the Director, but expressed no distinct preference for or against legislation to transfer these functions to him.

As Chairman of the Board, Dr. Walker testified that most of the responsibilities for planning, setting policies, and even operations reside with the Board unless it delegates them to the Director. The Board, as the Foundation has grown, has found it necessary to give the Director authority to fund projects up to certain dollar limits, to continue and expand established programs and to perform other acts in the name of the Board. But the responsibility for the consequences of these decisions rests with the Board, which may delegate authority but not responsibility. Moreover, Dr. Walker said, the Board cannot delegate its responsibility for establishing general plans for the Foundation, deciding in which direction the Foundation should go, and making the larger decisions in which the Director needs the specific support of the Board.[30]

Dr. Walker stated his conviction that when an organization grows beyond a certain size, as has the Foundation, there must be a clear-cut separation between policymaking and operations. In his opinion, the Board should turn its attention solely to policymaking, with whoever "* * * is running the show * * * clearly responsible for operations."[31] He suggested a full-time chairman and a small independent staff.

Vice Chairman of the Board, Dr. Philip Handler, noted that the Board is increasingly restricted to formulation of policy and advice for the larger, overall matters before the Foundation. A statutory change in the relation of the Board to the Director, in his opinion, might disturb the academic and scientific communities; but so long as the Board is appointed by the President, by and with advice of the Senate, he thought the impact should be relatively slight.[32]

As a member of the Board, Dr. Morison described the sharing of authority between the Board and Director as unusual and unlikely to survive very long. He would give the Director sole responsibility for management and operation, with the Board furnishing dvice on questions of policy and significant operations.[33]

Dr. Haworth supplied an interesting insight into the nature of the present Board when he replied, as follows, to a request to compare the Board with the five Commissioners who head and direct the Atomic Energy Commission:[34]

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[28] Rev. Theodore M. Hesburgh, C.S.C., president of the University of Notre Dame and a member of the National Science Board.
[29] Hearings, p. 481.
[30] Hearings, p. 567.
[31] Hearings, p. 569.
[32] Hearings, vol. II, app. 3, Dr. Handler's letter, question 7.
[33] Hearings, vol. II, app. 3, Dr. Morison's letter, question 7.
[34] Hearings, vol. II, NSF question B–11.

> Because of its part-time nature the Science Board cannot be as conversant with or play as intimate a role in the operations of the agency as does the full-time Atomic Energy Commission. By the same token the Board, with its strong roots in the scientific and academic communities, forms a considerably more independent body than does the Commission, which is a wholly integral part of the executive branch. This independence is enhanced by the fact that, in contrast to the Chairman of the Commission who is designated by the President and serves as such at the pleasure of the President, the Chairman of the Science Board is elected by the Board from among its members.

Dr. Wiesner, looking back to his service as the Director of OST and the Science Adviser to the President at the time of Reorganization Plan No. 2 of 1962, spoke of a certain amount of ambiguity between the Board and the Director and the inability of the Board to fully carry out all of its responsibilities on a part-time basis. He noted the Board has delegated most of the detailed responsibility to the Director and his staff. According to Dr. Wiesner, it was recommended during the development of Reorganization Plan No. 2 that the Board be made policy adviser, and that all of the operating responsibilities be given by law directly to the Director, rather than delegated by the Board. He continued:[35]

> Several Board members objected with sufficient violence and with a sufficient number of arguments that I concluded that they might be right, and I didn't pursue it. I still think this is a point that is worth considering and examining.

As a final note on the division of responsibility between the Board and the Director, both Dr. Haworth[36] and Dr. Waterman[37] pointed to the possibility of conflict between the two. The fact that relations during the past 15 years have been good is no bar to the Board's taking a position contrary to proposals by the Director pursuant to policies of the President and preventing the Director from functioning because of the reservation to the Board of responsibility for determining policy and for approving grants and contracts. This is a possibility that deserves further attention.

(1) *Delegation of authority.*—The subcommittee notes with approval the authority given to the Director under section 2 of Reorganization Plan No. 5 of 1965 to—

> * * * make such provisions as he shall deem appropriate authorizing the performance by any other officer, or by any agency or employee, of the National Science Foundation of any of his functions (including functions delegated to him by the National Science Board).

The subcommittee believes this authority should be of considerable help to the Director.

(2) *Possible alternatives.*—The subcommittee received considerable testimony and other material concerning the relationship of the

[35] Hearings, p. 663.
[36] Hearings, vol. II, NSF question B–1.
[37] Hearings, vol. II, question 7 to Dr. Waterman, pp. 1131–1132.

Board to the Director, and what should be the respective functions and responsibilities of each.

The alternatives ranged from the Board acting in the capacity of a multiple executive, fully in charge of all NSF policymaking and operations, through intermediate arrangements giving the Board various oversight and policymaking functions, to the Board as an adviser only. It appears that the Board in its relation with the Director is evolving toward policymaking, oversight, and advice, with operational responsibilities concentrated in the Director, who, in turn, has been enabled to delegate many of his functions to his senior staff.

(d) Staff for the National Science Board

The hearings and testimony brought out conflicting ideas about the need of the Board for its own staff. As Dr. Walker put it, this staff could "* * * dig out the necessary facts and to help the committees formulate policy." [38] Dr. Haworth opposed a separate staff for the Board on the grounds of setting up competing groups of staff.[39] His remark that additional staff support might be given, however, suggests that the Board's needs are not entirely met by the present occasional detailing of NSF personnel. Dr. Hornig did not favor a separate staff. Dr. Houston noted that the Board has no professional staff and that temporary assignment of NSF staff to the Board was difficult because of possible conflicts of interests.[40] On the other hand, Dr. Hesburgh [41] and Dr. Morison seemed satisfied with the present arrangement. Dean Price opposed a separate staff, saying: [42]

> I would hate to see within the Science Foundation any organizational step which would suggest that the entire Foundation staff is not really the Board's staff. I think to set up something like a system of checks and balances between the Board on the one side, and the Director who is a member of the Board on the other, would be wrong. If the staff is not serving the Board's purpose, I think the Director ought to be asked by the Board to get a different staff.

Several Federal organizations provide illustrations of boards and commissions that have their own permanent staff.

The National Aeronautics and Space Council is legislatively authorized to employ a staff headed by a civilian executive secretary who is appointed by the President by and with the advice and consent of the Senate. This executive secretary, subject to the direction of the Council, is authorized to appoint and fix the compensation of such personnel within a limit of seven persons.[43] Considering the size of the national space program and its staff, the space council surely would have had no problem in borrowing personnel from the National Aeronautics and Space Administration and other agencies.

The Water Resources Council is another example. Under section 105(a) of the Water Resources Planning Act, Public Law 89–80, July 22, 1965, the Council is authorized to employ and fix the compensation of such personnel as it may deem advisable.

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[38] Hearings, vol. II, question 7 to Dr. Walker, p. 1333.
[39] Hearings, p. 772.
[40] Hearings, vol. II, app. 3, question 9—Dr. Houston's letter, p. 1417.
[41] Cf., their letters, hearings, vol. II, app. 3.
[42] Hearings, p. 250.
[43] 42 U.S.C. 2471.

These two examples are significant, for each is a continuing body, as distinguished from temporary study commissions which, of course, employ staff. In each case, it would have been possible for the Councils to borrow staff from interested agencies, much in the way that the NSB now obtains staff support from the Director of the Foundation.

On the other hand, the part-time General Advisory Committee which advises the Atomic Energy Commission on technical matters, and which has had great influence upon AEC activities, has no staff of its own but draws secretariat service from the AEC's own staff. While the Atomic Energy Commission itself is not analogous to the National Science Board—because the former is clearly a multiple, full-time executive, while the latter is more of a policy formulator and overseer than an executive—it is worth noting that the 5 Commissioners are served by 10 full-time special and technical assistants plus a full-time secretariat staff and secretaries.

It appears to the subcommittee that a small full-time staff which could identify itself with the Board and its Chairman could enhance the Board's effectiveness and make it possible for the Board to obtain a range of alternatives in addition to NSF staff recommendations. The subcommittee recommends that the Director furnish this staff with the Board's approval.

(*e*) *The divisional committees*

Reorganization Plan No. 5, which became effective July 27, 1965, abolished the committees required under section 8 of the National Science Foundation Act of 1950 which advise each of the NSF divisions. Section 8 had provided that each divisional committee would be appointed by the Board and would consist of not less than five persons, each for a term of 2 years. Section 8 also had provided that—

> Each divisional committee shall make recommendations to, and advise and consult with, the Board and the Director with respect to matters relating to the program of its division.

This dual advisory function was curtailed by Reorganization Plan No. 2 of 1962 which cut off the committees from the Board by the provision that they should report to the Director alone.

Dr. Haworth, in testifying before the Subcommittee on Executive and Legislative Reorganization of the House Committee on Government Operations, expressed his intention to reconstitute these advisory committees, but fewer in number, which he could do under the greater flexibility of Plan No. 5.

Most of the Board members commenting on this change clearly expected some form of advisory committees to continue.

Dr. Walker's testimony contains a detailed history of the divisional committees. He evaluated them as an invaluable arm of the National Science Board, but noted that the Board had no opportunity to vote on Reorganization Plan No. 5, which abolished them, because the committees did not report to it.[44] Dr. Handler, as Vice Chairman of the Board, pointed to differing opinions about the worth of the

[44] Hearings, vol. II, app. 3, letter of Dr. Walker, question 2, p. 1329.

divisional committees. He thought they might not have been adequately exploited by the NSF as a strong coupling agent between the scientific community and the Foundation. In his opinion, the future of these committees will be a significant issue.[45]

On the whole, the testimony appeared to indicate a useful function for the divisional committees, one sufficiently important to support Dr. Haworth's expressed intention to form new advisory committees. The subcommittee assumes that the Director will give effect to his remarks concerning Reorganization Plan No. 5.

2. Leadership in science policy

In section 3(a)(1) of the National Science Foundation Act of 1950, Congress made it a responsibility of the Foundation "* * * to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." As seen in chapter II, this responsibility was changed by Reorganization Plan No. 2 of 1962 which transferred a vaguely defined part of this responsibility to the Director of the newly established Office of Science and Technology. Specifically, the plan transferred to OST—

> So much of the functions conferred upon the Foundation by the provisions of section 3(a)(1) of the National Science Foundation Act of 1950 * * * as will enable the Director to advise and assist the President in achieving coordinated Federal policies for the promotion of basic research and education in the sciences.

Although Dr. Hornig and Dr. Haworth were careful in their testimony to say how this responsibility for a national policy for basic research and science education was divided between their offices, the division of this responsibility in practice still seems unclear. There appears to be no consistent pattern of leadership for formulation of Federal science policy. Leadership can come from any direction within the Federal organization for science and technology and does not seem to be strongly identified with the Foundation. The NSF appears more to react to evolving changes in the interests of the scientific community than to take the initiative to influence and shape such changes to national needs. As the one agency within the Federal establishment concerned with the health of national resources for science and technology, and the means of fostering science and scientific capabilities, it would appear that the Foundation's voice in these areas should be carefully considered. The Foundation has the potential capability to influence the ways in which other Federal departments and agencies employ science and technology in furtherance of their mission objectives while at the same time strengthening the scientific and technological resources of the Nation.

With this in mind, it is useful to briefly examine the Federal superstructure for science and technology.

(a) The Federal superstructure for science and technology

The appearance of a superstructure for Federal science and technology as an aid to Presidential decisionmaking has been fairly recent. From the end of World War II to just before the Soviet Union launched

[45] *Ibid.*, letter of Dr. Handler, question 2, p. 1418.

Sputnik in 1957, the only formally constituted bodies to advise the President on science were the National Academy of Sciences and a relatively obscure Science Advisory Committee in the old Office of Defense Mobilization. Eight years later one finds that the President has acquired four new sources of advice and assistance for science and technology, in addition to the National Academy of Sciences. The testimony received by the subcommittee contains much information and insight into the organization, functions and interrelations of these sources. For the purposes of this discussion, the following features should be noted:

(1) *The President's Special Assistant for Science and Technology.*—Shortly after Sputnik, President Eisenhower created the top-level post of Presidential Science Adviser and assigned to it the task of taking stock of the Nation's scientific and technical resources, and the devising of ways to bolster and mobilize these resources to meet this new Soviet competition. The science adviser serves in a confidential capacity to the President and because of executive privilege, cannot be summoned to appear before the Congress.

(2) *The President's Science Advisory Committee.*—While the old Science Advisory Committee of the Office of Defense Mobilization did not report directly to the President, it did have the function of advising him, through the Director of the ODM, about scientific research and development for national defense. In December 1957, President Eisenhower transferred this Science Advisory Committee from the ODM to his office, making it directly advisory to the President and enlarging its membership—which increased its stature, power and appeal to the scientific community. The President's Science Advisory Committee is composed of his Special Assistant for Science and Technology and others of the Nation's most distinguished scientists and engineers, drawn from industry, the universities and other parts of the scientific and technological community. Its Chairman is elected by the Committee and, by custom, is the President's Special Assistant for Science and Technology.[46] The President appoints its members for terms of 4 years. PSAC meets about 2 days a month and is concerned with major issues bearing upon the country's scien tific and technological condition. It undertakes studies both on its own initiative and in response to requests from the President.

The PSAC is aided in its work by many panels of experts drawn from the scientific and engineering communities. Individual PSAC members contribute substantially of their time as panel members. Although these bring together many leaders of science and technology to advise the Government, the panels are temporary and have no responsibility for following through on implementation of their recommendations.

(3) *The Federal Council for Science and Technology* was created by Executive Order 10807 of March 13, 1959. Its function is to promote closer cooperation among Federal agencies and coordination for the total Federal effort in science and technology. Composed of top policy-level representatives from each of the Federal agencies involved in science and technology, it provides a two-way link between these policy level officials and the President and his office. It also has served to tighten White House control over scientific programs and policies of the Federal agencies, establishing a new path for Presidential

[46] For current membership of PSAC see Hearings, p. 103.

influence in parallel to the path already established through the Bureau of the Budget. The subcommittee notes that some confusion persists concerning the combining of the chairmanship of the Federal Council, the directorship of the OST and personal scientific advice to the President in one individual. It is not clear to what extent Dr. Hornig serving in these multiple capacities is free to answer congressional questions. The subcommittee notes that he chairs the Federal Council not as the Director of OST—who is accessible to the Congress—but as science adviser to the President, who serves in a privileged position.

Selected scientific and technological activities common to a number of agencies are coordinated through a series of interagency committees, including those on Oceanography, Atmospheric Sciences, Materials Research and Development, High Energy Physics, Water Resources Research, Behavioral Science, Patent Policy, Long Range Planning, International Programs, Science Information, Scientific and Technical Personnel, and a standing committee concerned with the operations of Federal laboratories. The Council Secretariat is provided by the Office of Science and Technology.

(4) *The Office of Science and Technology* completed the present framework of the Federal superstructure for science. It was established, with congressional accedence, by President Kennedy's Reorganization Plan No. 2 of 1962. The Director of OST is generally responsible for assisting the President in coordinating Federal science and technology functions. In essence, the OST did not represent so much a new scientific function for the Executive Office of the President as it did a formalizing of already existing functions.

The establishing of the OST may also be viewed as a response of the administration to congressional unrest over the lack of coordination and central control of the Government's expanding research and development. It provided Congress with a single spokesman to answer questions about the administration's plans and policies for Federal science and technology, a function that the previous Science Adviser could not fully perform because of his confidential relationship to the President. This separation of the role of the President's Special Assistant for Science and Technology from the planning and coordinating and evaluating functions of the Director of the OST appears to adequately preserve executive privilege while assuring Congress an open avenue of communication to the superstructure. However, as noted above, some possible conflict may still remain as long as the Director of OST simultaneously holds the posts of Special Assistant to the President, Chairman of PSAC, and Chairman of the Federal Council. It is not entirely clear to the subcommittee what standards can be used to draw the line between information and opinion which is properly privileged, and that which should be freely available to the Congress for public debate. This uncertainty might be reduced by separating the confidential functions of the adviser from the executive functions of the Director of the OST. By assigning these posts to different men, the adviser and PSAC could concentrate upon advice to the President, especially on subjects that have to be kept secret for the national security, while the OST and the FCST could concentrate upon public policy for science and technology.

(b) Relation of the National Science Foundation to the superstructure

To illustrate some of the relations of the Foundation to the Federal superstructure for science, Dr. Haworth presented the chart shown in figure 3. Note the arrow leading up from the NSF which indicates that the NSF by statute has a special role over and above other agencies with respect to collecting information and suggesting policy. According to Dr. Haworth: "This simply means that NSF feeds back to the executive offices, the FCST, et cetera, the results of its studies and the suggestions that it has." [47]

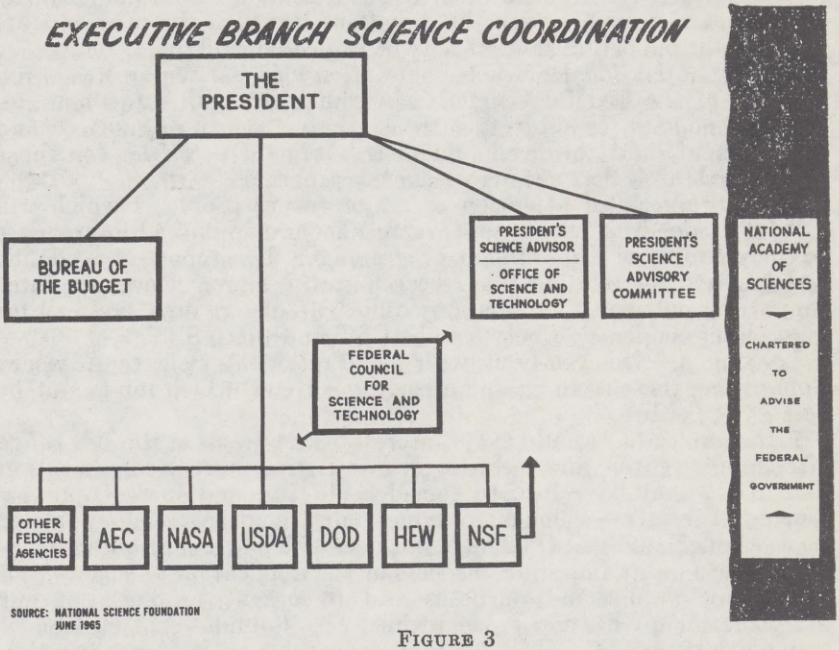

FIGURE 3

The most important relations of the Foundation to the superstructure appear to be those with the Office of Science and Technology. Dr. Hornig described these at some length and identified three special relationships: [48]

Collection of basic data: The Foundation has a central responsibility to provide basic data on science resources, on expenditures for research and development, and on scientific manpower. The data acquisition and analysis capabilities of the Foundation are utilized by the OST as a basis for the development of national science policies.

Special assignments: The Foundation can serve either as an executive agent or a delegated agent of the OST in taking the lead in certain assignments of broad importance. For example, the OST requested the Foundation to develop an interagency assessment of and reaction

[47] Hearings, p. 15.
[48] Hearings, p. 112.

to the recent report of the National Academy of Sciences on needs in ground based astronomy.[49]

Advice on science policy: According to Dr. Hornig, the Foundation is a "particularly valuable source of advice" [50] to the OST on science policies that merit consideration for Government-wide application.

Dr. Hornig also identified another relationship between the Foundation and the OST, similar to that of the Executive Office with other departments and agencies. The OST reviews and examines the programs of the Foundation in the same way it looks at those of other agencies. Because of the limited OST staff, this examination is highly selective and concentrates on items of major importance. It is concerned mainly with the directions in which the programs are tending, the opportunities that may be neglected, and major budgetary issues. The National Science Foundation also participates as a full member of the Federal Council in working out with other agencies common policies for subjects such as administration of research and development, and the level and distribution of activities for those fields of research that cut across agency programs.

Dr. Hornig called attention to major future problems which will call for stepped up efforts to develop new and improved approaches to the planning of Government programs for the support of academic research and for relating this research to the large science programs supporting particular national objectives. This, in turn, will call for even closer cooperation between the OST and the NSF.[51]

Looking at NSF relations with the President's Science Advisory Committee, these seem characterized by a trend, which might not be healthy for either.

Although PSAC's and OST's interests extend across the full range of Federal scientific and technological activities, since Reorganization Plan No. 2 they have focused considerable time and energy upon resources for science—which is a province and strength of the Foundation. As a result, PSAC and OST have not been able, on a continuing basis, to look into many important aspects of the application of science and technology to national purposes and to urgent problems of our technological civilization. Meanwhile, the Foundation's capability to pursue a national policy for basic research and science education appears noticeably inhibited.

For example, during the past summer, PSAC began a study of the criteria for distribution of Federal funds for research at universities to see how these funds might reinforce scientific excellence of existing institutions, increase the number of first rate institutions, and broaden the base of scientific research and education. The NSF is closely related to this study for it is providing the necessary staff support. Yet the only participation of the National Science Board, which is part of the Foundation, seems to have been the personal membership on the PSAC panel of four Board members. It would seem that a subject relating so directly to the state of our basic research might well receive the attention of the entire Board as a formally constituted, continuing part of the Government.

The PSAC reports dealing with scientific information and manpower are also examples of subjects relevant to national science resources that could have been examined by the Board.

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[49] It should be noted that the Foundation is usually responsive to recommendations from the National Academy of Sciences without formal endorsement of them by the OST or the Federal Council.

[50] Hearings, p. 112.

[51] Hearings, p. 116.

(c) *Problem areas*

The elaborate and intricate structure of executive branch organization for science policy formulation provides some reason for uneasiness. Coordination of Federal policy for science is splintered among a number of organizations. The present arrangements cannot help being somewhat inefficient and uncertain.

Since NSF does not fully exercise its science policy function, it has created a partial vacuum in Government affairs which is being filled by the OST and PSAC. PSAC and OST themselves are weakened and limited by concentrating so much of their time and energy in the fields of the National Science Board's interests and competence. The problem is to reassert and energize the function of the Foundation in creating and shaping a national policy for basic research and science education for the whole Government.

Despite the present and future importance of their advice and activities, neither the Federal Council for Science and Technology nor the President's Science Advisory Committee has shown a disposition to work with the Congress lacking a specific invitation. This points to the fact that important decisions of national policy may be made by groups which do not regularly appear before the Congress.

3. Research programs

The testimony at the hearings and other information available to the subcommittee present a convincing picture of the success of the Foundation's research programs in supporting high quality basic research by scientists of merit. NSF project grants appear as highly regarded as grants and contracts from other Federal departments and agencies. The success of this program is good reason for it to continue vigorously in the future.

The hearings did, however, identify some limitations of the NSF's basic research program. Briefly summarized, it appears that the NSF's basic research program does not—

Support all meritorious proposals from scientists of established excellence.

Provide different classes of competition so that young, fledgling scientists do not compete against men of well established reputation and standing for project grants.

Support basic research in engineering and social sciences at levels comparable to those of other fields of science funded by NSF.

Offer adequate opportunity to faculty of smaller, liberal arts colleges to receive NSF project grants.

Compensate for geographic concentrations in scientific research caused by research and development expenditures of mission agencies.

It appears also that NSF programs for basic research are:

Ambiguous concerning applied research.

Uncertain as to support of interdisciplinary undertakings.

These issues form the basis for some of the observations about the emerging role of the Foundation in chapter IV and recommendations in chapter VI.

(a) *Support of meritorious proposals*

The Foundation made a case that it has been able to support only slightly more than half of the research proposals which it receives, although it reports that 80 to 90 percent of these proposals are good enough for support were funds available. Moreover, according to the Foundation, few proposals are funded at the amount requested. The average grant was said to be about two-thirds of this amount. Also, while the average proposal requests support for 2.5 years, the average grant supports research for only 1.6 years. The cuts made by NSF in proposal budgets are largely in equipment and manpower.[52]

According to the Foundation, its budget for research project grants would have to be increased by 20 percent just to support proposals now being accepted at the level suited to the research rather than to limitations of NSF funds—and this increase would not fund a single *additional* proposal. If it were desired to support worthwhile proposals not now funded by NSF, an additional increase of about 50 percent would be required. These increases would care for all meritorious proposals at the rate they are now being received, but would not cover additional proposals that could be expected once the scientific community learned more funds were available. In terms of the fiscal year 1966 budget, the support of all meritorious proposals at the level proposed would require an increase in the project grants budget from the $155 million estimated to a new figure of about $280 million.[53]

On the other hand, it was not shown that scientists of high quality are unable to find research support among the various Federal departments and agencies. Even in terms of the NSF, a well qualified scientist has almost a 50–50 chance to get a grant. While the concept was advanced that all qualified scientists deserve financial assistance, no case was made that all academic scientists should receive Federal funds as they request them. The competition among proposals which is characteristic of the present system has a positive value that should be preserved even if there were no limitations upon funds.

(It is worth noting, also, that support of basic research over recent years has grown quite rapidly and appears to be ahead of the growth rate for the student body.)

One characteristic of project grants that was not explored during the hearings, but that, in retrospect, deserves future attention, is their duration. If the funds for basic research grants were to hold approximately level, then new projects could receive support only as earlier ones come to their end. But if through extension and supplementation of funds, the grants stretch out longer than first anticipated, then the amount of uncommitted funds is reduced and the award of new grants must slow down unless the budget for basic research grants continues to rise. Also, if the requested term for grants has to be reduced to fit NSF funds, as Dr. Haworth indicated was the case, the paperwork to sustain a project is increased with no offsetting increase in research productivity and the stability of research planning by the recipient institution is lessened. The process needs to be charted and analyzed to see the flow of funds each year to new grants and to extension of earlier grants. At issue is the basic concept: should the

[52] See Hearings, vol. II, NSF question H-1 for details.
[53] Hearings, vol. II, NSF question H-1.

Foundation furnish a scientist with funds for a limited time to enable him to show what he can do before undertaking a major research effort, or should the Foundation automatically fund the research of a good scientist for an extended period.

(*b*) *Different leagues for competition*

At present scientists proposing projects to the NSF all compete in the same, unlimited class. The new Ph. D. in a small liberal arts college struggling to maintain its place in science education must compete with the prestigious scientists of the famous great citadels of academic research. The world of sports furnishes a homely analogy. Minor leagues and big leagues are both necessary for the continuing development of athletic excellence. The promising young man in baseball rarely breaks directly into a major league team. Instead he is given his chance to compete in the minor leagues and there to build his skills to the point where he can enter the tougher competition. Yet in science, the young Ph. D. with promising capabilities is thrown at once into competition with the big names in his field who are well known in scientific circles and often are frequent commuters to Washington.

This idea was supported during the seminar discussion by the heads of small colleges. Dr. Atwood, of Emory University, spoke of the young professors who have finished their doctorates and are beginning to teach but are not yet ready, as a practical matter, to compete with well established scientists for Government research funds. He suggested "starter grants" to enable a newcomer to establish his own independent capability and to bring himself to the point where he can join in the larger competition.[54]

The credit given by NSF to established competence and demonstrated excellence in deciding who will get project grants certainly has fostered high quality research. But in the absence of different classes of competition, it may cause the young scientists to spend the peak of their early productive years working on projects conceived and directed by others rather than demonstrating and developing their own capacity for independent work.

(*c*) *Engineering and social science*

While the pursuit of knowledge and understanding through basic research is admired and held high in public esteem, the pragmatic reason for Government support of basic research is the anticipation that sooner or later the new discoveries and newly opened fields of science will produce results beneficial to our society. Application of new scientific knowledge is largely the work of the engineers. Anticipating and dealing with the social results of new applications of science and technology is part of the sphere of the social scientists. These two—engineering and social science—need opportunities for basic research just as do other fields of science. Yet, despite their importance for accelerating the application of science and technology, NSF funds for engineering and social science are growing no faster than other parts of the budget for basic research grants. Looking at actual obligations for fiscal year 1964 and at estimates for fiscal years 1965 and 1966, of the $112.4 million obligated for fiscal year 1964 for basic research project grants, engineering accounted for 11 percent and social

[54] Hearings, p. 761.

sciences for 8 percent; for fiscal year 1965 the estimate of $120.7 million had 11.6 percent for engineering and 8.3 percent for social sciences; for fiscal year 1966, the $191 million project grants budget had 11.8 percent for engineering and 7.9 percent for social sciences.

(1) *Engineering research.*—The fact that NSF support to engineering research has remained proportionately constant over the past few years does not indicate NSF disinterest. The status of engineering sciences was strengthened during fiscal year 1962 by the establishment of an Engineering Section which NSF turned into a full-fledged NSF division during fiscal year 1964. Nonetheless in the considered opinion of several witnesses, the level of the NSF's budget for engineering research and its relative size in comparison with other NSF research programs remains unsatisfactory.

Dr. Walker, speaking as president of the Engineer's Joint Council, said that many engineers have felt for some time that engineering has not received proper recognition from the NSF. He recalled that during the formative days of the Foundation, the engineers had tried to have it designated the National Research and Engineering Foundation, but that they had agreed to the word "science" after the assurance that by definition it would include engineering. Since then, according to Dr. Walker, engineering, although accepted as a member of the NSF family, has been in some respects treated as kind of a stepchild to the basic sciences.[55] He saw many practical needs in society today which could be filled by engineering systems and devices, but observed that for some reason we seem to be unwilling to spend anything like the amount spent for theoretical physics in designing systems and building engineering models for test purposes.[56] He concluded with a call for NSF support of projects which need research to bring certain fields of engineering to the point where cities, municipalities, States and even the Federal Government can use them.

Dr. Augustus B. Kinsel, appearing for the recently created National Academy of Engineering, was pointed in his criticism of the inadequate NSF support for engineering research. Noting that in 1962 the total Government dollar support for the engineering sciences was 7.4 percent of total Federal expenditures for basic research, and 6.6 percent for 1965, he considered this decidedly less than good judgment would indicate to support the Government's objective to increase the economy and the standard of living. In spite of NSF decisions to increase the support of engineering, Dr. Kinzel said that inertia and pressure within that organization have resulted in failure to effect the desired change. This should be rectified, in his opinion, by budgetary legislation.

Dr. Wiesner supported the complaint that engineering research has not been adequately supported by the Foundation, although he attributed the fault not so much to the Foundation as to the engineering community in failing to recognize what should be done and to propose programs. He emphasized the contribution engineering research could make to important national problems that are not likely to be handled adequately by commercial interests or other governmental activities. More basic engineering research is needed, in his opinion, for medical engineering, oceanography, atmospheric measurement, to name only a few possibilities. He also thought the engineering research in universities was distorting the engineering

[55] Hearings, p. 572.
[56] *Ibid.*, p. 402.

community by creating specialized interests for the graduate students. Because of large Federal defense needs, engineering curricula and university research competence have become strong in specialized fields such as advanced electronics, aerodynamics, radar, and communications. While engineers now graduating are well prepared in these subjects, Dr. Wiesner went on, we have not been turning out young engineers who are interested in and excited about some of the very important engineering problems of commerce and industry. People tend to want to continue in the research or development they began in their graduate education. It is the Foundation's responsibility then, to support the universities in engineering research related to national, nondefense problems.[57]

(2) *Social sciences.*—Authority for current NSF support of social science is drawn from the "and other sciences" phrase of the act.[58] The Foundation supports research which adds to the scientific understanding of social process and behavioral phenomena, but does not support studies designed to endorse particular social policies or to promulgate solutions of specific social problems. The primary fields open to NSF grants are cultural and physical anthropology, archeology, demography, economics, geography, linguistics, political science, psychology, sociology, and the history and philosophy of science.[59]

Dr. Pendleton Herring, as President of the Social Science Research Council, provided insight into the potentialities of social sciences, identifying it as a particularly American science. As for NSF support, he observed that grants have increased from an annual level of $2 million for fiscal year 1961 to over $10 million for fiscal year 1965. But although the rate of growth has been fast, the total support still remains modest. The NSF social science program was created in 1956, but languished until after Sputnik. It was not until 1958 that an Office of Social Science was established within the NSF. The subsequent elevation of this office to division rank showed a growing realization within the Foundation that social sciences were important, that they had a place coequal with other major NSF programs.

In response to a question whether an anticipated 350 grants for social science, out of an NSF total of 4,300 grants for fiscal year 1966, was adequate, Dr. Herring replied it was not possible to judge the appropriateness of support to a discipline from the number and percent of project grants it receives.[60] Another important factor to be considered was the fact that NSF assistance to the social science research community comes about almost entirely by means of research project grants, for there is no social science element in any of the NSF national programs.[61]

As for the junior partnership relation that Dr. Herring mentioned in his appearance, he expanded this into a forecast that as the dichotomy between natural and social science diminished and as new interdisciplinary relationships develops, there will be also a change "in spirit." The Foundation still has a big job to do, in Dr. Herring's estimation, about educating university people to understand that the NSF does indeed mean *all* sciences.[62] On the other hand, the

[57] Hearings, p. 659.
[58] For details, see the Review Report, p. 66.
[59] National Science Foundation, Fourteenth Annual Report, 1964, pp. 35-36.
[60] Hearings, vol. II, question 4 to Dr. Herring, p. 1298.
[61] *Ibid.*
[62] Hearings, vol. II, question 3 to Dr. Herring, p. 1298.

social scientists also must show more initiative in proposing projects and programs.

Dr. Haworth informed the subcommittee that NSF programs for social science research are now ready for further expansion. He said the Foundation should not be confined to the natural or physical sciences, that experience had shown social sciences have many areas of overlapping interest with the natural sciences and profit by association with them. NSF support should be focused, according to Dr. Haworth, upon that element of investigation in these fields which can be designated as *scientific*, meaning that the major area which has been excluded is policy oriented research.[63] He identified NSF encouragement to application of the scientific method in social science as a factor in accelerating the proportion of social science research which is objective, independently verifiable, and subject to useful generalization.

Concerning the level of NSF support, Dr. Haworth noted the Foundation had started late with social science and that it was trying to expand its efforts at a rate which in fact, was greater than for other fields. While the average support for all basic research project grants has increased since 1960 by a factor of about 2.5, that for social sciences has gone up by about 6.6.[64]

As for the future level of Foundation support, Dr. Haworth saw this depending upon: [65]

> Total funds available to the Foundation.
> Intellectual quality of proposed research.
> Importance of the research relative to its impact on education, the social sciences, and other sciences.
> Levels of support available to these disciplines from other sources.

Dr. Harvey Brooks pointed out that Federal, as distinguished from NSF, support for the social science has been growing more rapidly than for any other scientific area, but that the growth has a very small initial base. Still, Federal support for the social sciences in universities actually exceeds that for chemistry. The difficulty he sees is that this support is quite selective, with principal emphasis on mental health, although there is no clear evidence that good ideas for research in the social sciences are nor being explored for lack of funds. He thought there is a need for a more systematic and expansive study of possible opportunities for research in the social sciences than has yet been made and mentioned that a new study of the social science is being planned by the Committee on Science and Public Policy of the National Academy of Sciences.[66]

Dr. Wiesner saw a great reluctance to have NSF support social science research, but since there was no other group that could provide broad general basic support for this important area, and failing to find or create one, he believed it better to ask the Foundation "* * * to broaden its range of interest and support them strongly rather than to continue the past neglect." [67]

[63] Hearings, vol. II, NSF question A–6.
[64] Hearings, p. 764.
[65] Hearings, vol. II, NSF question A–6.
[66] Hearings, vol. II, question No. 17 to Dr. Brooks, pp. 1238–1239.
[67] Hearings, p. 760.

He also called attention to the sensitive matter of studying human behavior, saying that:

> The closer one gets to the social behavior of human beings, the more skittish the Science Foundation has been about getting involved, because they are obviously getting further and further away from the physical sciences. Even the National Institutes of Health have been somewhat reluctant to get into these fields, and probably with good reason. These, in a sense, are beyond the normal interpretation of their missions, and there are fields where it is often hard to judge what is good and what is bad.[68]

He decried the interpretation of "science" in this country which looks askance at participation by historians, economists, political scientists and others as full-fledged members of the scientific community, causing an unfortunate and undesirable split among American intellectuals.

Also, those concerned with social sciences have been influenced by fears of Congress. Some seem to anticipate that Congress will accuse them of trying to manipulate public opinion or to change our society. According to Dr. Wiesner—[69]

> This has been very genuine, a fear for people having responsibility for big programs, and who don't want to get their agencies in trouble supporting what they regard as peripheral activities. Anyone who is really candid with you will admit that this has been a factor in some elements of the social sciences.

On the other hand, he recalled his White House experience with calling together a group of behavioral scientists to say what was needed. "They didn't really know. They were so convinced they couldn't get support that they never bothered to try to get support." [70]

(*d*) *Opportunities for small colleges*

The subcommittee resolved at the outset of the hearings to look into the situation of research and science education in the small, liberal arts colleges. In doing so, it continued its long standing interest in science education. This interest has been bolstered over the past year and a half by special NSF studies on science education which were undertaken at the request of the subcommittee.[71] The subcommittee has been aware of concern—which appeared frequently in the testimony—that our small, liberal arts colleges may be losing out in science education.

(1) *Freezing out small colleges.*—The seminar discussion on August 5 about the relationship of the small colleges to science and research, and their relationship to the Foundation, was organized to call attention to complaints that the larger universities with their disproportionate concentration of Federal funds for research are tending to force smaller colleges out of science education. In the opinion of

[68] Hearings, p. 665.
[69] Hearings, p. 666.
[70] *Ibid.*
[71] "Science Education in the Schools of the United States," Report of the National Science Foundation to the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 89th Cong., 1st sess., 1965 (committee print).
"Higher Education in the Science in the United States," Report of the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, 89th Cong., 1st sess., 1965 (committee print, prepared by the National Science Foundation).

the subcommittee, any such result would be a genuine loss to the Nation. The NSF in its prehearing questions acknowledged that about one-third of the annual national supply of new science baccalaureates graduate from smaller schools and that graduates of small colleges have emerged at all levels of eminence in our society.[72]

The past effectiveness of smaller colleges as suppliers of well-qualified candidates for graduate study and the number of eminent scientists who studied their preliminary science in small colleges are potent reasons to recognize and conserve the teaching of science and engineering therein.[73] Small colleges access to funds for academic research must be assured as a means to this end.

The constant linking throughout the testimony of research with teaching as a requisite for effective science education supports the thought expressed above. Yet this same testimony showed little realization of the implication that such linkage augers a continuing limitation upon science education in the future to the favored few larger colleges and universities which have built up and expanded their research faculties and capabilities at Federal expense. The Foundation clearly recognized the position of the smaller colleges in this regard, noting that because "* * * they are typically in a less favorable position to conduct original research, they are not very successful when they compete for research funds." [74]

Moreover, many faculty members in smaller institutions are not aggressive in starting those research activities which would be possible even within the limits of their own competence and facilities; many college teachers are not experienced enough in research to effectively utilize research as a supplement to instruction; that there is relatively little money available to support research for instructional, rather than its scientific, value.

This viewpoint was recognized by the Foundation in its suggestion that NSF should provide more support for faculty training in research, and for research as an adjunct to instruction.[75]

(2) *View from the small colleges.*—The participants in the seminar made a convincing case for positive, timely action to preserve these institutions as a source of science students by assuring them reasonable access to funds for basic research. Five specific small college needs for NSF support were identified by Dr. Sawyer of Williams College. These included science buildings, equipment and research assistance, balancing of teaching loads, professional contact and development, and summer salaries. Financial assistance for these purposes is needed to bolster and preserve the scientific capabilities of the smaller institutions. Access to information is important too. Even as simple a matter as finding out where to submit proposals for academic research is a formidable problem to the unsophisticated smaller institution that lacks contacts in Washington. A central data bank for such information was suggested by Dr. Sullivan of Reed College. The significance of concentration of Federal funds in a few institutions was highlighted by Dr. Sawyer as he emphasized that the Federal expenditures account for only 2 to 3 percent of small college budgets versus 20 to 30 percent at many larger institutions.[76]

[72] Hearings, vol. II, NSF question E-17.
[73] An analysis of the membership of the National Academy of Sciences to show how many were educated in small liberal arts colleges appears in vol. II, app. 5 of the hearings.
[74] Hearings, vol. II, NSF question E-20.
[75] Hearings, vol. II, NSF question E-20.
[76] Hearings, p. 739.

The small institutions recognize their problem. Measures to combine their respective capabilities through consortia and through satellite relationships with larger institutions were suggested by the small college representatives. However, there were few signs of NSF leadership and assistance to smaller colleges to work out relationships to strengthen their own positions and, at the same time, to increase their ability to compete for Federal funds for basic research.

(3) *Opportunities for small colleges.*—Dr. Wiesner raised the case of the many small colleges not interested in professional education in science but which could and should do a reasonably good job of teaching elementary and intermediate science as part of general education for all their students. In turn this could be a stimulant and passport to further study for their students possessing an aptitude for creative research and engineering. The subcommittee is aware that this goal has not been realized today in many small schools. They need help with equipment, staff, and curriculum development.

Dr. Wiesner called for special science courses that can be taught well in spite of limited facilities of smaller colleges, with Federal provision of special facilities and perhaps other means of support for science faculties in these schools. He posed the idea of a Government Science Corps through which people can move from smaller institutions to government and industrial laboratories, and perhaps represent the country abroad as science attachés.[77]

Shortly before this report was completed, the National Science Foundation announced that some 164 participants in its summer research program for college teachers would be able to continue the research they began during the summer as a result of grants totaling $328,000. These academic year extensions provide $2,000 to the researcher's home institution and are usable over 2 years; $1,500 is earmarked for the project while the remaining $500 may be used by the institution either as backup for the research or for improvement of education in the sciences.[78]

The subcommittee views this step with considerable interest.

(e) Broadening geographic distribution

The geographic distribution of Federal funds for research and development, and their concentration in a relatively few colleges and universities in a few parts of the country was documented by this subcommittee last year.[79] A principal cause of this pattern, which has greatly enhanced existing centers of academic excellence but has not produced a corresponding increase in the number of new centers, is Federal emphasis upon short-term results from research projects carried on by leading scientists. This Federal attitude tends to equate spending for research with the buying of results. No one has challenged the demonstrated fruitfulness of this approach. However, it does not seem designed for national investment to create new and to foster the growth of lesser centers of scientific excellence.

The subcommittee is mindful of pioneering experiments by the space agency, the National Institutes of Health and the National Science Foundation which make grants to institutions for general purposes of scientific research and science education. These efforts

[77] Hearings, p. 661.

[78] "National Science Foundation Helps Small College Faculties Continue Research," NSF Press Release 650150, Oct. 18, 1965.

[79] Geographic Distribution of Federal Research and Development Funds, Government and Science No. 4. Report of the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics, 88th Cong., 2d sess., 1964. (Committee print.)

mark a promising avenue toward the goal of strong scientific resources well distributed throughout the Nation. But it is clear that the present scale of efforts must be expanded, and that this cannot be done without the understanding and active support of the Congress.

The problem now to be faced is the balancing of programs for project research with those for institutional support among the Federal departments and agencies so that leading scientists and institutions can continue their quest for excellence in science while at the same time other institutions with the initiative and energy to seek after such excellence can be encouraged and helped to develop their resources.

The Foundation's first annual report noted its attempt to "provide in every section of the country educational and research facilities which will assist the development of such men," referring to scientists of high competence. This first report also stated a goal of "strengthening many institutions which have not yet developed their full potentialities as scientific centers." [80] and said: "The National Science Foundation proposes to support basic research on as broad a geographical and institutional basis as possible." [81]

Concentration of Federal R. & D. funds was still a matter of concern when the Foundation said in its third report: [82]

> Generally speaking, Federal funds in support of research at universities and colleges have been concentrated in a relatively small number of institutions. However, in evaluating this institutional concentration of funds, one factor must be kept in mind. The Department of Defense, the Atomic Energy Commission, and other agencies which have supplied the greater part of Federal research funds at educational institutions, mainly sponsor research related to the operating functions of the agencies. These agencies need and expect results which further their overall programs and, therefore, place research contracts and grants in large, well-equipped, and well-staffed institutions. Regardless of the long-term national gains to be obtained through broader institutional support of research, these agencies on the whole dare not risk any substantial portion of their research support effort in institutions which cannot quickly and effectively meet their operating needs.

The original intent of Congress that the Foundation give consideration to regional distribution of its funds was made clear in section 3(b) of the National Science Foundation Act of 1950 which directed the Foundation "* * * to strengthen basic research and education in the sciences * * * throughout the United States, including its territories and possessions, and to avoid undue concentration of such research and education."

The Foundation has made progress in broadening the distribution of its research support funds. But the relatively limited funds available and the great number of pressing and outstanding proposals have reduced the effectiveness of its efforts in this direction. The greatest possibilities for improvement appear to be through the Foundation's

[80] National Science Foundation, First annual report, 1950, p. vi.
[81] *Ibid.*, p. 16.
[82] National Science Foundation, Third annual report, 1953, pp. 34-35.

institutional support grants and its grants for research by faculty in the smaller colleges.

Testimony this year revealed nothing especially new about the previously established facts of geographic distribution and concentration of Federal funds for research and development. Information supplied by the Foundation showed continuation of the patterns of earlier years.[83] As for distribution of the NSF's own funds for basic research, Dr. Haworth compared the spread of NSF academic research support distribution of graduate, undergraduate and high school degrees, making the case that NSF funds are distributed comparably to the distribution of intellectual capabilities as indicated by educational achievements on the principal regions of the country.[84]

Statistics made available last year by the Foundation to the subcommittee showed that regional unbalance in Federal support is far more pronounced for development than for "research" and is less pronounced for NSF basic research in the universities.

If the Foundation is to successfully upgrade the scientific capabilities of those regions that are now relatively weak, then a positive initiative must be expected from it to channel proportionately *more* funds to the States and institutions that are trying to catch up. The idea is not to maintain the status quo. It is deliberately to infuse new capabilities into the weaker parts of the Nation, to bring them to a level of scientific and technological competence sufficient to meet the demands of this scientific age, and to do so without taking Federal funds from the centers of scientific excellence that are now so important for the Nation's research and development. Additional funds will be needed, for it would not be wise policy to raise the level of some institutions by cutting down those already at a high state of academic quality.

Obviously this is easier said than done. The mission-oriented agencies and the Foundation fear to allocate funds on some geographic basis because they believe the principal criterion for selection should remain the promise of proposed work. Even were the Foundation to use its academic research funds to strengthen regional capabilities, its own appropriations could scarcely change the present distribution and concentration of Federal funds. Dr. Hornig made this practical fact of life clear when he pointed out that NSF supports only about 14 percent of the acadeimc research budget and only 4 percent of the total Federal research budget; that its grants to colleges and universities are exceeded by both the National Institutes of Health and the Department of Defense; that the AEC and NASA each support about half as much as NSF.[85] Moreover, he definitely opposed the idea of awarding NSF academic research grants on criteria other than excellence, saying that "* * * the effect on the quality of U.S. science would be disastrous, and the source of high quality people to staff developing centers would also dry up." [86]

It should not be thought that Government emphasis upon project research and development is without side benefits. As one looks across the Nation, one sees in distant parts of the country Federal research centers that are helping to enhance the scientific resources of their regions. The Atomic Energy Commission's installations in

[83] Hearings, vol. II, NSF question A-21.
[84] Cf. Hearings, chart 20, p. 71.
[85] Hearings, p. 113.
[86] Hearings, vol. II, question 17 to Dr. Hornig, p. 1113.

Tennessee, in New Mexico, in Washington and the NASA installations in Alabama, Florida, and Texas do not exist in a vacuum. They interact with the surrounding colleges and institutions in many ways. For this reason, it may be desirable to further explore the relations of such Federal centers with neighboring entities to see how these relations can be made the most productive.

The testimony of Dr. Wiesner defined the geographic distribution of research support as one of the most serious problems confronting the Foundation and the Government. Noting the growing recognition around the country and in the Congress, and particularly in the Science Foundation, that the economic well-being of the various geographic areas is related to their technological base, he said "* * * we have to do something to insure that such a base is available in all areas." [87]

President Johnson's memorandum of September 14, 1965, to his department and agency heads lends support to the concept that the Federal Government has an interest in and a responsibility for measures to strengthen regional resources for science. A theme of his statement was that: [88] [89]

> 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.

While the subcommittee does not necessarily accept all of the methods and ideas expressed in the President's instruction, the controversy about the problems of geographic distribution of Federal funds for research and development, and the many proposals for corrective action, will make it interesting to see how the departments and agencies carry out this directive. The practical problem before the Congress is how to foster the growth of State and regional scientific resources in a helpful way that responds to local initiative and energy but does not attempt to force the growth of institutions without regard to local interests. It may be that more can be done by building on what has been started than to turn to new programs that might conflict with, rather than supplement, ongoing Federal programs of project research.

[87] Hearings, p. 656.

[88] Weekly Compilation of Presidential Documents, Sept. 20, 1965, pp. 268–269.

[89] His memorandum set out the following functions for Federal agencies in relation to this goal:

(*a*) The National Science Foundation continues to have responsibility for augmenting the research capabilities of academic institutions in all fields of science through the support of basic research and research facilities and through measures for improving the quality of education in the sciences;

(*b*) The Department of Health, Education, and Welfare will contribute to the overall development of colleges and universities and to the development of health professional schools, particularly through programs of the Office of Education and the Public Health Service;

(*c*) All Federal agencies with substantial research and development programs have an interest and need to develop academic capabilities for research and scientific education as a part of their research missions.

To the fullest extent compatible with their primary interests in specific fields of science, their basic statutes and their needs for research, the memorandum instructed all Federal agencies to:

(*a*) Encourage the maintenance of outstanding quality in science and science education in those universities where it exists;

(*b*) Provide research funds to academic institutions under conditions affording them the opportunity to improve and extend their programs for research and science education and to develop the potentialities for high-quality research of groups and individuals, including capable younger faculty members;

(*c*) Contribute to the improvement of potentially strong universities through measures such as:

Giving consideration, where research capability of comparable quality exists, to awarding grants and contracts to institutions not now heavily engaged in Federal research programs;

Assisting such institutions or parts of institutions in strengthening themselves while performing research relevant to agency missions, by such means as establishing university-administered programs in specialized areas relevant to the missions of the agencies.

(f) Applied research

At the time the Foundation was established, the scientific community was apprehensive that the attractiveness of short-term benefits from applying scientific research to programmatic ends would divert funds from scientific research which promised no immediate application and was not visibly related to agency missions. As a result, the legislation of 1950 emphasizes basic research, and the Foundation, consistently, has paid great attention to this adjective. However, the assignment of weather modification research to the Foundation by Congress in 1958 and the Foundation's own decision to take over Project Mohole from the National Academy of Sciences suggest that the Foundation is not fundamentally adverse to work aimed at specific problems or involving substantial applied research, engineering, and development. This leads to some ambiguity.

Just how far the Foundation should go in applied research was not a subject of common agreement among the witnesses. Some opposed any departure from basic research. Others thought the Foundation could and should support work to bridge part of the gap between discovery and application, particularly through engineering projects that would go through demonstration of systems. Dr. J. H. Hollomon, Assistant Secretary of Commerce for Science and Technology, was an articulate witness on this point; for his Department is particularly concerned with applications of research and development. After calling attention to cooperative and fruitful relations with the Foundation and its national research programs, he noted that the NSF had also made funds available to his Department for the initiation of important new programs which might not otherwise have started when the need first became apparent.[90] The National Standard Reference Data System and the Clearinghouse for Federal Scientific and Technical Information both were supported in part by the NSF in their early stages. However, aside from furnishing seed money of this kind, he questioned the extent to which NSF should go beyond basic research toward practical applications, and stated his view that NSF should not take on responsibility for applying knowledge or for operating development programs, except in science education and information.

NSF involvement in applied research is clearly a major policy question for future consideration, for it appears that the mechanisms through which results of basic research come into practical application are not yet sufficiently understood or established to assume the benefits of basic research will flow without further attention.

The subcommittee is mindful that more needs to be said of the future responsibility of the Foundation for applied research in relation to unmet national needs. The upgrading of the status of applied research in higher education appears to be important if we are to maintain national science resources well balanced between investigation, discovery and application.

Basic research, applied research and development form a trinity. Each part depends upon the health of the others. It is the intention of this Subcommittee to foster cooperation and mutual interest among these scientific and technological activities so that each will be enhanced and enriched by its relations with the others.

[90] Hearings, p. 412.

To clarify the potential role of the Foundation for applied research relating to major national problems, such as environmental pollution or transportation, and to buttress Foundation-sponsored studies of the application of science to practical problems, it appears appropriate to authorize the Foundation to sponsor scientific research—*basic or otherwise*—where the public interest is involved.

(1) *Weather modification* raises a special question concerning applied research, for there seems to be some uncertainty about what is expected of the Foundation.

Dr. Hollomon expressed definite views about the role of the Foundation in weather modification. He questioned its role in the practical, information-gathering aspects and developmental aspects of weather modification, saying: [91]

> I believe the assignment of responsibility to NSF in weather modification has led to a loss of initiative on the part of other agencies to develop programs leading to useful results.

He also forecast a substantial expansion of weather modification research and development, suggesting that the project will ultimately be done by many nations working together with administrative and organizational problems that will be staggering. He questioned who should have responsibility for scientific tasks of this nature, and what institutions or mechanisms were necessary. Dr. Hornig said that weather modification research was given to the Foundation in 1958 because a research program rather than an operational program was then clearly indicated.[92] On the other hand, it would seem that focusing responsibility for weather modification study, research and evaluation in the NSF indicates a desire for work intended to improve the practical possibilities of weather control. This approach would call for a project-minded approach with specific goals, definite plans, and positive project direction. The specific authority given to the Foundation in section 14 to contract for research and to obtain information by regulation or subpoena suggest that Congress had in mind more than the traditional, undirected support of basic research.

At present the Foundation appears to be administering weather modification as it does any other of the NSF's basic research programs. That is to say, there seems to be no NSF planning to identify what information is needed for a technology of weather modification, or to find qualified research groups willing to pursue relevant studies. Instead the Foundation waits for proposals which reflect the academic interests of the scientist and may or may not be relevant to planned, practical applications.

To provide flexibility for future planning of Federal weather modification research and development, it may be desirable to repeal section 3(a)(9) and section 14 of the National Science Foundation Act which specifically authorizes and directs the Foundation to initiate and support a weather modification program. This would not change the basis for present NSF support for research in this field, but it would facilitate the effort that should be made to coordinate the relevant research and development of various agencies, and could help prepare the way for possible reassignment of applied research and development for weather modification.

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[91] Hearings, p. 413.
[92] Hearings, vol. II, question 23 to Dr. Hornig, p. 1116.

(*g*) *Interdisciplinary research*

As the impact of science and its applications upon national cultures and economies becomes more evident and the problems of growing world population take on new dimensions, the full resources of the life, physical and social sciences will be called upon, not singly but together. Also, if the examples of biochemistry and biophysics are valid, one can expect new steps towards greater understanding as the scientific investigations further combine these different disciplines. While NSF project grant support appears to be keyed to the established scientific disciplines, the Foundation's national research programs should offer increasing opportunities for scientific research bridging several disciplines.[93]

4. The NSF and "Big Science"

The appearance of "big science" is a major characteristic of scientific research since World War II. As Dr. Kistiakowsky observed in his paper in the NAS report, "Basic Research and National Goals," since the late 1940's the use of costly facilities has been growing very rapidly and has led to the establishment of a new category of basic science which has been called "big science." The organized teamwork that is usual with the use of these costly research facilities has opened completely new fields to scientific research and greatly advanced our knowlege of the world we live in. But the costs of individual big science projects has been rising rapidly perhaps by a factor of 100 during the past 18 years, and there seems to be no natural upper limit to such costs. "Big science" is fiscally open-ended because the commitment of scientific personnel per project rises comparatively slowly and the costs instead are concentrated in major engineering efforts to design, develop, and build the special facilities and to maintain, operate, and improve them.

When the NSF was created in 1950, it was concerned with the basic research activity of the individual scientist and the individual graduate student. Since then the Foundation has gradually become involved with "big science" through its support of astronomy, weather modification, studies of the earth's crust and radio astronomy. The national research programs in some ways resemble big science for they now account for better than $30 million annually in operating costs in the NSF's budget. With the exception of weather modification, the entry of the Foundation into big science has come about under the broad grant of authority in the National Science Foundation Act so that NSF has not had to seek additional authorization from the Congress.

Another characteristic of big science relevant to NSF is that the decentralized methods of selection characteristic of little science must be replaced for "big science" by centralized deliberation, planning and supervision. This calls for an entirely different outlook by NSF staff, an approach that is outside the long-established principles and traditions of the Foundation.

An important question before the subcommittee concerning "big science" was whether the Foundation should continue on with it and, if so, how well prepared was the NSF to provide the requisite administration. Dr. Shannon and Dr. Seaborg both expressed concern about NSF responsibility for direction and management of large

[93] Cf. NSF review report, table 5, pp. 38–39.

projects [94] and Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, thought that the Foundation, by the very nature of things, should continue in the role of a granting and not as an operating agency.[95]

This big science involvement raises two issues: First, to what extent do these NSF laboratories and NSF national research programs commit future NSF funds, thus reducing its budgetary flexibility and the availability of uncommitted funds from future appropriations. Second, to what extent do national research programs and large projects impose demands upon the time and energy of NSF top management and require NSF to possess the ability to administer large projects?

(*a*) *NSF funding of "Big Science"*

NSF spending for large, special scientific devices and for research centers has become large enough to warrant continuing congressional scrutiny. Table II, below, shows a rising trend for NSF expenditures for its national research programs, its funding of specialized research facilities and operations of its national research centers. Note that over recent years these big science expenditures are roughly half of the amount for basic research project support.

TABLE II.—*Selected summary of budget requests and obligations*

[In millions of dollars]

Program	Budget request, fiscal year 1966	Estimated obligation, fiscal year 1965	Actual obligation, fiscal year 1964	Actual obligation, fiscal year 1963	Actual obligation, fiscal year 1962
National research programs	31.6	41.7	25.8	17.0	12.3
Specialized research facilities	31.5	26.7	19.6	23.8	20.6
National research centers	22.8	19.3	19.2	14.5	9.7
Total	85.9	87.7	64.6	55.3	42.6
Basic research projects	191.0	120.7	112.4	107.2	84.9

Source: The National Science Foundation, a general review of 1st 15 years. Table 4, p. 34.

In 1956 when the National Science Foundation first requested an appropriation from Congress for support of its large-scale facilities and research laboratory program, it argued that such support would be sought only upon the basis of (*a*) an urgent need, (*b*) the national interest, and (*c*) unavailability of funds from other sources. Some expectation of cost sharing by the institutions also was voiced, recognizing however, the need for flexibility in individual situations. The Foundation's original justification stated the principle that whereas Federal support should generally be limited to the initial establishment and construction costs, in individual instances continued support may be required. This "foot-in-the-door" commitment today is a source of congressional concern. That this will become more rather than less critical in the future was forecast by Dr. Haworth when he said,

> In stressing the importance of research in academic institutions and the need for it to grow, I do not mean to neglect the important role played by the national research centers.

[94] Hearings, vol. 2, pp. 1180 and 1258.
[95] Hearings, vol. 1, p. 425.

> They must continue to be supported and their programs should be strengthened and expanded. Perhaps from time to time there may be occasion to establish more of them in special fields. For example, I expect that, once it reaches the research stage, Project Mohole will be operated as such an activity.[96]

These observations also suggest to the subcommittee that Congress, when it considers proposals from the Foundation, and from other agencies for major new scientific and technical facilities, should inquire about: (*a*) the expected operating lifetime; (*b*) the best estimate of operating and other capital funds to be required throughout the years, and (*c*) the circumstances under which the installation ultimately should be retired from active service.

(*b*) *Management of NSF projects*

As the Federal commitment for national research centers increases, it appears likely that their activities will come under closer scrutiny. Does initial approval for a research center constitute a commitment for long term support? To what extent should Congress exercise oversight over the activities carried on within the research centers? The testimony of Foundation officials that these programs should be strengthened and expanded gives rise to congressional desire for careful control and administration of expensive facilities and installations, and better initial estimates of the duration and total Government commitment implied in congressional approval of a new center.

As for NSF administration of big science projects, the subcommittee is not persuaded that NSF responsibilities extend only to selecting among proposals and making and auditing expenditures. The Foundation has a responsibility for its national laboratories and for large projects. It would seem that NSF should have a competence, through its own staff or through others, to periodically assess the quality of work and administration of such undertakings. In particular, for a direct NSF operation such as Project Mohole, the Foundation should have a sufficiently strong engineering capability to independently review the major decisions and approvals required during the course of a "big-science" project. NSF organization for big science projects must certainly be properly structured so as not to detract from top management attention to other of its programs.

(*c*) *Weather modification*

The assignment by Congress of weather modification research to the Foundation has introduced a program with applied overtones that seems out of character with the original basic research mission of the Foundation. Furthermore the Foundation's responsibility and authority for interagency coordination of weather modification research is vague and the NSF itself has taken different views of its coordinating function. If the Foundation's role in weather modification is to be directed towards the basic research aspects only, then it would appear that the interagency coordinating authority and responsibility should be clearly assigned to the Interagency Committee for Atmospheric Sciences.

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[96] National Science Foundation. Hearings before the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics, 89th Cong., 1st sess., vol. 1, at p. 91.

(d) Project Mohole

While the broad focus of the subcommittee's general review of the National Science Foundation precluded detailed consideration of problems associated with Project Mohole, the project was discussed several times during the hearings. The testimony received served to confirm earlier thoughts that three important questions for future consideration are:

1. To what extent should the NSF assume responsibility for the direction of large projects?
2. What kind of project management capability is required?
3. How can this capability be obtained?

The Foundation's involvement in Project Mohole is perhaps the best case to illustrate the kind of problems underlying these three questions. For this reason, some highlights about the project follow. Greater detail may be found in the review report on the Foundation.[97]

It should be noted at the outset that Project Mohole, although undertaken as a basic research study of the earth's mantle, is largely a developmental and engineering effort. It is a pioneering scientific venture that has imposed extraordinary demands upon many technologies to produce the equipment and techniques to drill 18,000 feet into the sea floor from a platform floating in approximately 14,000 feet of water.

Project Mohole was begun in 1957 by a group of scientists affiliated with the National Academy of Sciences and financed by the National Science Foundation. In Phase I of the project, an investment totaling $1.8 million carried the preliminary work through study of the project's feasibility and some test drilling. At the conclusion of Phase I in 1961, the Academy requested the Foundation to assume responsibility for organization and operation of the project, and the NSF agreed.

By the end of fiscal year 1965, the NSF had committed $37.5 million to Phase II of the project. On September 28, 1965, the Foundation authorized award of a subcontract for construction of the Mohole drilling platform. The award was made by NSF's prime contractor for Mohole, Brown & Root, Inc., of Houston, Tex., to the National Steel & Shipbuilding Co. of San Diego, Calif., for a firm, fixed price of $29,967,000. In comparison, the NSF estimated $16 million for the platform in its testimony before the Senate Independent Offices Appropriations Subcommittee in November 1963.[98] Cost estimates for Mohole have shown a continued rapid increase. The cost of putting the drilling platform into the water, equipped and ready to start preliminary drilling, is now estimated at $77 million, which is $25 to $30 million higher than was estimated a year ago.[99] In March 1962, the costs for building and equipping the platform and operating it for 5 years was estimated to range between $35 and $50 million. Eighteen months later, the estimate for the total project cost, including a 3-year operational period, was put at about $68 million. In June of this year, Mr. Gordon Lill, the Mohole project director, testified that this cost would be at least $90 million.[100] His estimate was revised by Dr. Haworth, in testimony to this subcommittee, to be

[97] "The National Science Foundation: A General Review of Its First 15 Years," *op. cit.*, pp. 85–110.
[98] Senate Independent Offices Appropriations, 1964, p. 2340.
[99] Hearings, vol. II, NSF question F–13.
[100] Senate Independent Offices Appropriations, 1966, p. 601.

about $110 million for the total project cost including piercing the earth's mantle.[101] Annual operating costs are now estimated at approximately $11 million,[102] which compares with NSF's combined fiscal year 1966 budget request for operation of its National Radio Astronomy Observatory and its Kitt Peak National Observatory.[103]

Funding for the project comes from the Foundation's general appropriation. This means that as Mohole cost estimates increase, unless additional funds are appropriated, the NSF must divert funds from other projects or delay the start of new ones.

Not only has Project Mohole claimed an increasing share of the Foundation's funds, it has also imposed a great administrative burden upon the Director and his top staff. In addition to the effort of managing an unusual, large-scale engineering venture into many new areas of technology, the uncertainties about certain technical factors and the continuing escalation of cost estimates have subjected the Foundation to severe criticism. At issue have been questions of the scientific guidance of the project, the goals and methods of implementation, and the Foundation's responsibility for monitoring the project and reviewing principal decisions of the engineering contractor. With supervision of the construction contractor for the Mohole platform soon to add its demands upon the NSF, the Foundation's in-house capabilities to supervise the work seems likely to need strengthening.

To acquire better performance characteristics in regard to Project Mohole, it may be desirable for NSF to examine the approach, policies, and procedures of other Federal agencies, including in-house operations, which have proven successful.

(*e*) *Computers for universities*

According to Dr. Haworth and other witnesses, the NSF is likely to become increasingly involved with providing and replacing computers at colleges and universities. Computers are becoming a prerequisite for academic research, and for effective education of scientists and engineers. In essence, computers are becoming an essential resource for science, and as such can be expected to claim more NSF support. It appears, however, that future NSF responsibilities have not been sufficiently delineated.

According to a report of the National Science Board, "Use of Digital Computers in Universities and Colleges," which the Board adopted last May, the Foundation should assume a general responsibility for—

> * * * monitoring and encouraging appropriate development of these facilities and their use in universities and colleges. This policy does not specify the proportion of total financial support to come from the National Science Foundation * * *. However, * * * the NSF should undertake to see that automatic data processing facilities become extensively and increasingly available to American institutions of higher learning.[104]

[101] Hearings, vol. II, NSF question F-13.
[102] *Ibid.*
[103] Review report, p. 38.
[104] Dr. Eric Walker included the text of the NSB report in his testimony. See Hearings, vol. II, question 11 to Dr. Walker.

Dr. Haworth spoke of the question of financing computers and computer development centers at universities. He speculated whether the institutions in an area would be better served by one very large computer with satellite stations feeding into it from nearby universities or whether several smaller computers should be installed at individual institutions. He recognized that this is not "big science" in the same sense as Project Mohole, but "it is big money." Dr. Wiesner characterized the magnitude of the university computer problem as "* * * several times the scale of the Science Foundation's resources to deal with." [105]

It seems likely that replacement of obsolete computers will account for an appreciable part of the NSF computer effort. Computers that originally cost from $50,000 to $100,000 need replacement with new models costing $500,000 or more. Where extensive research is involved, the cost per machine is likely to range from $1 to $3 million. The Board's report mentions a 45-percent annual growth curve of the purchase value of computers presently at universities and colleges. It notes also that annual staff costs are about one-fifth or one-quarter of this figure and are rising rapidly. Another question is whether to rent computers or to buy them. Still another is the question of central purchasing by the Foundation versus individual purchase by the participating institutions.

Even though the largest part of such usage costs are already devoted to scientific and engineering research along lines of the Foundation's major interests, these costs, according to the Board, reflect only the barest beginnings of the very large role that digital machines will have in education itself, and in many technologic university endeavors which are now barely involved.[106]

According to the Board's report, several NSF task forces are gathering information for preparing to submit to the Board various policies which would activate the role of the Foundation for supplying computers. Because the ultimate outcome of these studies will be of considerable interest to the subcommittee, it is pertinent to note that the task forces include:

(*a*) A group having interagency associations which will seek to identify the current university computer support in terms of the Federal agencies and fundings.

(*b*) A group which will study the accounting and fiscal aspects of controls relating to computer support in universities and colleges. This group, which will be primarily comptroller officials of various agencies, will consider such problems as the requirement that all academic users, sponsored or nonsponsored, be charged at the same rate. It will be also concerned with the rent-versus-buy questions and other elements of the Federal policy.

(*c*) A group of experts in computer systems design and usage, from Government, universities, and industry (perhaps not the computer industry), who will assess the opportunities for organizing facilities for academic use. This is so that the many options can become known to the many institutions which may be acquiring facilities.

Since the computer paper was adopted by the Board, which includes the NSF's Director, this report also has the support of the Director. How they will obtain the funds necessary to mount a

105 Hearings, p. 667.
106 *Ibid.*

computer program of the scale indicated in the Board's report is an open item. It would appear that an NSF undertaking of this magnitude probably will need further inquiry and study by the executive branch and by the Congress.

5. Strengthening institutional support

Three issues emerge from the Foundation's present programs for fostering the growth of new centers of scientific excellence at academic institutions. First, NSF institutional support appears delayed and still too small for national needs, particularly to assure a substantially greater number of centers of excellence widely dispersed among the States. Second, institutional support can offset the possible decrease of freedom of action of college and university administrators in determining the overall institutional pattern of development and growth. Dr. Haworth observed that this pattern may have been unduly influenced by the nature of programs finding most ready acceptance in Washington.[107] Third, institutional support may offer a way to reduce costs of academic research administration and to keep responsibility for business administration aspects of research on the campus where it belongs.

It is evident that the NSF has made a start in institutional support and is doing what it can within its means. The subcommittee would encourage the Foundation to push ahead with its institutional programs, to open them to more than the top colleges and universities in the country, and to seek out these smaller institutions whose own energy and initiative indicate that with encouragement and support they can become genuine centers of excellence in research and science education.

Institutional support was discussed by many witnesses in terms of what the Foundation has done and also by what it has not done to these institutions. Problems identified by witnesses, and by other informed sources may be summarized in two broad headings: [108]

(a) Federal emphasis upon project grants

The hearings reflected some of the controversy that may arise between university officials who, because they think of the institution as a whole, prefer institutional support which keeps decisions about research activities at the university level, and individual scientists who prefer more centralized decisions by advisory bodies of their professional peers serving research-oriented Federal agencies. It appears that much of this controversy may stem from the very success of the project system in applying the scientific capabilities of academic institutions to Federal interests.

Witnesses agreed that continuation of the NSF project grants was essential, but that its funding of institutional science programs was insufficient. The solution invariably recommended was to increase appropriations for institutional support while maintaining or continuing to increase those for project research. This is not to say that project grants are without flaw. Dr. Haworth mentioned several

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[107] Hearings, p. 93.

[108] See also: Dael Wolfle, "The support of Science in the United States," from *Scientific American*, July 1965, in remarks of Senator William Proxmire, *Congressional Record* (daily ed.), v. 111, July 13, 1965, pp. 16075–16077; U.S. National Science Foundation, Fourteenth Annual Report, 1964. Washington, U.S. Govt. Print. Off., 1965, 128 pages. At pp. xxii–xxiii of the Director's Statement; National Academy of Sciences, "Basic research and national goals; a report to the Committee on Science and Astronautics, U.S. House of Representatives" Washington, U.S. Govt. Print. Off., 1965, 336 pages, essay by Saunders MacLane, at pp. 199–201, in particular; and Harold Orlans, "The effects of Federal programs on higher education," Washington, The Brookings Institution, 1962, 361 pages, at pp. 250–279.

problems that project grants either do not help or intensify. He called attention to lack of flexibility that project grants created at the departmental level within a university, and to the difficulties of supporting general, or centralized facilities and services such as shops, general-use computers, and libraries. Another was the possibility of some decrease of freedom of action of academic administrators.[109] Thus, while the basically agency-to-individual relation of project grants has produced valuable results, it seems timely to recognize its limitations and to offset these through expanded institutional programs.

Other problems which were identified and attributed to Federal and NSF reliance on the project grants included the following:

Difficulty of supporting interdisciplinary units or programs under the system;

Emphasis on quality as the basis for selection means that younger, unknown investigators from smaller colleges have difficulty obtaining support; and

Danger of subtle distortion of science by a temptation to tailor requests to areas where support is most likely.

(*b*) *Institutional development*

The Foundation's institutional base grants make available to colleges and universities amounts in direct proportion to the total NSF project grant support which the institution received during the previous year. This money may be used by the institution at its discretion.

The more recent science development program has just begun to furnish funds to increase the number and geographical distribution of centers of excellence, providing assistance to selected institutions that have potential, the determination, and a definite program to improve their activities in science and engineering.

The institutional base grant program has served a useful purpose in providing funds with which institutions can redress some of the project-related costs not covered by the grants. But the base grants do not seem to have significantly narrowed the gap between the have and the have-not institutions. The Foundation's idea of including all Federal research and development money at a college or university in the calculation of base grants would direct more of this assistance to those colleges with heavy NASA and DOD commitments, but how it would help the institutions with little Federal research is not clear.

The science development program has been criticized as slow in getting started. While Congress showed an initial reluctance to accept this program, it now appears solidly behind it. Now the question seems to be whether the Foundation's initiative is adequate to meet national needs for institutional development. There is some doubt inasmuch as the scope of the present program and the criteria for selecting institutions seem vague. Is the program limited to boosting leading institutions of the minor educational leagues into the big league of first-rate centers of excellence, or is it also intended to plant and upgrade research centers on a geographical basis so that each State, or region, has a minimum academic capability for research and science education? If the latter objective is the goal, should not it be openly identified as such?

These are some of the questions which witnesses and informed critics have raised. Answering value questions of this kind

[109] Hearings, p. 93.

is the responsibility of Congress, as is the furnishing of the necessary funds. The subcommittee believes further congressional support will be forthcoming as the goals of institutional development are better understood.

6. Educational programs

The range and variety of NSF approaches to science education is ample evidence of initiative and energy, as is the high regard for these programs in the academic world. There are issues, however, deserving attention:

NSF support for graduate training of engineering students does not seem proportionate to anticipated national needs. NSF's curriculum research and development has yet to extend undergraduate science education, especially for the smaller liberal arts colleges. NSF science teacher training does not provide opportunities to scientists and engineers interested in teaching as a second career. Also, while it is not the job of the Foundation to refresh the education of working scientists and engineers, it would seem that the NSF's educational research should extend to the problems of personal obsolescence of professional personnel caused by rapid changes of science and technology. Also, because the results of education are less readily discernible than the results of basic research, there is needed a mechanism, which does not now exist, to evaluate the effectiveness of the Foundation's educational programs.

Looking to the general public and its need to understand science and its meaning for this day and age, the Foundation's early, imaginative program for public understanding of science has not kept pace with the growing involvement of science and the scientific method in great national problems of transportation, pollution, weather modification, pesticides, population control, etc. An expanded, revitalized effort is necessary.

Once again, however, the impact of NSF educational programs is much more a function of appropriations than it is of the means for distributing the funds. The main thing to be considered is the sufficiency of present and future funding. This is a subject high on the subcommittee's list of future interests.

(a) Graduate training of engineering students

During the hearings, the subcommittee delved into NSF measures to educate the scientists and technologists needed for the future. One aspect of this manpower supply function meriting separate attention in this report is the graduate training of engineers. The reason for singling out engineering education is that future benefits expected from applications of science and technology to public and private purposes will certainly be held back if good engineers are in short supply.

Before commenting on the Foundation's engineering education activities it is desirable briefly to review recent thinking about the future requirements for scientists and engineers.

(1) *Estimates of needs and supply.*—The starting point for any discussion of manpower is an awareness of the uncertainties of estimates. Dr. Wiesner frankly admitted this. In answer to a question about the supply of scientific manpower he said: [110]

[110] Hearings, p. 668.

> This is a question about which it is hard to get good facts. The Government has tried, over the last half dozen years to come to grips with this question. While I worked here I oscillated violently between believing that we were creating terrible manpower shortages and feeling that we were running a danger of creating an oversupply. Every time we got some new data, we oscillated between these two extremes. It is because the labor market is so flexible; that is, when you create more jobs by starting scientific activities you attract people who have been doing other things.
>
> I think the best judgment at the moment, as far as basic research is concerned, is that the country has enough trained people who can do good scientific work that we are not in danger of manpower shortages. In fact as the population grows, as our productivity increases, we should be glad to have these job opportunities for people to go into rather than to fear that we are draining off too large a fraction of the manpower into these activities. I must say this is a judgment that is based largely on looking at actual data and talking to people, rather than any hard facts that I could muster to prove my point.

(i) *The Gilliland report.*—A landmark among the studies of requirements for scientific and technical manpower is the 1962 report of the President's Science Advisory Committee. Prepared by a panel on scientific and technical manpower—chaired by Prof. Edwin R. Gilliland, of Massachusetts Institute of Technology—this report was published with the endorsement of the President and thus represented the position of the administration.[111]

The central conclusion of the Gilliland committee, which dominated and shaped its recommendations, was that:

> Impending shortages of talented, highly trained scientists and engineers threaten the successful fulfillment of vital national commitments. Unless remedial action is taken promptly, future needs for superior engineers, mathematicians and physical scientists will seriously outstrip the supply.[112]

The report identified manpower needs in engineering, mathematics and physical scientists (EMP), examined projections of numbers of students available to enter these fields, and determined that it was feasible to expand the Nation's educational capabilities, including teachers and institutional facilities, for offering graduate training in EMP. It urged national efforts toward achievement of four goals.[113]

> Increase the number of doctor's degrees awarded each year in EMP to reach 7,500 in 1970.
>
> Increase the number of students who complete a full year of graduate training in EMP to reach 30,000 during 1970.
>
> Encourage the strengthening of existing centers of excellence in EMP and develop new centers of educational excellence.

[111] Meeting Manpower Needs in Science and Technology: Report No. 1: Graduate Training in Engineering, Mathematics, and Physical Sciences.
[112] Gilliland report, p. 1.
[113] Gilliland report, pp. 6–8.

Provide wider geographical distribution of centers of education excellence.

(ii) *Current thoughts about the Gilliland report.*—In consideration of the major effort still to be made if the goals of this PSAC report are to be attained, the subcommittee inquired of many witnesses whether these goals of 1962 still appeared valid.

Dr. Haworth said the manpower production goals of the Panel were not unreasonable, but also were not firmly fixed. He said the Foundation would consider these goals to be a reasonable approximation of the needs as seen at a given point of time and noted that the Panel did not claim its target figures were the "right" ones, but rather goals that could be reached and were worth additional Federal investment to achieve. Furthermore, projections prepared by the Office of Education and the National Science Foundation agreed that the goals proposed for 1970 were attainable providing present trends of increasing graduate degrees in EMP fields continued. He continued on a cautionary note: [114]

> It must be emphasized, however, that the continuation of the trends and the attainment of these goals depend upon the further commitment of resources of faculty, facilities and student support. We are in a position where the proposed goals are now possible of attainment thanks to the hitherto unprecedented support provided for these fields in the later 1950's and early 1960's. *However, further increases of about 60 percent* in the doctoral and master's degrees awarded in 1970 over 1964, which will be necessary to meet the Panel's goals, *will require both the continuation of past efforts and a substantial further effort* on the part of all parties concerned.

Former Commissioner of Education, Dr. Keppel, said that according to most recent projections, the number of doctor's degrees in EMP awarded in 1970 would be 7,890 and the number of master's degrees 38,550, thus exceeding the Gilliland goals. [115]

Dr. Eric A. Walker, as Chairman of the National Science Board, was of the opinion that the goals are still valid and will remain so for at least another 5 years. [116]

Dr. Wiesner saw no reason to change the goals, and emphasized that the real need was not so much "bodies" as it was quality. He reiterated that the PSAC goals were determined from estimated maximum educational capability rather than projection of needs, which appeared to be substantially larger than the estimated supply. [117]

Dr. Waterman summarized two NSF reports regarding projected shortages of scientists. The first forecast some 2.5 million professional scientists and engineers by 1970 with a net annual increase then of 6 percent, or 150,000 more engineering jobs—and this figure did not include additional graduates to make up for people leaving the field; and about 168,000 scientists and engineers with Sc. D. or Ph. D. degrees, increasing at a net annual rate of 7 percent, or 13,760. [118] The second NSF report examined the trend in employment of scientists and

[114] Hearings, vol. II, NSF question E-19. Emphasis supplied.
[115] Hearings, vol. II, question No. 18 to Dr. Keppel, p. 1227.
[116] Hearings, vol. II, question No. 12 to Dr. Walker, p. 1342.
[117] Hearings, vol. II, question No. 8 to Dr. Wiesner, p. 1375.
[118] Investing in Scientific Progress, NSF Report, NSF 61-27, p. 14.

engineers for the next decade.[119] Both warned of serious shortcomings in planning and funding. However it should be borne in mind that these reports were based upon a rate of growth for research and development during the 1960's that may not be fully sustained in the future.

Dr. Killian recalled the study he had chaired for the National Academy of Sciences on the utilization of scientists and engineers. This report found that contrary to many public statements there is the risk of having too few rather than too many students elect to study science and engineering, and that the proportion of the college students committed to science and engineering has not been robbing the humanities or other fields of manpower.[120]

From this testimony it appears that the goals of the Gilliland report continue to represent the position of the administration as to the possible—as distinguished from desirable—output of manpower for science and technology.

(iii) *The need for engineers.*—The PSAC-Gilliland report set out a goal of 7,500 doctor's degrees annually in engineering, mathematics and physical sciences by 1970, and 30,000 master's degrees or equivalent. The supporting estimates of the Gilliland panel projected as reasonably possible of attainment a total of 8,640 to 8,792 doctor's degrees annually by 1970, with engineers constituting approximately 2,000 to 3,000 of them, but gave no figures for master's degrees in engineering. The Killian report showed that since 1950 engineering students have accounted for about one-third of bachelor's and master's degrees in science and engineering, which, in turn, account for about one-fourth of all bachelor's and master's degrees. Its figures show that until recently the proportion of total college population electing engineering had been dropping, as had been the absolute number of students graduating with a bachelor's or master's degree.

Indeed, the number of graduating engineers with a bachelor's or a first professional degree has yet to regain the 42,000 reached in academic year 1950–51. Instead, the number of engineering graduates has been well below this level over recent years. For the academic year 1959–60, 38,000 bachelor's and first professional engineering degrees were awarded. The number decreased to 36,000 for 1960–61, dropping again to 35,000 for 1961–62, and again to about 33,000 for 1962–63, and recovering somewhat for 1963–64, to about 35,000.

(iv) *American Society for Engineering Education forecast.*—Early this fall, the Goals Committee of the American Society for Engineering Education issued its preliminary report on "Goals for Engineering Education." Dr. Eric Walker, Chairman of the National Science Board was also chairman of this ASEE committee. The Goals Committee called attention to the steadily rising utilization of engineering manpower in the United States and the rising aspirations of individual students for higher levels of education. A substantial expansion of the national engineering education was seen as a requirement for the coming decade. To illustrate this point, the Goals Committee recalled that at the beginning of the 20th century, the ratio of total graduate degrees to bachelor's degrees in engineering was only 1 in 100; by 1930 it had progressed to about 1 in 20; rising to 1 in 4 by 1960 and to 1 in 3 in 1964. Looking ahead, it is expected that this ratio will reach 1 in 2 within 10 years.

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[119] "Scientists, Engineers, and Technicians in the 1960's."
[120] Hearings, p. 684.

The projections of the Goals Committee indicate it expects the annual production of engineers for 1970 to be about 3,100 doctor's degrees and 20,000 master's degrees, in comparison with the PSAC estimate of 7,500 doctoral degrees and 30,000 master's degrees for engineering, mathematics and physical sciences *combined.*

A jump in annual output of higher education from some 35,000 bachelor's and master's degrees in engineering for 1963–64 to the 115,000 by 1976, forecast by the Goals Committee, would require marked expansion of existing centers of engineering education and the emergence of new ones. The Goals Committee forecasts that as many as 40 institutions not now offering doctoral programs in engineering will be doing so by 1976.

(2) *Role of the National Science Foundation.*—The testimony showed the Foundation is encouraging graduate study of engineering. Dr. Haworth explained the details of the recent NSF traineeship program which was instituted in 1964 as a result of the Gilliland panel. Unlike the NSF fellowships, which give the recipients their choice of subject and institution, the traineeship program channels funds to specific institutions, into specific departments. The NSF, for the first year of this program, decided to concentrate on engineering instead of scattering traineeships across many fields.[121] However, the approach changed the following year. Dr. Walker noted in his statement that the NSF's traineeship program began with approximately 1,200 traineeships for fiscal year 1964, with about 2,800 for fiscal year 1965. The second year, however, saw 1,637 of the traineeships in engineering; of this number, 925 represented second-year continuations; so that only 712 new traineeships were available for engineering in comparison with 1,200 the year before. He noted the disappointment in academic circles caused by this cutback, but indicated that NSF funds permitted no greater support.[122]

As for the Foundation's support of science, engineering, and mathematics education, in comparison with other agencies, Dr. Haworth estimated that approximately 18,000 full-time graduate students in these fields would be supported during fiscal year 1965 through the Atomic Energy Commission, National Aeronautics and Space Administration, National Science Foundation, Office of Education, and the Public Health Service, with about one-third supported by the NSF.[123]

The testimony of Dr. Kinzel, as head of the National Academy of Engineering, that there was a lack of engineering fellowships from the NSF [124] brought a detailed response from Dr. Haworth during his concluding appearance before the subcommittee.

Dr. Haworth emphasized that among the total of all fellowships, the number of engineers that received fellowships was virtually in the same proportion as the NSF average for all applicants. He quoted a figure of 24.7 percent for engineers who apply for fellowships in comparison with the NSF average of 24.3 as evidence that there was no discrimination for or against engineers, which there should not be because "* * * we do award these fellowships on merit, without relationship to field." [125]

Secondly, in terms of total awards, about 40 percent of all NSF predoctoral fellowships and traineeships go to engineers, even though

[121] Hearings, p. 56.
[122] Hearings, vol. II, question 12 to Dr. Walker, p. 1342
[123] Hearings, p. 57.
[124] Hearings, 402.
[125] Hearings, p. 764.

only 31 percent of all graduate students are engineers. In other words, Dr. Haworth continued, the engineers, if anything, are getting more than a proportionate number of such awards. So, he concluded, that there certainly was, in his opinion, "* * * no failure on the part of the National Science Foundation to recognize the need for student support among the engineers." [126]

It is clear that the NSF is acting to encourage graduate engineering education. What is not as clear, however, is the basis for the NSF's decision to dilute the effect of the traineeship program by substantially reducing the number of opportunities for engineering students during the second year of this program. An answer to this question must extend to the larger question of the extent of the Foundation's responsibility for meeting the national goals for graduate education of engineers, and also the goals for mathematicians and physical scientists. Since the overall picture will not be complete until estimates are made for the life sciences, the social sciences and for technicians, the subcommittee assumes that estimates for these latter needs will soon be made. As these other needs become known, it may be desirable for the Foundation to extend its training programs for scientific and technical manpower to help fill urgent national requirements.

It should be remembered that the national goals of the PSAC's Gilliland report were *national* goals, not goals for the Federal Government, or for any one specific agency. Therefore, there is still no yardstick or standard with which to measure the NSF's share of higher engineering education. As for undergraduate engineering education, unless the number of undergraduate degrees is substantially increased, it is not evident that public and private need can be met, and at the same time provide men to enter advanced professional study. This in turn leads to the question of whether the Office of Education or the National Science Foundation should have basic responsibility for fostering the undergraduate study of engineering. According to the testimony, the Foundation sees itself as primarily concerned with graduate education in engineering, presumably leaving to others matters of undergraduate study.

It appears to the subcommittee that the Office of Education and the Foundation should present a joint plan for attaining the goals of the Gilliland report for engineering, mathematical and physical sciences manpower, taking into account relevant fellowship programs of the National Aeronautics and Space Administration, the National Institutes of Health, and the Atomic Energy Commission, and covering *both* undergraduate and graduate students. This would be a step preliminary to follow-on identification of manpower goals for the other sciences.

(b) Public understanding

> A democratic citizenry today must understand science in order to have a wide and intelligent democratic participation in many national decisions. Such decisions are being made now. They cannot be postponed for twenty years while we are improving our present educational system so that its products will constitute a significant fraction of the mature voting population * * *.

Thus, the President's Science Advisory Committee expressed itself more than 6 years ago in its report "Education for the Age of

[126] Hearings, p. 765.

Science." [127] The intervening years since 1959 have underscored the importance of public understanding. During the year of this PSAC report, the National Science Foundation decided to approach the general adult public through mass media—newspapers, magazines, radio and television—as the most effective first step.

To do this it chose an indirect route of helping reporters, science writers and editors to improve the science content of their work. The President's Commission on National Goals in 1960 also laid out a requirement of public understanding if effective democratic decisions are to be made about social and political problems with strong scientific overtones, and the "disastrous gap * * * opened up between the thinking of the relatively small body of scientists as contrasted with the beliefs, attitudes, and activities of the rest of our culture * * *." [128]

The public understanding program began in fiscal year 1960 at a level of $316,501, and has continued since at a level not exceeding $500,000. NSF requested $400,000 for fiscal year 1966 included, as part of its science education program, for conferences between scientists and science writers and reporters; educational materials such as television films and study materials for group discussions and science exhibits; lectures and seminars for the general public. Because other sources of funds were becoming available for conference activities, the Foundation proposed to shift some of these funds to a new approach—assistance to colleges and universities in starting courses about the impact of science on society and the role of science in government. Such courses would be aimed at nonscience students and should help produce a leavening of citizens with understanding of science in modern society.

The annual funding of NSF public understanding activities thus far is a minute part of its budget, about 0.3 percent of the science education program request for fiscal year 1966 and less than 0.1 percent of the total request. In past years, Dr. Waterman did attempt to increase it, requesting $1 million for fiscal year 1962, but the increase was denied. The House Appropriations Subcommittee for the 87th Congress opened its discussion of this request with the question: "Is this not a program we can get along without?" [129]

Chairman Seaborg of the Atomic Energy Commission made several specific suggestions including: [130]

> A serious attempt to explain to the public the ultimate benefit to society from scientific and technological developments.
>
> Better literature on opportunities for careers in science and education.
>
> Encouragement for the study of the history of science.
>
> Conferences and institutes at which faculty of arts and sciences can join with people from business, industry, and government to exchange ideas on the nature of big science and its impact on society.

In the opinion of the subcommittee the scale of the public understanding program deserves future attention to see whether it is too

[127] "Education for the Age of Science," statement by the President's Science Advisory Committee, the White House, May 24, 1959, p. 21.

[128] Quoted in "Independent Offices Appropriations for Fiscal Year 1962," hearings before the subcommittee of the House Appropriations Committee, 87th Cong., 1st sess., 1961, p. 518.

[129] "Independent Offices Appropriations for Fiscal Year 1962," hearings before the Subcommittee of the House Committee on Appropriations, 87th Cong., 1st sess., 1961, p. 518.

[130] Hearings, vol. 2, Seaborg question 22, p. 1181.

small. A level representing about 1 percent of the science education program would not seem excessive.

7. Science information

As Dr. William T. Knox [131] testified, representing the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology, "a modern, healthy, information system is as vital to the health of the overall scientific and technological programs of this country as a healthy circulation system is vital to a healthy human being." [132] This thought, of course, has circulated in the executive branch and within the Congress for many years and is a strong reason why much has been expected of the National Science Foundation in improving the science information for the country.

The Foundation, however, has not carried out a principal part of the information task assigned to it: the coordination of the science information activities of the several departments and agencies. As a result, this function had to be assumed by the Federal Council and its Committee on Scientific and Technical Information and by the Office of Science and Technology. The Foundation still has a residual function of coordinating Federal science information with activities of non-Federal organizations, but even here COSATI seems to be the focal point. At present it seems that NSF is only one of many Federal agencies active in science information and, in terms of money and size of operations, it is a junior member. Meanwhile a decision is in the offing about possible assignment to an existing Federal agency of increased responsibilities for top-level planning and coordination of the present complex of individual information systems that make up a real, but still amorphous national network. According to Dr. Knox, the Foundation will be a serious contender for this kind o responsibility.[133]

(a) The national science information network

The great increase in Federal spending for research and development has naturally led to a great increase in the reporting of new data and information about accomplishments and work in progress. Much of this information is in the form of reports written by the scientists in charge and distributed through Federal information systems. There is an increasing interchange of reports among these systems and to private science information systems. Out of this interchange appears to be emerging a loosely knit relationship, which has been compared to a grouping of independent telephone companies that are interconnected—only in this case the present individual information systems lack the common technical and procedural standards of our many telephone systems.

The Federal part of the national information network consists of the several Federal agencies with strong science and technology programs. The scale of operations for Federal science-technology information is estimated at about $380 million for fiscal year 1966 [134] of which the NSF's estimated obligations is $18.4 million.

The subcommittee notes, however, that of the four recent additions to the Federal part of the national information network, two are

[131] Dr. William T. Knox, member of the Office of Science and Technology and Chairman of the Committee on Scientific and Technical Information of the Federal Council on Science and Technology.
[132] Hearings, p. 585.
[133] Hearings, p. 597.
[134] See Hearings, p. 589.

funded by the NSF.[135] These two, the Science Information Exchange and the National Referral Center for Science and Technology, have heavy responsibilities for providing information to non-Federal users. Although the Foundation has no large program to supply information resulting from its own activities (and it is this service-type activity that accounts for most of the activities of the other agencies), NSF is in the forefront of those agencies engaged in bringing the results of Federal research and development to those in the private world who can make good use of it.

(*b*) *Interagency coordination*

For years Congress has been interested in scientific and technical information and its desire for a more effective, coordinated system has been frequently expressed. Congressional opinion following the launching of Sputnik in late 1957 was highly favorable to a single agency undertaking the coordinating function. The analysis of the proposed Science and Technology Act of 1958 issued by the Senate Committee on Government Operations [136] is a good example of this interest. That same year, on December 7, 1958, the President, upon the recommendation of his Science Advisory Committee, directed the NSF to take the lead "in bringing about effective coordination of the various scientific information activities within the Federal Government." The preference for coordinating the activities of the individual agencies into one coherent network for Federal scientific and technical information has been predominant ever since.

Details about the Foundation's partial success in this function, the appearance of COSATI, and the final shift of coordination to OST following Reorganization Act No. 2 of 1962 can be found in the testimony of Dr. Haworth, Dr. Hornig, and Dr. Knox, and also in the review report.

The Foundation did try to carry out the coordinating function. Its Office of Science Information Service was engaged in certain pressing problems such as translation of foreign reports, and establishment of a national policy for payment of page charges for publication of papers in scientific journals. However, it did not succeed in bringing about a coordinated interagency approach to major matters such as the dissemination of reports from Federal research and development. In retrospect, it seems the Foundation was given a job bigger than it could do without continuing visible support by the Chief Executive. As a small newcomer, it simply did not have authority and influence of its own great enough to change the well-established activities of the large, mission-oriented agencies. In a world where money talks, it lacked the weight of a large operating budget for information and was outclassed in scale and scope by the information programs of the Department of Defense, the Atomic Energy Commission, NASA and others. Furthermore, it lacked powers of direction and had to rely instead upon persuasion and example. Also other agencies were legitimately constrained, or took refuge in, the diversity of statutes dealing with the acquisition and dissemination of information relating to their missions.

[135] The other two are the Clearinghouse for Federal Scientific and Technical Information and the National Standard Reference Data System, both operated by the Department of Commerce. See Hearings, pp. 592–593.

[136] Science and Technology Act of 1958: Analysis and summary prepared by the staff and submitted to the Senate Committee on Government Operations on S. 3126, Committee on Government Operations, 85th Cong., 2d sess., 1958 (committee print).

It did not go unnoticed that this testimony focused mainly upon COSATI and what it is doing, with little attention to the Foundation. Perhaps this attitude indicates COSATI already is persuaded against expanding the coordinating responsibilities of the Foundation and, of returning to it some of the functions originally intended for it by the Congress. It is hoped that this is not the case—pending a persuasive study which uncovers solid evidence of the advantages of placing this function elsewhere.

(c) *Residual role of the NSF*

The hearings threw further light on the shift of the coordinating function from the Foundation to COSATI and the OST. In answering a related question, Dr. Haworth quoted from the exchange between him and Dr. Hornig early in 1964 about this function. Dr. Haworth agreed with the recommendation of COSATI that—[137]

> * * * under the intent of Reorganization Act No. 2, the Office of Science and Technology should provide leadership in effecting cooperation and coordination among Federal agencies with respect to their scientific and technical information activities. The National Science Foundation will, of course, assist the Office of Science and Technology in those areas where the Foundation has particular responsibilities.
>
> I consider one of the Foundation's primary responsibilities to be that of providing leadership in effecting cooperation and coordination among non-Federal scientific and technical information services and organizations toward the end of developing adequate systems for the collection, organization, and dissemination of information. Also, the Foundation has a major responsibility in developing adequate relationships between Federal and non-Federal scientific activities.

Dr. Hornig replied, writing in part:

> I fully concur with your views and support the concept that the National Science Foundation shall provide leadership in effecting cooperation and coordination among non-Federal scientific and technical information services and organizations, and in developing adequate relationships between Federal and non-Federal scientific activities.

As for the OST's new functions, he went on to say:

> The Office of Science and Technology, with the assistance of the Federal Council for Science and Technology, shall provide overall leadership of all Federal scientific and technical activities, including the above * * *.

On the other hand, Dr. Knox in testifying mentioned the early recognition by COSATI of the "importance of continuing dialogs with representatives of the various components of the complex of information systems" and identified COSATI as the mechanism for the Federal Government. But, he went on, for non-Federal scientific and technical information activities *there is no such mechanism.* It was a COSATI task group, not the NSF, that met with top level representatives of scientific and engineering societies, industrial and trade associations, the technical and business press, and library groups.

[137] Hearings, vol. II, NSF question G-1.

This seems to suggest that COSATI may be taking on some of the NSF's "major responsibility in developing adequate relationships between Federal and non-Federal scientific activities" mentioned by Dr. Haworth and concurred in by Dr. Hornig.[138]

On December 8, 1965, well after the subcommittee had concluded its analysis of the testimony, the Office of Science and Technology released the COSATI "Recommendations for National Document Handling Systems in Science and Technology." These recommendations were sent for review to Federal organizations and groups concerned with science and technology. Dr. Hornig has emphasized the advisory nature of the report.

The recommendations appear to give the OST an operating function in science and technological information, for they propose that the OST, in collaboration with other agencies undertake to:

1. Develop a comprehensive coordinated program for insuring the acquiring, cataloging, and announcing of the significant worldwide scientific and technical literature. The establishment of one or more national libraries * * * should be considered as elements of the integrated national network.

2. Develop policies concerning the legislative bases for document and information services in or sponsored by the departments and agencies.

3. Propose or endorse legislation necessary to enable departments and agencies to assume responsibility for insuring effective information and document-handling services in agreed-upon areas of science and technology.

In addition, the report recommended that OST, in collaboration with appropriate Federal agencies, *should encourage the private sector* to formulate document-handling plans and programs for its consideration * * * in the development of the integrated national network.

The subcommittee notes that the responsibilities for working with the private sector—which appeared to be the primary responsibility of the Foundation—would be focused in the OST. This seems at odds with the exchange of correspondence between Dr. Hornig and Dr. Haworth, noted earlier. In addition, nothing is said about the responsibility of the Foundation for sponsoring research in science nformation. It would appear that these recommendations of COSATI merit the further attention of this subcommittee, as do the functions and responsibilities of the statutory Science Information Council which serves NSF in the information field.

(*d*) *What of the future?*

Dr. Seitz, speaking for the National Academy of Sciences, saw that NSF could be a major coordinator of scientific and technical information. His opinion is shared by the subcommittee which sees important operating and research functions for the NSF. Strengthening of the Science Information Exchange won consistent support from witnesses, while the National Referral Center appears to be performing a function that will become more valuable as the State Technical Services Act of 1965 stimulates private interest in applications of research and development. To improve the ultimate effectiveness of present and future systems, the Foundation should continue its support of basic research and education in the information process.

The Foundation foresees an increasing pressure for exploitation and practical application of new knowledge, techniques and equipment resulting from its information research programs to information systems. If the anticipated efforts by organizations serving the

[138] See hearings, p. 593.

communities of physicists, engineers and other disciplines materializes as expected by the NSF, its present funding level will be far from sufficient to satisfy the implied requirements. As non-Federal organizations become greater users of Federal scientific and technical information, the Congress ultimately may have to decide to what degree which parts of the evolving information network are appropriate Federal responsibilities and which are appropriate private enterprise responsibilities. Congress will be looking to the Foundation for workable arrangements with the non-Federal systems to encourage operations and financing so that they will become strong enough to avoid complete dependence on the Federal programs. Congress also will be interested in measures to indicate the quality of information contained in the national information network and to reduce low quality or superfluous information that seems to clutter present systems.

8. The balance-wheel function

At a time when NSF testifies that it cannot support all the worthwhile research proposed to it, and that the projects it does select often are approved at budgets and terms less than requested, the Foundation nonetheless must assume a responsibility that will impose great future financial strains upon it. This responsibility is that of becoming the Federal balance wheel, for scientific research. That is to say, the Foundation, having identified national needs for science and the intentions of other agencies, has a responsibility to compensate for any disparity in level of support or allocations among different fields of science. This function does not appear in the Foundation's organic legislation, nor has it been specifically approved by the Congress. However, it is recognized by the subcommittee. Chairman Miller of the full committee also has spoken of the Foundation as "* * * a most important balance wheel in our national scientific and technological effect." [139]

Because the balance-wheel concept implies a long-term, continuing increase in appropriations for the Foundation, the workings and implications of this idea merit careful attention.

(a) Origins of an idea

An early delineation of the balance-wheel function appears in the President's budget message of January 25, 1965. The President said in part:

> I also propose to expand present programs of support for academic research and science education. In 1966, expenditures by the National Science Foundation will increase by 25 percent, primarily to help provide an adequate rate of growth in Federal support for basic research in universities.[140]

The subcommittee itself in posing the questions to the National Academy of Science that led to its report "Basic Research and National Goals," sought to elicit, among other things, yardsticks that could be employed to assess the balance of the NSF programs in size and distribution.

The Academy's response supported a growth in NSF funds. Although there was little agreement on details among the NAS papers in the report, a minimum annual growth rate in *total* support of basic research of about 15 percent emerged a strong recommendation.

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[139] Hearings, p. 2.

[140] Budget of the United States, Fiscal Year 1966—Message from the President of the United States (H. Doc. 15). *Congressional Record* (daily ed.), v. 111, Jan. 25, 1965, p. 1074.

While no quantitative data was advanced to support this figure, a 15-percent annual increase was judged, in two reports, to be the minimum to provide support for all highly qualified scientists and to meet expanding educational needs. It was not clear in the NAS report, and subsequent testimony did not clarify this point, to what base should the 15 percent apply. Should the total Federal budget for basic research increase 15 percent yearly, or only that part spent on campus, or only the smaller part relating to little science? What base should be used for the proposed annual increase? Should it include "big science" as well as little science? How would the increment be used each year? Would it be distributed by geographical location, by field of science, by type of institutions? Questions such as these remain to be answered.

As for the NSF, the NAS report suggested the possibility of expanding its budget to the point that it could serve effectively as the "balance wheel," or even the main "umbrella" of support of basic research in the physical sciences. This possibility, the report points out, involves a major political decision.[141]

The discussion in the NAS report of allocation of support among fields, according to the summary, did not provide sufficient basis for the formulation of a balanced answer to the second question of the House committee about distribution of funds among fields of science.

There was allusion, however, to a "deep financial crises" in the physical sciences (the biological sciences being proportionately better supported through NIH).

Emergence of the balance-wheel concept should be no surprise. The Foundation has endeavored since its origin to improve its analytical capabilities to diagnose gaps and uneven distribution of scientific effort. Neither sound methodology, nor criteria for support have yet been perfected, and the Foundation seems to have tacitly adopted the philosophy that its response should reflect the free play of the scientific marketplace of ideas; i.e., letting the individual scientists, collectively, decide what is important, and then endeavor to support approximately the same fraction of proposals in all fields. Another way of putting this is that the Foundation responds to "proposal pressure," seeking and allocating its financial resources in response to the number and quality of proposals submitted from different fields of science. Dr. Brooks, commenting both as a National Science Board member and as a participant in the NAS Committee on Science and Public Policy study, said proposal pressure is still the best measure of relative needs and should continue as primary, although not the sole basis of judgment in allocation of funds for basic research grants.

The balance-wheel concept received considerable attention this year. In testifying before the Independent Offices Subcommittee of the House Appropriations Committee, in connection with the

[141] The Academy's report suggested two courses to furnish the increased support believed necessary for basic research. The first was that mission-oriented agencies devote a larger part of their budgets to basic research. The second proposed the balance-wheel function for the Foundation. The report said:

"The second course, which by no means excludes the first, is to make the National Science Foundation a much larger agency than it now is—so large that it can eventually become the 'balance wheel,' or even the main 'umbrella,' for the support of basic research—especially in the physical sciences—that is too remote to merit support from the mission-oriented agencies. Such a specific policy with respect to the future growth of the National Science Foundation involves a major political decision by Congress and by the executive branch, as formidable and far-reaching as its decision has been with respect to expansion of the National Institutes of Health" ("Basic Research and National Goals." A report to the Committee on Science and Astronautics, U.S. House of Representatives, by the National Academy of Sciences. March 1965, pp. 23–24).

fiscal year 1966 budget, Dr. Haworth described the balance-wheel function in the following terms: [142]

> Through the Foundation there are opportunities for experimentation and for novel approaches. *In relation to the total Federal effort in support of science, the Foundation could be likened to a balance wheel in a conventional timekeeping device.* [Emphasis supplied.] We have the statutory authority necessary to assure the balance and the continuity of scientific progress. As a minimum requirement the Foundation should, in my opinion, (*a*) provide extensive support for broad areas of scientific interest, including research support, training, and specialized facilities as appropriate; (*b*) provide a substantial component of the total Federal support of basic research projects in colleges and universities (i.e., 25 percent or more); (*c*) provide a comparable fraction of the student support for graduate and postgraduate training of scientists and engineers; and (*d*) provide resources for training and education programs at all levels, with emphasis on innovation and on improving quality on a broad scale through concentrated efforts, as in the curriculum improvement and teacher training programs.

The balance between the Foundation and other agencies was the point of Dr. Wiesner's testimony that the NSF's share of basic research support is probably too small.[143] He expanded this balancing idea later, noting that as several mission-oriented agencies found it necessary or desirable to restrict the growth of their basic research support, the fields which they had traditionally supported had been pinched. As examples he cited the Navy Department's inability to meet growing needs of oceanographic research and the leveling off of AEC support of research in chemistry. Whenever this happens, he continued—

> * * * the NSF should be directed to assume the responsibility for providing that margin of funding needed to insure that support for the particular branch of science is adequate.[144]

This might be done as part of the budget process. The OST and the Bureau of the Budget might prepare a summary of Government support planned for the various scientific disciplines. These figures could be compared with the NSF's estimate of the overall need in each area. Then the NSF could be charged with the responsibility of insuring that adequate funds were available for each.[145] Dr. Thomas F. Bates, assistant and science adviser to the Secretary of Interior, treated the concept in detail in his testimony, making the points that more funding, better communications, and realistic, management-type decisions would be required.[146]

Other witnesses testified in favor of this concept, especially Dr. Hornig. He identified major problems lying ahead for the Foundation that definitely relate to the balance wheel function. Essential

[142] "Independent Offices Appropriations for 1966." Hearings before a subcommittee of the House Committee on Appropriations, p. 573.
[143] Hearings, p. 665.
[144] Hearings, vol. II, answer to question 6 to Dr. Wiesner, p. 1374.
[145] *Ibid.*
[146] Hearings, vol. II, questions 12 and 15 to Dr. Bates, pp. 1358–1360.

parts of these problems were to determine, on a geographical basis, the distribution of facilities for scientific research and education which are needed to meet social and economic needs of regions as well as the Nation as a whole; to determine how support should be allocated among universities to meet regional needs while at the same time assuring that high quality in academic research is not only maintained but enhanced and expanded; to develop methods to choose meaningfully among the growing number of opportunities for further research; and to use research to meet the growing needs of our society for answers to questions which we now believe should be solved by national action.[147] He also identified the study by the President's Science Advisory Committee of rational guidelines for academic research, for its growth and choice among fields for support, and the relation of the many Federal agencies involved.

Dr. Philip Handler, Vice Chairman of the Board, in appearing with Dr. Haworth before a Senate Appropriations subcommittee to seek restoration of a cut in the fiscal year 1966 NSF budget, stated that Dr. Hornig had been "very instrumental" in introducing into the NSF budget a substantial increase in funds for general research grants. He then made three basic arguments for restoration of the funds:

> The first of these was the fact that this is a portion of the budget which ties itself to graduate education, and as necessary for the research aspects of that education also be increased.
>
> Secondly, there is a very simple fact that the cost of doing business in any given aspect of science continues to increase every year * * *.
>
> Finally, there is the fact that there was the real intent on the part of Dr. Hornig and the President's Science Advisory Committee which is shared by the membership of this Board that the Foundation should really contribute substantially to the overall support of science by the Federal Government. *It should be the balance wheel in this entire enterprise* and in order to do so, so that it may properly look after the vitality of each area of science, it is necessary that it assume a rather substantial fraction of the total Federal support of science and this year in which support of science by the Department of Defense is beginning to diminish, this would appear to be the proper time to do it.[148] [149]

In his concluding appearance before the subcommittee, Dr. Haworth clarified the role of the Foundation as gap filler, calling for an active, anticipatory role. He said:

> Now I would rather describe NSF's relationship with the basic research and support of education of other agencies by saying that we should take every advantage of what they can do, rather than by saying, "We are going to be here as a sort of service of supply and they are going to be the fighting troops; we are going to be the reserves and just fill in the gaps where they appear in the line." I think we should be in the

[147] Hearings, vol. II, question 1 to Dr. Hornig, p 1101.
[148] Independent Offices Appropriations, 1966, hearing before a subcommittee of the Senate Appropriations Committee, pp. 565-566.
[149] Emphasis supplied.

> forefront, but we should take account of all the capabilities and support that the other agencies can give and are giving, rather than say we are just the fillers-in.[150]

It appears to the subcommittee that, through executive action, the Foundation already is beginning to act as a balance wheel. While, as noted before, this idea seems attractive, it is by no means certain that the details and the full ramifications of this idea are fully understood within either the executive branch or the Congress. For this reason, the subcommittee reaffirms its intention of oversight in regard to the working of the NSF as a balance wheel.

(*b*) *Funding the balance wheel*

If the Foundation indeed is to be a balance wheel, NSF must have criteria with which to judge the balance and funds to bring it to the desired balance point.

The funds can be taken from other NSF programs—which was not thought desirable by the witnesses—or by increasing NSF funds. The reports submitted to and testimony heard by the subcommittee all talked of an annual increase of 15 percent, but were not consistent about the base to which the 15 percent applied, and for how long the growth should continue. Should the 15 percent apply to the entire NSF budget, to the basic research grants alone, or to the national research program and national laboratory programs? Should it apply to all Federal scientific research, to Federal basic research only, or to Federal basic research at academic institutions?

Dr. Haworth in presenting the idea to a House Appropriations subcommittee specified 15 percent of total Federal academic research, with the NSF balancing any shortfall of other agency programs. He said:

> Hence, it is estimated that in fiscal year 1966 an overall increase of about 15 percent in total Federal support for research at academic institutions will be needed merely to maintain a constant relative level of research activity in those institutions—to hold our own so to speak. A substantial part of this increase will be provided by Federal agencies that have specific missions to perform. However, the decisions of these agencies with respect to the support of academic research are made with primary reference to their mission requirements rather than to the needs of colleges and universities as such. Inspection of the budgets being proposed for fiscal year 1966 by these agencies provide for somewhat less than the desired 15-percent increase in the support of academic research. Because of the Foundation's responsibility for the strength of basic science and for science education, the Office of Science and Technology and the Bureau of the Budget proposed, and the President adopted the concept that the Foundation's budget for academic research should be sufficiently large to assure the necessary 15-percent increase in overall Federal support. Hence the rather large increase in our request for basic research project funds.[151]

[150] Hearings, p. 578.
[151] Hearings, Independent Offices Appropriations, House of Representatives, 89th Cong., 1st sess., 1965, p. 574.

Dr. Kistiakowsky, in his paper in "Basic Research and National Goals," argued for 15 percent overall annual growth for "little science" [152] for the next 5 to 10 years. The way he proposed to do this was to:

> * * * set the research budgets of the National Science Foundation so as to allow for budgetary trends in other agencies and thus to insure the overall growth of "little science" that has been decided upon. At the same time, the mission-oriented agencies should be discouraged from abandoning basic research, since otherwise the Federal system will become too centralized.[153]

Dr. Carl Kaysen in his paper in this NAS report proposed that basic research be treated as an overhead cost of mission R. & D. set at about 9 percent of the total R. & D. expenditures and with 55 percent of the funds from Federal sources.[154]

This subcommittee heard three reasons from Dr. Haworth why increasing support is needed: [155]

> Many first-rate scientists are not now adequately supported to permit them to reach their full effectiveness;
>
> Support must be provided for increasing numbers of faculty members and graduate students as academic institutions expand their enrollments. This is estimated at 8 to 10 percent per year, for many years to come.
>
> The cost of research per scientist continually increases, primarily because of the growing complexity of research requiring the use of more expensive equipment and additional staff. This annual increase in cost per scientist is estimated at some 5 to 7 percent.

These estimates combined into an overall annual increase of 15 percent or more "* * * merely to maintain a constant relative level of research effort in those institutions * * *." On this basis, Dr. Haworth estimated that Federal basic research support at universities would reach nearly $2.5 billion in 10 years, and that NSF support would grow from about $130 million to a little under $540 million by 1975—just about equal to the *total* present Federal funding for academic research.[156]

The manner in which OST factored this increase into the NSF's budget request for fiscal year 1966 was explained in detail and summarized as follows by Dr. Hornig: [157]

> I hope that the Congress will recognize that the National Science Foundation must perform all "balance wheel" function in maintaining a steady and healthy overall growth in American science and science education, taking into consideration other sources of support.
>
> To accomplish this task it will be necessary to increase the NSF's fraction of total Federal support in the universities substantially above the fraction in past years. If, as now seems likely, this increase in the National Science Foundation's fiscal year 1966 budget is not granted by the Congress and the academic research budgets of other agencies are cut, the 10 percent more graduate students in science, who will

[152] "Basic Research and National Goals," p. 180.
[153] *Ibid.*, p. 181.
[154] *Ibid.*, p. 154.
[155] Hearings, p. 88.
[156] Hearings, p. 89.
[157] Hearings, p. 115.

be there next year will not be as well supported as their predecessors.

(c) Using the 15 percent

Although the Federal witnesses were prepared to support the 15-percent increase—annually, or for at least 1 year—not much was heard about the specific uses to which the additional funds would be put. Would they simply be spread evenly across existing NSF support of basic research—thereby preserving present patterns and distributions, and freezing out entry of new fields of science? Dr. Haworth, in reply to a specific question, said he had no basis for saying that the distribution of support among the various fields and disciplines of academic science is likely to be very different in the next few years from what is it now. Its distribution will be determined by the interests of the faculties at the universities, and these are not likely to change very rapidly.

(d) Appraisal and evaluation

Although it is convenient to think of an NSF balance-wheel function as mechanical, responding automatically and impartially to changes without the fallibilities of human judgment, the facts of life demand that the NSF, if it is to act as a balance wheel, and if it is to take the positive approach called for by Dr. Haworth, must make judgments about the basic research of other agencies, and about the state and relative needs of different fields of science. For the Foundation to function effectively, it must be privy to the planning and budgeting of other agencies for academic research.

But the history to date of the Foundation's authority to evaluate Federal research casts some doubt upon its ability to carry out this part of the balance.

It may be that the authority to evaluate Federal scientific research programs should be reassessed, at least for Federal research in colleges and universities. As a minimum, the NSF should make definite plans to appraise periodically the various fields and disciplines of science, bringing to bear the best collective judgment of the academic community to identify newly emerging fields in need of support. Serving as a lens to focus the judgment of the scientific community could be one of the most important things that the NAS's Committee on Science and Public Policy, and similar groups, could do. Equally important is identification of fields which have benefited from past NSF and other Federal support, but which are past the peak of new discoveries and progress.

(1) *Evaluation of other agency programs.*—The National Science Foundation Act of 1960 authorized and directed the Foundation to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups.[158] This function, however, was never undertaken. As Dr. Waterman took pains to emphasize during his testimony, the Foundation "should be *aware* of what basic research is going on in other agencies and complement that by its own program," but it could not and should not attempt to "evaluate and supervise their programs." [159] Dr. Waterman summed up his position on the matter as follows: [160]

[158] 42 U.S.C. 1862.
[159] Hearings, p. 148.
[160] *Ibid.*

> * * * At the very beginning, when I was asked if I would serve as Director I wanted that clarified, because I do not think it would be proper for an agency on the same level as other agencies to attempt to evaluate and supervise their programs. This leads to a division of authority. Practical agencies have reasons for doing basic research that would not be the Foundation's reasons, and I did not think, and still do not, that this kind of evaluation is a desirable thing for the NSF to attempt.

It is this kind of evaluation which was taken from the Foundation by Reorganization Plan No. 2 of 1962. President Kennedy explained why the evaluations had not been made, saying, in his transmittal of the plan to Congress, that—[161]

> The National Science Foundation has proved to be an effective instrument for administering sizable programs in support of basic research and education in the sciences and has set an example for other agencies through the administration of its own programs. *However, the Foundation, being at the same organizational level as other agencies, cannot satisfactorily coordinate Federal science policies or evaluate programs of other agencies.* [Italic supplied.] Science policies, transcending agency lines, need to be coordinated and shaped at the level of the Executive Office of the President drawing upon many resources both within and outside of Government. Similarly, staff efforts at that higher level are required for the evaluation of Government programs in science and technology.

Accordingly, the evaluation function was transferred to the Director of the Office of Science and Technology. When questioned about this transfer, Dr. Wiesner elaborated: [162]

> * * * I think the Science Foundation was initially given responsibilities to do things which we later concluded it should not have been asked to do. That is to have the coordinating responsibility over areas that are the responsibility of other departments of the Government. This is the role, which, as an operating agency, as a funding agency, we concluded it could not really play. It can play an advisory role, a statistical-gathering role, a leadership role, but it cannot play the kind of Government-wide decision making and coordinating role that was originally visualized for it.

When the subcommittee, in pursuing the matter further, inquired how the OST could make evaluations in view of its limited staff, Dr. Hornig admitted that although there was no desire for the OST to become a "new bureaucracy," a somewhat larger staff and organization than at present was needed.[163] He referred to the recent evaluation of the National Institutes of Health by the Woolridge committee as an example of appraisal of Federal research and development. Without detracting from the work of this NIH Study Committee, it may be noted that its membership included no one from the OST, or from any other Federal department or agency. This reliance upon temporary, ad hoc groups which have no responsibility for implement-

[161] Reorganization Plan No. 2 of 1962. H. Doc. No. 372, 87th Cong., 2d sess., pp. 2-3.
[162] Hearings, p. 667.
[163] Hearings, p. 108.

ing their recommendations, does not seem likely to strengthen the ability of the executive branch to appraise and assess the health of the Federal scientific effort. It would seem that the National Science Board should be a useful repository for a Federal capability for such appraisal.

Independent committees, such as the Woolridge committee, have a very important job of providing an independent insight and viewpoint from the scientific community, but they should not be the only instrument for appraisal. A continuing, in-house Federal capability is necessary so that the government can test the conclusions and recommendations of independent studies against its own experience, and maintain continuity of judgments, ideas, and personnel from study and appraisal through ultimate disposition of the recommendations. As far as basic research is concerned, an input from NSF should be sought and given prime consideration.

On the other hand, as Dr. Hornig pointed out, the reorganization plan left with the Foundation its statutory responsibility for *correlating its* scientific research programs with those undertaken by individuals and by public and private research groups,[164] thus preserving for it room to take the initiative in fitting and meshing its programs with the research interests of the academic community.

(2) *Evaluation of basic research.*—The second kind of evaluation—the assessment of the needs of basic research in various fields of science—appeared to the witnesses, and to the subcommittee, to be a proper concern for the National Science Foundation, both now and in the future. It is in this role that the Foundation can assume a gap-filling function. Dr. Waterman elaborated on this point: [165]

> * * * the Foundation should find out what is going on in other agencies in the support of basic research by fields of science—physics, chemistry, mathematics, biology, etc. Then if one puts together the agency programs in the field of physics, in the field of chemistry, and so on, one can by means of existing advisory committees and with the help of the National Academy, if desired, survey these and evaluate them as Federal programs in science. That is a very different matter from trying to criticize agency programs as such.

Although he recognized that the Foundation could fulfill this function only with the cooperation of other agencies, he saw no need for a "new mechanism" in order to get a complete picture of science, but only "closer attention to an existing one."

9. Science policy planning

As a supplier of the principal statistical data about financial and manpower resources for research and development, and with whatever remains of its science policy formulation responsibility, the Foundation remains strategically placed to initiate and help shape and form national science policies. The subcommittee is mindful of the definite steps taken by the Foundation to provide input of data and ideas and interpretations on the basis of which both the NSF and other agencies can base their plans and programs for science. However, these steps have been halting and slow, sometimes directed more toward the academic interests of the researchers than toward the

[164] Hearings, p. 107.
[165] Hearings, p. 148.

needs of national policy, and do not reflect the priority among NSF activities that is necessary.

NSF should do more to establish and promote interagency standards for collection of such data and to assert itself in the coordination of statistical information collected by other agencies relating to science resources. It should allocate more of its resources to collecting data, and especially to analyzing it and tailoring it to needs of policymaking.

The growing function of the Foundation as a balance wheel or gap filler for the national scientific effort will require new analyzing to indicate what the Foundation itself might do to influence that balance, and where and how other agencies may be involved.

As for pursuit of national science policy, it appears that the OST was obliged to move to fill a vacuum which occured when the Foundation was not able to fill the policy role originally intended for it by Congress. The splintering of Federal responsibility for national science policy caused in part by Reorganization Plan No. 2 has further weakened the ability of the Foundation and the National Science Board to become leaders in national science policy.

It is the view of the subcommittee that the Foundation is now well enough established and of sufficient size and importance to resume a responsibility to develop and encourage the pursuit of national policy for promotion of basic research and education in the sciences.

This role should be reasserted. It should be reasserted both to restore to the Foundation some of the functions assigned to it by the Congress and, still more important, to give the Foundation greater responsibility for national policy concerned with resources for scientific research—whether basic or applied—in terms of the needs of industry and government as well as the academic community.

(*a*) *Statistics for science policy*

As the uses of its statistical data about research and development continue to expand, the Foundation will have to pioneer further, finding ways to better digest and organize the output of its collections and those of other agencies, and to present this information in forms readily usable.

The testimony of Dr. Dael Wolfle, Executive Director of the American Association for the Advancement of Science, presented a compact and detailed discussion of the statistical information furnished by the Foundation. According to Dr. Wolfle, those who use these statistics are indebted to the Foundation for the amount and detail of information now available that was not to be found a dozen years ago. However, these users are not satisfied. They would like to have more information, in greater detail, sooner. He cited four reasons for dissatisfaction with NSF statistical information:

> First, the questions that can be asked will always outrun the information available. There are always new questions to be thought up.
>
> Second, neither NSF nor any other agency can possibly ask for all the information that someone may wish to have tabulated. Restraint in collection is necessary both for economy with NSF funds and to avoid needless diversions of time and effort within the scientific and technological communities to filling out frequent long questionnaires.
>
> Third, some of the questions of particular interest deal with future trends and require projections based on assumptions which cannot be always forecast accurately.

Fourth, NSF publication of finances and manpower usually report the situation several years after the fact.

These reasons indicate an awakening to the possible uses for good information about the Nation's science resources of money and manpower, and are a call for more of a good thing—with improvements.

To meet these four points, Dr. Wolfle recommended: the gathering and publishing statistics be given a higher priority, or present performance be accepted without further complaint; and reduction of delays by using data processing equipment or methods of higher speed and capacity.[166]

On the other hand, Dr. Bowen C. Dees of the National Science Foundation,[167] emphasized his feeling that the Foundation had done all it should have done, or perhaps all it could have done with the resources available to it. As for increasing these resources, he recalled past cuts made by Congress because "many of these studies are of doubtful value and should be curtailed." [168] This attitude he attributed in part to the relatively poor job done by the NSF in selling the need for this kind of information.[169]

National Science Board member Dr. Harvey Brooks observed that statistics never satisfy everyone because each user wants them for a different purpose. He said there is still no general agreement either within the Board or within OST as to what statistics are most relevant and useful for policymaking. This leaves the Foundation in the position of trying to outguess a policymaker's future desires for information—particularly when the policymaker himself isn't quite sure of what he wants.[170]

Dr. Brooks reported that improvement of the NSF's compilation and analysis of statistics was under discussion between OST and the National Science Board and that improving them is a matter of constant feedback between user and producer.[171] It would seem at this late date that there should be more understanding and agreement about the purposes, content, and details of the Foundation's data-gathering and analysis.

(*b*) *Manpower information*

The strengthening of the NSF's responsibility and functions dealing with manpower statistics and analysis was probed by the subcommittee, for it has been increasingly aware that planning of major technological projects involving scientists and engineers requires the "budgeting" of manpower as well as funds. Future decisions for short term and long range scientific and technological ventures will depend more and more upon the matching of manpower supplies and requirements both for quantity and quality. The timely and effective planning of these undertakings in turn requires reliable, complete manpower information as a base for early steps to educate and train the scientists and engineers required.

Many agencies contribute to and draw upon the national pool of scientists and engineers. Government-wide statistics and studies are needed if we are to have the benefits of flexible, coordinate, but decentralized decisionmaking within a frame of central policy.

166 Hearings, pp. 174–175.
167 Dr. Bowen C. Dees, Associate Director (Planning), NSF.
168 Hearings, p. 698.
169 *Ibid.*
170 Hearings, Vol. II, question No. 15 to Dr. Brooks, pp. 1237–1238.
171 *Ibid.*

NSF continues to be the appropriate agency to collect a wide variety of manpower data and to interpret it as source material for plans and programs of Federal agencies. To do this intelligently NSF must strive to anticipate the questions for which statistics are required and the relationships which must be established between different elements of data.

The need for a sophisticated, coordinated approach to manpower information for science and technology with the Foundation in a pivotal position was recognized last year by the House Select Committee on Government Research, and was the subject of comment in the PSAC report, "Meeting Manpower Needs in Science and Technology" and explicit recommendations in the Academy's report, "Toward Better Utilization of Scientific and Engineering Talent: A Program for Action" (the Killian Report).

To throw further light on the present manpower situation, the statistical problems involved and the part played by the Foundation in the scheme of things, the subcommittee invited six leaders in manpower studies to meet with it in a seminar. Dr. Killian took this opportunity to repeat his recommendation of his NAS report that a single agency or office have the responsibility and authority for coordinating the various Federal information activities on scientific and technical manpower. He wanted more interpretations and projections, and information to explain the decline in degrees awarded in engineering from 10 percent in 1958–59 to 7.5 percent in 1962–63, and to assess the convertibility of scientific and technical manpower from defense and space to civilian uses. Dr. M. H. Trytten, of the NAS's Office of Scientific Personnel, called for more study in depth of manpower. He believed the NSF's data collecting activities are so demanding that it has little opportunity to study what the statistics mean. Thus he favored Dr. Wolfle's proposal and proposed that NSF pick up the future support of the Commission on Human Resources, presently privately financed at the Academy. He also was concerned about the need for information about quality as well as quantity of manpower.

The testimony of Dr. Wolfle and Dr. Brooks and their answers to supplementary questions are pertinent to the Foundation's manpower functions and deserve close attention. In particular, Dr. Wolfle's recommendation that the NSF study the feasibility of collecting information to show the flow of scientific and technological manpower, and his recommendation to establish a new organization for science manpower studies, deserves close attention. He proposed an agency, which might be patterned after the Institute for Defense Analysis of the Department of Defense or the RAND Corporation of the Air Force, to interpret, synthesize, criticize, and improve methodology of scientific manpower studies. While the NSF's charter seem broad enough to encompass direct NSF studies of this kind, Dr. Wolfle thought the Foundation had not done so sufficiently because of three countervailing pressures: [172]

> Priority had to be given to its regular publication of basic statistical series such as "Federal Funds for Research, Development, and Other Scientific Activities," and to analysis of the National Register of Scientific and Technical

[172] Hearings, vol. II, question No. 1 to Dr. Wolfle, pp. 1143-1144.

Personnel, and to tabulating data for congressional committees, the OST and other Government agencies.

Personnel ceilings.

Insufficient congressional interest in, or support for, such an expansion. Strengthening the capability of the Foundation to move deeper into methodological and analytical work will require either additional funds or a curtailment of other Foundation activities.

A separate organization presumably would be protected from these pressures and could pursue the proposed objectives with less distraction and diversion, leaving the handling of day-to-day problems with the Foundation. However, if NSF has been unable to get the funds and manpower to do this itself, it would face difficulties in obtaining funds to contract this function.

The subcommittee recognizes the attractive features of an independent organization, but it is reluctant to see capabilities so important to formulation of national policy established on the outside. To do so might aggravate a trend of siphoning the best men out of government, thereby reducing the quality of government operations.

Authority for coordinating the various agency activities in collecting and analyzing data on scientific and technical manpower remains as important as ever, and the subcommittee welcomes the support given to this concept last year by the House Select Committee on Government Research.[173]

The testimony received by the subcommittee, which is illustrated in part by these few highlights, supports the opinion that a strong and current system is needed for collecting and analyzing statistics about scientific and technical manpower. At present, neither the Foundation, nor the Office of Science and Technology, nor the President's Manpower Committee is doing the needed job. The NSF appears to be the appropriate agency to pull together information about scientific and technical manpower from the many sources in government and to put it into useful, analyzed form. But it cannot do so unless fully supported by the OST and the agencies. One way to obtain this support might be through the creation of a new committee of the Federal Council for Science and Technology, chaired by the NSF, together with the backing of the Director of OST.

10. Science and foreign policy

National foreign policy recognizes the Nation's scientific activities as an important element in foreign relations. Yet the role of the NSF is still to be crystallized. The NSF has been and continues to be involved in international scientific undertakings. From Dr. Haworth's standpoint, there are four areas of international science activity which are or could be the basis for NSF programs:

International cooperative research programs, such as the International Geophysical Year, the Antarctic Research Program, or the International Indian Ocean Expedition;

Purchase from abroad of research services unavailable here, or that can be done better there;

[173] The Select Committee recommended that:

"* * * a single agency be given specific responsibility and authority for coordinating the various efforts of the Federal agencies to provide an adequate and continuing body of information on scientific and technical manpower * * *."

Manpower for Research and Development, study No. II, report of the Select Committee on Government Research to the House of Representatives, 88th Cong., 2d sess., 1964. H. Rept. 1907, p. 70.

Support of science and science education in developing countries; and

Support of science activities abroad to promote American foreign policy objectives.

Each of these areas must be considered on its own merits in terms of whether or not it should be properly a Foundation activity and if so, what the extent of the involvement should be.

That the Foundation may need guidance was suggested by Dr. Haworth's testimony which indicated that although the international role of the Foundation has been discussed a great deal, no definite conclusions concerning it have yet been reached.

The testimony to the subcommittee generally favored an expansion of the Foundation's international scientific functions. Although some witnesses believed such activity should be related to the foreign policy objectives, others favored limiting the Foundation scientific activities abroad to fulfilling research needs which could not be satisfied domestically.

In addition to its modest unilateral funding of science abroad, the Foundation has been important in the coordination and funding of international cooperative research programs. The International Geophysical Year, the Antarctic research program, the International Indian Ocean Expedition, the International Years of the Quiet Sun, and the International Upper Mantle Project—all illustrate international undertakings open to participation by Federal agencies through NSF leadership as the "delegated agent" to coordinate and handle the financial aspects of United States participation.

Commitments for these research programs have been substantial. For the International Geophysical Year Congress appropriated a total of $43.5 million, excluding extensive technical and logistics support. For the continuing Antarctic Research Program, funds obligated by the Foundation have ranged from $5 to $8 million annually since fiscal year 1960. Annual funding of the International Indian Ocean Expedition has varied from $1.4 to $4.9 million. As for the International Upper Mantle Project, the total agency cost for the 3-year program was estimated to be approximately $31 million.

The International Indian Ocean Expedition raised two questions that relate generally to international undertakings. First, what was the coordinating function of the Foundation vis-a-vis those of the Federal Council on Science and Technology and its Interagency Committee on Oceanography? Second, how much responsibility has the NSF assumed to assure that participating U.S. scientists report their findings and data to the World data bank? More information on both points seems desirable.

Congressional appropriations were made specifically for the International Geophysical Year apart from the Foundation's annual budget. It is significant, however, that subsequent research programs have been included directly in the Foundation's appropriations. This poses a possible problem. Once a commitment has been made to fund such a program, the NSF is obliged to honor the commitment even if it has to take funds from other programs.

There are signs that the Foundation will soon be involved in two more international cooperative programs—the International Biological Program, and observations of the total solar eclipse in South America in November 1966.

The first mention of Foundation involvement in the International Biological Program, a potentially major study of the biological basis of productivity and human welfare arising out of concern with the "population explosion," appeared in the NSF's budget request for fiscal year 1966. No special funds were requested. The estimated costs of approximately $500,000 for fiscal year 1966 were to come from project research funds for environmental and systematic biology. Later information from the Foundation indicated that special budgetary treatment (akin to that for national research programs) may be needed in fiscal year 1968 at which time the International Biology Program would become fully operational. The National Academy of Sciences has received funds from the National Institutes of Health and from the Foundation for planning the program. U.S. subcommittees, paralleling the seven international subcommittees, have been appointed and representatives from the State Department, the Departments of the Interior and Agriculture, NIH, ONR, AEC, NASA, OST, as well as the Foundation have been observers at meetings called by the Academy. However, it is understood that no one agency has yet been assigned the overall responsibility for the International Biological Program.

As for the role of the Foundation in coordinating Federal agency activities for observation of the total solar eclipse in South America, on November 12, 1966, little more is known than that the Foundation has been designated to do so by the Federal Council for Science and Technology.

While the NSF's present charter does not extend to the support of science and science education in developing countries, there may be some reasons to consider this. Dr. Haworth posed the question: [174]

> * * * Should we, other things being equal, support some science in some place where our foreign policy objectives would be helped, even though we could get it done just as well at home.

He went on to say:

> I think this is a question that would be fruitful for Congress to think about—how the objectives of science and the objectives of foreign policy can be combined effectively and appropriately. [175]

Whatever the ultimate outcome of this question, there remain two substantial reasons for continuing participation of the Foundation in international scientific activities. One is the NSF's positive mission to foster the interchange of scientific information among scientists in the United States and foreign countries. The other is the success of the Foundation in international scientific undertakings. Indeed, considering the trend of some apparatus for basic research to become more and more expensive—particle accelerators and experimental equipment for high energy physics is a good example—it would be desirable for the Foundation to study and report on the feasibility of United States initiative to encourage international construction and operation of major research facilities for selected fields of basic research.

[174] Hearings, p. 788.
[175] *Ibid.*

The international nature of science together with the high repute of the NSF abroad and the reasons mentioned above suggest the possibility that the Foundation should have a greater role in representing American science within the community of nations. Perhaps NSF could provide the equivalent of a roving ambassador for science, and provide the scientific attachés to embassies and consulates at foreign centers of scientific activity. Such a step could strengthen and augment the scientific capabilities of our diplomatic staff abroad, while making service as scientific attachés more attractive to scientists in government, universities and industry.

To develop one aspect of the idea of NSF science attachés, the subcommittee requested information about experience of the AEC with the staffing of its six foreign offices. The information about the functions of these offices, their relation to the State Department, the staffing of them, the advantages and disadvantages of using agency staff, all appear to show the idea is practicable.[176] The AEC experience also indicates a positive benefit to Federal agencies that assign staff to foreign offices during some part of their careers.

An alternative which could preserve the present identification of science attachés with the State Department while strengthening their capabilities might be for the Foundation to assume the responsibility for supplying well-qualified candidates, and for supplying the information needed by the attachés in their work and analyzing information obtained by them.

On the whole, the subcommittee believes the Foundation's responsibilities relating to international science can be served considerably better through the expanded use of science attachés closely identified with the State Department, selected, funded by the Foundation and directly linked to its science information activities.

The importance of science as an element of international relations seems to be approaching a point where the Government will have to review Federal scientific activities abroad and decide how these should be related to national foreign policy. The subcommittee believes the Foundation and other Federal agencies with scientific interests abroad need guidance so that they can fulfill their missions to the advantage of American science and our international goals and relations.

[176] For details see the memorandum from the Atomic Energy Commission in vol. II, app. 8, of the hearing.

CHAPTER IV

The Congressional View

Reviewing the National Science Foundation's 15-year history has heightened the subcommittee's appreciation of the still to be developed potentialities for congressional leadership in identifying and specifying national goals for and overseeing our research and development programs. It is aware of arguments that would limit the Congress to a passive role because only the executive branch has the means of dealing with so complex a subject. However, the past hearings have reaffirmed the subcommittee in its view that few of the issues and problems of science and technology which come before the public are purely scientific or technical. Instead, the issues appear largely as value judgments, choices between alternative goals, selection and specification of objectives, assessment of effects of past policies and programs, and evaluations of performance and administration. Forming judgments about such matters is well within the competence of Congress and is important to the preservation of the vitality of our Constitutional system.

Thus the subcommittee expects congressional interest in Federal research and development to continue to increase.

In keeping with this trend, a better understanding by Congress of NSF objectives and programs will be necessary in the future. Individual members are interested in and perhaps are concerned about the rising trend of the Foundation's budget. This concern sometimes has appeared in the singling out of individual NSF projects as examples of questionable or unnecessary Federal spending. Congressman Boland remarked on this during recent budget hearings, saying:[1]

> I do not know of a year we have not had this budget on the floor that someone does not start to get into some of the programs and projects of the National Science Foundation on the basis of ridicule.

In keeping with the theme that awareness of public aspects of science and technology is a leading responsibility of the Committee on Science and Astronautics, the subcommittee intends to make further inquiries, from time to time, into various aspects of the Foundation's activities and also into those of other departments and agencies whose programs affect the condition of our national resources of knowledge, funds, and manpower for science and technology.

CONGRESS AND NATIONAL SCIENCE POLICY

Within a single generation, science and technology have so permeated our society and economy that there remains scarcely a part of the Federal Government not profoundly influenced and affected by

[1] "Independent Offices Appropriations for 1966." Hearings before the House Subcommittee on Appropriations, p. 565.

Federal research and development. With this change has come a congressional involvement with science that has increased markedly from year to year. Today almost every committee of both the House and the Senate is concerned with science and technology, albeit in varying degrees. Legislative committees whose interests are *primarily* scientific include the House Committee on Science and Astronautics, the Senate Committee on Aeronautical and Space Sciences, and the Joint Committee on Atomic Energy, A quick look at the jurisdictions of other committees reveals scientific and technological interests of the Joint Committee on Economics; the House Committees on Agriculture, Armed Services, Education and Labor, Foreign Affairs, Government Operations, Interstate and Foreign Commerce, Judiciary, Merchant Marine and Fisheries, and Post Office and Civil Service, and the Senate Committees on Agriculture and Forestry, Armed Services, Commerce, Foreign Relations, Government Operations, Judiciary, and Labor and Public Welfare.[2] These scientific interests generally are a part, not the whole, of the committees' jurisdictions. Furthermore, most of the committees confine themselves to after-the-fact reviews. Except for those committees which participate in advance planning through exercised authorization functions, most others have confined themselves largely to ad hoc investigations of specific aspects of Federal research and development which limit their opportunities to lead in shaping national science policies. At present, the programs of the Atomic Energy Commission; the National Aeronautics and Space Administration; the Department of Defense for procurement of aircraft, missiles, and ships, and for research and development; the Arms Control and Disarmament Agency and foreign aid require annual authorization.

The Appropriations Committees of the House and the Senate have a special sort of role and their influence and impact is of a different kind. They are strategically placed to influence important aspects of policies and programs for science and also in prescribing specific limitations as well.

In the Senate, the continuing interest of the Government Operations Committee in science information is well known, as is also its interest in a Commission on Science and Technology. It was the Subcommittee on National Policy Machinery of that Committee which is credited with the suggestions for reorganizing scientific activities in the Executive Office which resulted in the establishment of the Office of Science and Technology. A few months ago, in August, the Committee on Government Operations announed appointment of a Special Subcommittee on Government Research to conduct studies and hearings into the operations of Federal research and development programs.

In the Senate also, the Select Committee on Small Business held extensive hearings on the role and effect of technology in the nation's economy during 1963. Recently, during May and June 1965, the Employment and Manpower Subcommittee of the Senate Labor and Public Welfare Committee held hearings on the impact on national scientific and technical manpower of Federal research and development policies.

[2] For further details, see U.S. National Science Foundation. Federal organizations for scientific activities, 1962. Washington, U.S. Govt. Print. Off., 1963, 598 pages. At pp. 557–563.

Recommendations from congressional studies that Congress acquire its own scientific staff led to the establishment of a Science Policy Research Division within the Legislative Reference Service of the Library of Congress.

The fragmentation of Federal science among the Committees of Congress poses a problem of congressional management of its own affairs so that it can give better attention to the whole of Federal scientific activities. Despite this fragmentation, members and committees of Congress are beginning to ask probing questions about the purposes and policies of Federal science. The intention is not so much to take over the policy initiative for scientific research as it is to assure that someone within the executive branch should seize the initiative and do it well and thoroughly.

Some of the questions likely to be pursued in Congress include:

What indications are there of a broad strategy for science in public affairs?

What framework is there for considering the effect of science and technology in regard to the national economy and the development of policy concerning it?

How can issues of Federal research and development be identified before they reach the crisis stage? How can executive accountability for Federal research be improved?

Is sufficient attention being given to setting priorities for choice among different possibilities for Federal basic research?

How can Congress satisfy itself that scientific activities which cut across agency lines are in balance and are effectively coordinated?

What are the facts about concentration of Federal research funds in certain institutions and areas of the country, and what are the implications?

Should the executive branch, through the Office of Science and Technology, prepare an annual report on the substance, organization, costs, goals, problems, and progress of science and technology? This might be a strategy document similar to the Economic Report of the President, and could be complemented by evaluations from the National Science Board and the Foundation on the Nation's resources for science.

Concern over these and other questions has been reflected in recent congressional activities. In the House the principal expressions of this concern have included the studies of this subcommittee, the establishment of the Select Committee on Government Research, the subsequent designation of a Government Operations Subcommittee on Research and Technical Programs, and the introduction of H.R. 15 and H.R. 5609 in the last Congress. The proposal in these bills to create a Commission on Science and Technology is a clear expression of congressional interest in the effectiveness of government programs, organization, and operations for scientific and technological research.

The appointment of a Subcommittee on Research and Development by its Armed Services Committee, of a similar subcommittee of the Government Operations Committee, and the introduction of S. 1136 as a companion bill to H.R. 5609 are corresponding examples of senatorial concern.

This growing congressional activity shows a readiness to come to grips with the problems and issues of government research and development. In fulfilling its legislative role of setting national policies,

Congress should exert strong leadership as it formulates fundamental objectives to be set before the departments and agencies. Consonant with this should be greater congressional attention to setting the national policies for development of the manpower and institutions necessary for future national research undertakings.

LEGISLATIVE OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION

Through the first 15 years of its history, the Foundation has received attention of several committees of the Congress. In the House, the Committee on Interstate and Foreign Commerce had jurisdiction for the NSF until 1958 when this responsibility was assumed by the House Committee on Science and Astronautics. The establishment of this Subcommittee on Science, Research, and Development in 1963 provided the base for the present review of the Foundation. In the Senate, the Committee on Labor and Public Welfare has had continuing jurisdiction.

As an indication of the range of total congressional interest in the Foundation, the NSF Director has appeared before at least nine committees of the House, eight of the Senate, and two congressional joint committees. The subjects of these hearings have ranged from NSF organization to radioactive fallout and its effect upon man.

The published record of the Independent Offices appropriations subcommittee hearings show the scrutiny of NSF programs and activities by the Appropriations Committees of each House. These hearings reveal matters of concern to the Congress such as management of research programs, funding of expensive facilities and concentration of research funds and fellowship grants. While the Appropriations Subcommittees do not determine what research and development should be done by agencies appearing before them, they can and do question and change budget allocations for specific programs. For example, the House Appropriations Committee in its report on the independent offices appropriation bill for fiscal year 1964 approved only $323,200,000 of the $589 million requested for the Foundation, and recommended against expending funds for any of the new programs proposed in the 1964 budget estimate. This action clearly disapproved the Foundation's initial request for funds to begin its science development program. In the Senate, apprehension about Project Mohole reached a point where its Appropriations Committee reported in 1963:

> Such a diversity of scientific and engineering opinion has been presented to the Committee on Project Mohole that it is obvious that construction of the large drilling platform at this time would be unwise. The committee therefore *directs* that no planning, research, or construction funds leading to such platform be expended until more data is available to this committee upon which it can base a more informed judgment.[3]

That same year, the Subcommittee on Oceanography of the House Committee on Merchant Marine and Fisheries held 7 days of hearings on the NSF's Mohole project. The comprehensive testimony taken from many interested parties provided a valuable state-of-the-art report on the project and elicited a number of previously un-

[3] Independent Offices Appropriation Bill, 1964. S. Rept. 641, 88th Cong., 1st sess., p. 21.

disclosed details. When Mr. Mosher, as a new committee member, inquired about the role of the committee in reviewing the project he received the following reply from Chairman Lennon:

> That is a ponderable. I would say we are sitting here now as a sort of oversight committee, having in some degree participated in this and other oceanographic objectives since coming into existence. We have no authorization authority as such. The money was appropriated through the Independent Offices Appropriations Committee for this contract. It is rather unfortunate, perhaps, that we do not have a legislative committee with the authorizing authority for such projects.[4]

As the Foundation's budget approaches the half-billion dollar mark and as it funds an extending panoply of grants and contracts for basic research, institutional support, science education, national research programs, international research programs, and NSF national laboratories, we find Congress somewhat apprehensive about the control and accountability for such large public outlays. The Foundation's budget may meet future resistance unless its program objectives are clearly stated and related to one another, and its program management is strengthened. For its part, Congress may have to give more attention to the formulation, funding and performance of NSF programs if an undesirable, unstable cycle of budget spurts and cutbacks is to be avoided.

LONG-TERM COMMITMENTS

The growing expenditures for the NSF's national research centers and the possibilities that other centers may be founded in the future, and the growth of big science projects such as Mohole give rise to a congressional desire for a stronger ability by the Foundation for the control of expensive facilities and installations. In particular, it would be desirable for the Foundation to periodically review the original reasons for establishing individual laboratories and major projects in comparison with their present functions and operations, and to assess their productivity of significant new knowledge in science. The subcommittee agrees with the viewpoint that national laboratories should not continue their existence indefinitely without good reason, and hopes that the Foundation shares this view.

Related to the future of existing NSF national laboratories is the question of establishing new ones. If and when new installations are proposed, it is not sufficient merely to establish the scientific need for them. Better initial insight into the duration and likely cumulative amount of government commitment should be provided. The prospective life cycle of the installation should also be outlined, showing the expected periods of rapid growth, steady state and ultimate cutting back of operations so that the Congress will be better informed on the possible extent of the future commitment for support implied in authorization and/or funding before proceeding with a new undertaking.

[4] "Mohole Project". Hearings before the Subcommittee on Oceanography of the House Committee on Merchant Marine and Fisheries, 88th Cong., 1st. sess., p. 54.

INFORMATION FOR CONGRESS

The discussion in chapter III about information for policy making and the related material in the Subcommittee's review report confirm that public decisions about science and technology require a firm base of timely and reliable information. Congress looks to the Foundation to support its requests with studies that present and analyze information about research and development, and their impacts upon the society and the economy. The increasing stream of reports from the Foundation is expected to contain more interpretive evaluation of projected needs so that the meaning and value of the basic data can better be appreciated. Information relating science and technology to broad public purposes is particularly to be desired.

The subcommittee notes that no studies were submitted by the Foundation during the hearings in support of the proposed annual 15-percent increase in Federal funds for academic research. It would seem that so important a concept would need backing by a systematic presentation and interpretation of supporting data. Likewise, no detailed study was available on the financial implications of the balance-wheel concept for the NSF, even though it was the basis for the NSF's budget request for fiscal year 1966.

It is hoped that the Foundation will provide more information in its future dealings with the Congress. It is part of the Foundation's responsibility to support its requests with reliable, quantitative and explanatory studies so that the pertinent committees of Congress and individual members have information to arrive at decisions concerning the support for these requests. As the Foundation's budget increases, a correspondingly increased effort must be made to collect and analyze data to show the relation of increased expenditures to the national interest.

A second need of Congress is for pertinent and up-to-date information about the total Federal funding of research and development activities. The NSF's series of reports on Federal funds for research and development are very useful in this respect, particularly since NSF lately has issued them with more current information. Congress looks to the Foundation for this and other data to make meaningful comparisons of past activities and as a basis for forming expectations of the future. As indicated earlier, better information is needed on quality as well as quantity of scientific manpower, the nation's most valuable resource.

Finally, Congress looks to the Foundation as the logical source for special studies and reviews of major problem areas. The subcommittee has requested and obtained this type of assistance on many occasions. One of the most noteworthy was the Foundation's major study, "Obligations for Research and Development and R&D Plant, by Geographic Divisions and States, by Selected Federal Agencies, Fiscal Years 1961–64"; others include the reports this year on the state of science education in the United States.

CHAPTER V

Emerging Role of the National Science Foundation

The Subcommittee on Science, Research and Development undertook its review of the National Science Foundation in the expectation of gaining a better understanding of the emerging shape of its future. With the benefit of the information and opinions expressed in the testimony, it seems evident that the Foundation's responsibilities and programs 10 years hence are apt to be significantly different from those of today. While it will continue to respond to the interests of the scientific community as expressed in studies and in individual proposals, the NSF also will assume an active leadership in developing national resources for science. It will seek to identify and to help meet the requirements for scientific knowledge, trained manpower, and specialized facilities brought together in new or strengthened centers of academic excellence. Dr. Haworth sees the Foundation leading sciences into wholly new channels of experimentation in the national interest. Problems in engineering and social sciences, as well as in the physical and biological sciences, await the impetus of NSF identification and support, with interdisciplinary studies becoming an important element in the future application of science resources to meeting national needs and to solving national problems of the 1970's.

SOME SPECIFIC THOUGHTS

As a result of the subcommittee's inquiry some fairly definite indications of future activities of the National Science Foundation have begun to take form.

1. Academic research

It seems certain that in the years ahead the NSF will become a mainstay of basic research at colleges and universities. It will have greatly expanded responsibilities for funding, for fostering new fields and disciplines of science, and relating them to the national interests.

(a) Funding academic research

As the Nation, its economy and its manpower resources continue to grow, a corresponding growth of Federal support for academic research seems certain. Science faculties are expanding as more young people are attracted to science. How much they, in turn, will be able to contribute to our national resources for science will depend upon their future opportunities to work with scientists and, later, to do research of their own. Academic research should continue to increase, but at what rate is not clear. The proposed annual growth of 15 percent for government-sponsored academic research represents an exponential growth which would mean a doubling of the budget every 5 to 6 years. The next few years should produce clarification

87-071 O - 68 - 21

of both the desirable growth rate and its duration. If the mission oriented agencies can increase their funds for academic research at a rate that matches the Foundation's, NSF need concern itself only with its own basic research program. However, if, as may be more likely, mission agency appropriations for basic academic research do not rise this rapidly, or reach a plateau, or even fall off, then the Foundation may be expected to fund this "shortfall." Given the latter, the Foundation probably would have to increase its academic research to levels substantially above the present—with a stronger voice in Federal science affairs as a natural concomitant. While one would not expect the annual increase to go on without limit, it may be necessary for NSF funds in the future to account for as much as half of all Federal funds for academic research.

Just as the early research grants and contracts of the NSF and other agencies were supported in part because they helped to train scientists, the funds of the Office of Education flowing to higher education may also support some scientific research as a means of educating scientists. It will be interesting to see to what extent this may occur. Such a trend could be particularly important to the future of small colleges in science education.

(*b*) *Balancing*

Using the Foundation as a balance wheel can open the way to novel ideas in Federal research administration, to new opportunities and responsibilities for the scientific community, and to innovations for interaction between the scientists and government. If the Foundation obtains the funds to carry out this function, it will have to pioneer new ways and means to judge the health of American science, to evaluate the state of specific scientific disciplines and to determine how NSF funding should be distributed and adjusted among various fields of science. All of these judgments, in turn, can be expected to call for substantial advice from the scientific disciplines in relating science to national needs.

As indicated above, the balance wheel function will require planned distribution of NSF funds among different disciplines and institutions, supplementing proposal pressure with deliberation and weighing the relevance of fields of research to the national interests. Making the balance wheel concept work while preserving the high quality research projects will require of the Foundation a high order of scientific statesmanship. It will also open up new possibilities for the National Academy of Sciences and the National Academy of Engineering in giving voice to the views of the scientific and technological communities of the Nation.

(*c*) *"Big Science"*

The subcommittee sees the Foundation continuing to support large-scale undertakings for basic research such as its national laboratories. In doing so, the NSF should acquire a program administration capability comparable to those of NASA and the AEC. This will be particularly important for Project Mohole as it moves into construction and operation.

But future NSF commitments for new Big Science projects seem vague. All that Dr. Haworth forecast was construction of facilities for ground-based astronomy.[1] No advanced plans were mentioned for

[1] Hearings, p. 785.

other fields of science. Nonetheless, the subcommittee will be surprised if the NSF's laboratories by 1975 are not increased in number and size. As for providing or replacing computers at colleges and universities, NSF involvement is likely to be more of a purchasing operation than the organization and construction of a big new project. The total impact of NSF big science activities will demand a strengthened top management to assure firm direction or control and to relieve the Director and the Board from excessive preoccupation with details.

(*d*) *Social science*

Despite the risks of possible unfavorable reactions to research into human behavior, the Foundation seems destined to become a more important sponsor of social science. The present preoccupation of NSF funded social science research with quantitative measurement will come into a better balance with the interpretation of this data and its significance. Assuming a continuing expansion of world population, the inevitable reduction in living space and the continuing impacts of new applications of science and technology will make it even more essential that knowledge of human behavior be quickly increased.

(*e*) *Engineering*

The Foundation's support of engineering research can be expected to continue and expand. The further investigation of ways to apply systems engineering to large, complex projects, and to pioneering engineering for applications of new scientific discoveries will increase in importance as more public attention turns to the application of the results of scientific research. NSF research in engineering will help provide the vital underpinning for new technologies.

(*f*) *Multidisciplinary studies*

The coming decade should add a new dimension to scientific research by developing the potentialities of the interdisciplinary approach. This will call for innovations in NSF programs, both for basic research grants and for national research programs. Institutional grants in support of multidisciplinary studies may be one effective way to provide the flexibility in planning necessary to take advantage of such an approach.

2. Regional and institutional development

The Foundation should have a unique opportunity to redress some of the imbalance of scientific competence that now exists among parts of the country and their institutions of higher education. Making sure that all parts of the country have an opportunity to develop a fundamental measure of scientific competence will demand imagination and initiative from the Foundation as well as from the States, individually and as regional organizations, and their institutions. Because national resources are limited, future institutional development will have to focus upon those institutions which are willing and able to mobilize and join their resources with those of the Foundation. Institutional development is and should continue to be a joint undertaking.

3. Science education

Support to higher education seems very likely to expand, with many activities of the Office of Education of the Department of Health, Education, and Welfare, paralleling science education activities of the Foundation. The future relations of the Office of Education and the Foundation will bear close watching. If their respective educational programs begin to compete with or unnecessarily duplicate each other, it may be necessary to inquire into some sort of unified program under a single administration.

Supporting graduate and postgraduate education in the sciences and engineering is definitely a future NSF function. To reap the most benefit, the Foundation must organize its programs to attract superior students to those scientific and engineering disciplines which look toward future application of science and technology for both public and private purposes.

4. Application of science

As the output of scientific research continues to increase, the Foundation may become more involved in improving the use of this new knowledge and understanding where the public need is involved but where other Federal agencies have yet to begin their research. One can see the Foundation bridging part of the gap between discovery and application. It may well sponsor further research in selected fields of science to establish a firm base of theoretical and quantitative understanding upon which the technologists can build new applications. Experimental engineering, in particular, will extend to demonstrations that prove the principles of new technologies. Of particular importance will be NSF support of interdisciplinary investigations of the more complex questions of the sciences.

5. Information for science

The subcommittee sees the Foundation with a more active, responsible function for Federal science information. Its research into fundamental processes of science information can be expected to improve the national science information network and to definitely identify the Foundation as a leader in the science of information, both among Federal departments and agencies, and among the non-Federal parts of the network. With increasing competence and extensive relations within the world of science information, the Foundation should become a major element of the impending effort to improve coordination of all the parts of the national information network.

6. International scientific undertakings

The Foundation can be seen as a representative of American science in international scientific undertakings. It has a great potential as principal initiator of American participation in future projects, extending beyond collaborative ventures to include the international construction and operation of facilities for basic research. This capability should be developed and should be given a freedom of action greater than it enjoys today. As suggested above, the subcommittee is especially interested in future NSF initiatives to obtain international support and sharing of costs for large basic research projects. Machines for high-energy physics already have become so large, complex, and expensive to build and to operate that joint ventures appear very

attractive. In fields of science where other agencies have the primary interest, such as the Atomic Energy Commission in high-energy physics, the Foundation could become a catalyst, a broker, an instigator to take advantage of the possibilities of international cooperation. In addition to multilateral savings in costs, such projects could be a powerful means of increasing the dialogue among nations of differing economic and political views.

The Foundation's past experience with international scientific programs has created within it a valuable resource of experience and practical know-how for organizing and carrying out U.S. participation in future ventures. On the other hand, no appreciable expansion of NSF support to individual foreign scientists is expected unless this becomes important to foreign policy and foreign relations.

The very real and valuable competence of the Foundation in science education may well be turned to advantage in those developing countries that are willing and able to mount an effort requisite for full entry into the Scientific Age. The Foundation's future interest in the application of science would be relevant here, for countries seeking to transform themselves into industrial powers must emphasize application of science and technology until they are far enough along in later years to afford basic research.

7. Statistics and information

All of the foregoing must take place within the framework of responsible, representative government. Thus Congress and the public, as well as the executive branch, will continue to require good, reliable, current information about research and development throughout the nation, about the state of the nation's resources for science—particularly manpower, funds and facilities. The Foundation has an important responsibility of pulling together and correlating existing sources of information, developing new ones, and devising methods of analysis and ways of presentation of statistical data so that it is meaningful and useful for national decisions concerning science.

8. Science policy

One more aspect of the Foundation's emerging future is its role in the establishing of national policies for science and technology. This role can be best indicated by stating a few assumptions about the future functions of the Foundation, the National Science Board, the Office of Science and Technology, the President's Science Advisory Committee and the Federal Council on Science and Technology.

All of these are collectively concerned with the creation and application of science and technology, with the OST at the apex of the organizational interrelations.

The Foundation will be concerned with the state of national resources for science, including knowledge, manpower and institutions, with the National Science Board becoming increasingly active in studies that extend beyond the programs of the Foundation. One can see the Board taking on science resource studies of the kind sometimes now handled by PSAC and OST. Hence, the Board can enable them to turn more of their attention to the application of science, to scientific research in mission agencies, and to technology as these affect great national problems. In addition, an annual appraisal of science resources by the National Science Board should

nicely complement a needed annual review by the Office of Science and Technology of the status of applied science and technology. An OST yearly report on the substance, organization, costs, programs, goals, progress of Federal science and technology could be used by the Congress as a basis for annual hearings about the national state of science and technology. By following the example of the Joint Committee on Economics with its annual hearings on the President's Economic Report, the Congress might open the way to better public debate of issues of Government and science. The Federal Council, for its part, could become a more effective means of amplifying departmental collaboration and cooperation with the Foundation in activities affecting science resources and in collecting and analyzing statistical data about them.

As a concluding thought, an aspect of science policy which can be expected to become more active during the coming decade is the interaction between Congress and the executive branch. Much of Federal planning for science ultimately comes to the fundamental questions of who decides what is to be done, where, when and for how much. Each of these questions is and will continue to be well within the boundaries of congressional interests and capabilities. Also likely to receive sustained future attention are the means and incentives to assure strong, positive interdepartmental cooperation and coordination in sciences and technologies that cut across agency jurisdictions.

CHAPTER VI

Conclusions and Recommendations

The review of the National Science Foundation, its functions and operations which the subcommittee has thus far completed reveals a large number of possible recommendations for changing and improving the Foundation's charter. At the same time, many of the possibilities are characterized by such a variety of facets and inherent complexity as to require caution in suggesting their implementation.

Accordingly, the subcommittee is limiting its findings to the following points, each of which the subcommittee believes to be supported by the evidence it has obtained during the past year from both government and non-government sources.

The findings fall into three categories:

Recommendations for changes in the organic act of the Foundation.

Recommendations for alterations in the structure and/or practice of the Foundation's administrative machinery.

Observations which, while not in the form of recommendations, appear germane and worthy of further study and consideration.

AMENDING THE NATIONAL SCIENCE FOUNDATION ACT OF 1950

The subcommittee recommends that the Foundation's organic act be amended so as to—

1. Give the National Science Board (NSB) almost exclusively a policymaking function in its relationship to the National Science Foundation.

This is not to suggest that the Board should become "advisory" in nature. In fact, the change is intended to make the Board more active and operational. It would, as an example, release the Board from current time-consuming requirements that it weigh and decide whether to approve large grants. Thus the Board could concentrate on policy matters which, according to testimony, are proliferating rapidly.[1] At the same time it would lend legal sanction to what is already happening. The trend toward concentrating on policy appears to be a proper one and to be working well, but the subcommittee feels that the Board should have a clear statutory mandate from this point on. This is particularly important since NSB is the only available instrument of its kind, outside the Executive Office of the President, where across-the-board science policy may be considered and made. The development of such capabilities by an independent group in establishing Foundation policies has proved of great value to NSF. In addition, it is noted that this function of the Board could provide an extra input into the deliberations of the President and the

[1] Note that not all executive and administrative functions of the Board would be removed, see 5(a), infra.

Office of Science and Technology (OST) which might be highly illuminating in view of the growth of Government-sponsored scientific research. It is the subcommittee's belief that, if properly utilized, the Board could provide valuable services to the Presidential office in the determination of many phases of Government science policy.

2. Require the Board to make an annual report on the status and health of science and its various disciplines, the report to be made to the Congress via the President.

This procedure would be especially useful to Congress, which has been demonstrating a desire for greater information on the current state of science and technology. It would result in the Congress receiving up to date information on the subject, including national scientific resources and trained manpower, and from a competent source not hitherto used by the legislative branch. Such studies should also include an assessment of basic scientific progress made during the previous year and indicate whether such progress has technological overtones or potential which might be applied to the needs of the American society. A specific date for the submission of this report should, perhaps, be set.

3. Require NSF to evaluate the status and needs of individual science disciplines across the entire scientific spectrum and report to the Board at appropriate intervals.

This would likewise be useful and perhaps necessary in helping the Board carry out its duties mentioned in #2 above. Beyond that, however, it would seem essential if NSF is going to fulfill its role as "balance wheel," since the Foundation must know where the problem areas are. It is not suggested here that NSF make such evaluations entirely by in-house methods. The Foundation should be free to employ, by grant or contract, such consulting services as might be warranted. Finally, this recommendation, if adopted, should help NSF to reacquire some of the stature which Congress intended for it, but which was partially removed through Reorganization Plan No. 2; e.g., the original task of evaluating agency performance with respect to science support and fundamental research.

4. Authorize NSB to delegate policy functions to the Director and/or to the Board's executive committee.

This recommendation is purely in the interests of efficiency—and it is intended only as a permissive authorization. The Board would be able to delegate, if it so desired, but it would not be required to. The subcommittee's inquiry clearly shows that there are times when the Director or an executive committee of the Board should be empowered to exercise this kind of authority.

5(a). Modify the existing authority of NSB with regard to the certification of major grants and programs so that such authority need be exercised only in cases of disapproval.

On all large grants (over $2 million or $500,000 in 1 year) the Board must now consider each grant and approve or disapprove it. The intent here is to leave with the Board the authority to disapprove the grant if it feels such action is necessary—but not retain the requirement of approval on each such grant. The same would apply with regard to major new programs, contracts or operational ac-

tivities of NSF. This is essentially a streamlining sort of proposal, one which should provide greater flexibility of administration.

5(b). Redefine the duties and responsibilities of the Director to give him complete management authority plus authority to approve all grants, subject only to the Board's veto if the latter wishes to exercise that power.

This proposal is intended to increase the administrative stature of the Director, to give him the authority and flexibility he needs for fast and efficient decisions, and to cut down on red tape. At the same time it would take up the slack created by the modification of the Board's authority set out in 5(a). The proposal also would serve notice of congressional desire for improved management practices regarding NSF operations.

6. Provide a small professional staff for the Board, at its option, such staff to be made available by the Director of the Foundation with Board approval.

The Board now has one secretary assigned to it full time. This proposal would permit the appointment of a full time professional for each of the Board's three main working committees and for the executive committee as well. This would mean a professional staff of three or four who would be provided and budgeted for by the Director but assigned full time to the Board. If the Board were dissatisfied with any of the staff assigned, it could arrange for a replacement satisfactory both to the Board and the Director. The subcommittee believes it important not to have two competing or conflicting staffs. The modest scale and method of the recommendation here, however, should avoid that contingency.

7. Authorize the Board and NSF consultants up to $100 per diem for time spent on Foundation business.

Existing statutes on this point seem illogical and inequitable. Many, if not most, non-government persons providing consulting services to the various Federal agencies are paid a per diem of $100. However, members of the NSB are restricted by the Foundation's organic act to $50 per diem—while NSF advisory committee consultants (concerning whom the act makes no mention) are paid $75 per diem. This amendment would simply permit NSB members and other Foundation consultants to be paid at the highest going rate for this type of service.

8. Provide for a Deputy Director and up to four assistant directors appointed by the President and subject to confirmation.

The intent here is to strengthen the Foundation's administration. The plan would give the Director the additional high-level staff assistance he needs in order to delegate authority and get the increasingly difficult jobs of the future done. The subcommittee's interpretation of the original NSF act is that it permitted only a modest delegation of authority. The proposal here would back up recent reorganizational authority regarding the ability to delegate [2] and would emphasize the necessity of doing so. An added factor is that this proposal would enhance the position of the Foundation within the executive family, attract well-qualified personnel, and thus pro-

[2] Reorganization Plan No. 5 of 1965, dated May 27, 1965.

vide NSF with such new and useful administrative tools as may be necessary.

9. Place the Director at the top level so far as independent offices pay scales go. This is Level II. The Director is currently Level III.

Cabinet members are Level I. First deputies are Level II, etc. Some heads of independent offices are also Level II, such as the Chairman of the AEC and the Administrator of NASA. This proposal would place NSF on the NASA–AEC level. Over the past 15 years the Foundation has grown to the point where the Director is entitled to such recognition—and where such status will be necessary in continuing to attract men of high caliber for this position in the future.

10. Replace section 3(a)(9) with a new section authorizing "scientific research"—basic or otherwise—where the public interest is involved; also remove all references to weather modification.

This change would not alter the Foundation's charter to support basic research. It would simply make support of *some* applied research permissive if such research were directed toward a major national problem such as pollution or transportation. There would, however, be no mandatory requirement for this kind of support. Removal of all references to support of weather modification research would similarly leave the present situation intact. NSF could continue the kind of weather research support it has been engaging in—which is primarily basic in nature. But the change would free the administration to reorganize and include weather modification in its new environmental science organization if it wishes.

11. Add the word "social" to section 3(a) (2) and (4).

This proposal would not alter any NSF power or function. It would simply emphasize congressional interest in and desire for increased support in the social sciences.

12. Revise section 3(a)(8) to require the collection, interpretation, and analysis of data on scientific and engineering manpower and provide policy guidance (not direction) to other agencies in this field. Also require maintenance of a current register of scientific personnel.

The present act simply calls for a register. Since NSF legislation was written, there has been an increasing awareness that planning of major technological projects involving scientists and engineers requires the "budgeting" of manpower as well as of funds. Decisions regarding both short- and long-range programs increasingly depend on the estimated match between available and required manpower. Collaterally, when strenuous requirements are anticipated, special steps can be taken for training and education. NSF is the appropriate agency to collect a wide variety of data and to furnish interpretations on the basis of which both NSF and other agencies can establish plans and programs. Emphasis on a *current* register reflects a general belief that the register as developed by NSF tends to be incomplete and out of date. NSF should support this effort with whatever talent and money is necessary to produce a useful manpower-evaluation tool.

13. Include in section 3(a) a requirement to keep data on total Federal research grant money going to individual institutions.

The intent here is to concentrate in one place complete information on how much Federal grant money is going to what institutions and

other contractors for the performance of basic scientific research. Hence it would be possible to determine at a glance the amount of Federal grant money from all Government agencies which may be going to any given private or State institution. The method of carrying out this requirement might best be left to the Foundation. The information desired, however, could be gathered either from Federal agencies or the institutions themselves, or both. In order to make this data meaningful, it seems probable that NSF would also have to include money earmarked for basic research in contracts let by the mission-oriented agencies. A number of Federal departments, including the Defense Department, for example, permit a certain percentage of overhead contained in procurement contracts to be used by the contractor for fundamental research allied to the general purpose of the contract. Such funds run into the millions of dollars, and it would prove highly useful to the Congress as well as the executive to have an up-to-date check on those funds readily available.

14. Repeal section 7. Rather than stipulate organization around particular branches of science, revise this section according to function setting up the following or similar categories:

1. Support of basic research.

2. Support of scientific and technical manpower development—education.

3. Support of institutional development.

4. Support of science information, its collection and dissemination.

The point of this alteration would be to remove present requirements that NSF be organized according to individual science disciplines—such as physics, chemistry, biology, etc. It would permit organization along functional lines, very much in keeping with the manner in which NSF has set up its offices, de facto, for administrative purposes. The enumeration of support lines listed, however, is not intended to imply a limitation to those particular categories.

Internal structuring, as proposed here, would have the advantage of requiring identification of program and budget elements that should permit clearer definition of their scope and relative balance. Such structuring would also facilitate congressional and even Presidential review. Most important, the statement of major function may help clarify the role of the NSF vis-a-vis OST. In concert with item 8 which provides for presidentially appointed Assistant Directors, this proposal should make the responsibility of such individuals clearer.

NONLEGISLATIVE RECOMMENDATIONS

The subcommittee believes that the following recommendations which, while not pointed toward legislative change, should be carefully considered by the parties involved.

The subcommittee recommends:

1. The Congress make use of the NSB so as to receive a continuing view of the direction and health of U.S. science and the development which often follows the emergence of new knowledge.

This, of course, is the other side of the coin of earlier recommendations (particularly No. 2). The same rationale applies. Obviously neither the President nor the Congress can be forced into seeking

advice they do not want. But the Board, if recognized and accepted as the unique and talented body it is, could be a prime source of valuable information and advice to both branches of Government. The mechanisms for its use should not encounter serious difficulties since there is an endless array of possibilities, formal and informal.

2. The NSB hold itself available to advise the President on the status and potential of science and its disciplines, if requested.

This point has also been touched on in the foregoing recommendations for legislative change. However, it needs amplification here. The effect would be to give the Board a second mission, one it is competent to undertake and one which the President's Science Advisory Committee is not particularly designed to fulfill. The recommendation is intended to point up the desirability of the President's having alternative points of view on scientific issues available if he wants them. Since the Board is a continuing body and concerns itself mainly with fundamental research, while PSAC usually functions on an ad hoc basis in regard to specific missions (often of a security nature) the action here suggested need not be duplicative.

3. A stronger representation on the NSB of the nonprofits, industry, small colleges, and the social scientists.

Each of these categories is or has been represented on the 24-member Board. But the Board nonetheless is weighted with physical scientists from the larger universities. It is important that the Foundation not be too closely meshed with the university world. It is a *National* Science Foundation, not a *University* Science Foundation. Contrary to popular concepts, a great deal of basic research is being done in all the categories mentioned. They may well deserve more NSF attention than they are getting.

In addition, the subcommittee believes that it is important to have a balance of Board members who tend to think in terms of broad social issues, rather than in a narrow, specialized scientific way. This is not to say that the present Board does not have such members. It is to suggest that a balance—perhaps a better one than exists at present—is necessary if the voice of *all* the scientific community is to be heard by the Foundation.

4. Improved liaison with the State Department, plus a special NSF committee to work with the Department's Office of International Scientific and Technical Affairs in supporting programs furthering American interests.

Increased stature for this division of the State Department and the development of a positive program for surveying scientific development around the world.

Science attachés who are provided and budgeted by NSF in the same manner that military, commerce, and agriculture attachés are at the present time.

Retraining grants for U.S. nationals who have been abroad for lengthy periods on scientific matters.

Almost without exception witnesses who appeared before the subcommittee were strongly in favor of increased participation by NSF in the international area. The points set out seem self-explanatory. However, it must be noted that some of this recommendation is directed to the State Department and doubtless would require further

hearings before appropriate congressional committees. At the same time the subcommittee, on the basis of its inquiries, to date, senses that a stepped-up, more dynamic role for the Department's international science program would bear dividends. Moreover, if science attachés were provided through NSF, this would seem likely to result not only in budgetary advantages but a flexibility of operations and communications that could prove invaluable.

5. Additional emphasis on institutional and developmental grants, traineeships, etc.

The Foundation is currently displaying a disposition to move in this direction and, of course, the President's recent directives to his Cabinet on the point have added impetus. Nonetheless, in spite of the trend, the ratio between grants of this type and the project-grant has changed little. It is the consensus of the subcommittee that, in order to obtain an optimum effectiveness for the NSF research dollar, a greater effort must be made to bring out the science potential—both teaching and research—in a larger number of institutions. This is not to suggest a downgrading of the project-grant system, which has worked well and proved itself many times over. Nor is it to suggest that the actual number of dollars going into project-grants be reduced because of added emphasis on institutional or developmental grants. What is suggested is that as the Foundation's role expands, a greater proportion of its attention and support be given over to the needs of institutions as such—both large and small in accordance with their individual capabilities. There is, of course, a danger of diluting scientific capability where it now resides unless precautions are taken and careful criteria are worked out to determine the allocation of the research dollar among institutions which will use them well.

6. In connection with the revision of section 7 (of NSF's organic act) efforts should be made to insure top administrative and management personnel.

NSF has had its troubles in dealing effectively with the big operational programs. The subcommittee believes that this is due, in part at least, to the lack of trained and experienced professional management. Difficulties encountered with Project Mohole provide a graphic case in point. After a 3-year study of this plan plus some preliminary drilling, which itself cost nearly $2 million, NSF estimated in 1962 that a 5-year project, exclusive of drilling, would run about $44million. By 1963 this estimate, including 3 years of drilling, was placed at $68 million. Today the estimate, with 3 years of drilling, has reached $110 million and platform construction alone is put at $30 million or about double what NSF planned to spend for it. In addition, the project has been troubled by administrative pulling and hauling, a lack of managerial decisiveness, plus a considerable loss in time and money through lack of adequate engineering evaluation.

Managerial problems have also arisen with NSF-supported educational curriculum studies, the Antarctic program and other operations. They suggest that this recommendation is a valid one. Moreover, the recommendation emphasizes a growing view, in Congress and out, that one does not necessarily have to be a scientist or engineer to be a good administrator in these areas. Modern scientific projects of real size and scope are very complex; and they require unusually skillful managing in order to avoid delay and waste. In light of the

expected expansion of NSF and the need for it to play a variety of roles in the future, it is the view of the subcommittee that managerial improvements will also need to be made as time goes along. Hence it is recommended that the administration pay special heed to this factor—particularly when and if it approves the buildup of higher level staffing for NSF.

OBSERVATIONS

Without making any recommendations in regard thereto, the subcommittee desires to submit the following points for further inquiry and discussion:

1. The appointment and tenure of the NSF Director.

Present law provides that the Director of NSF shall be appointed by the President for a 6-year term unless removed sooner by the President. He may also be reappointed for any number of terms. The question raised here is whether the Foundation might be made more effective by—

(*a*) Having the Director appointed to serve indefinitely at the pleasure of the President.

(*b*) Making the Director's term coincide with that of the President, i.e., every 4 years.

(*c*) Permitting the situation to remain as it is—with no legislative change.

The arguments in favor of either of the first two alternatives are to the effect that they would tend to make the Foundation more responsive to the goals and programs of the administration—and thus more effective in translating new knowledge into benefits for society. Such change might also upgrade the Director with regard to protocol and give him a stronger voice in the administration's official family. Disadvantages include the possibility of placing the Director too far into the political arena in such a way as to impair the objectivity of his scientific judgment. They might further make the Director less responsive to the NSB—or at least place him in an awkward position between the directives of the President and the policy set by the Board. Finally, it can be argued that the scientific community might construe a change along these lines to foreshadow an increasing amount of Federal control over basic research, plus uncertainty as to the consistency of Federal support, and a consequent drop in the quality of research.

2. In order to avoid undue concentration of scientific advice, should members of the Board be prohibited from serving on other Government advisory committees simultaneously—particularly PSAC?

There is a conflict of thinking on this matter also. But it is not a new conflict. Testimony adduced by the subcommittee shows that a great deal of soul-searching, appraisal and reappraisal has been taking place at the top echelons of science and technology concerning it—and for a considerable length of time. From the arguments advanced, it is apparent that there is no easy solution.

Some, for example, believe that, in order to avoid too much inbreeding of science advisers, such a prohibition would be useful. They point out that often the same people are found on the NSB, PSAC, committees of the National Academy of Sciences which

advise the Foundation, and possibly other Government advisory groups. The effect, as they see it, seems to be a combining of the functions of prosecutor, judge and jury in the hands of a few highly placed scientists and engineers, and they doubt if those involved are able to give sufficient time to do a satisfactory job in each capacity. On the other hand, there appears to be merit in the contention that certain advantages exist in having some of the same people serve in several of these capacities—at least insofar as they may tend to improve liaison and become familiar with the overall picture of the government-science endeavor. A further dissent alleges that prohibition of this sort might prevent good people from serving on the Board simply because they would not wish to be automatically excluded from other Federal advisory activity for the 6-year period.

3. Is there an imbalance of NSF funds as between the various scientific disciplines and, further, as between support of research and the support of education, including teaching?

The record on this does not seem to be entirely clear, although the figures provided suggest that there is an imbalance in favor of support of the hard physical sciences. It has been pointed out to the committee that funds going into engineering projects, for example, are at approximately the same level with those of the physical sciences. However, it is noted that the parallel applies only as between engineering and any one of the given categories of the physical sciences. Certainly the support of engineering is relatively small when it is compared with the support of all the physical sciences rather than a single one.

Insofar as the ratio between support of research and support of education is concerned, funds available for research normally are about double those available for education. This may, indeed, be the most productive way of using the Government's science dollar. However, the great and growing importance of science education and the creation of good science teachers suggest that this matter should be given a fresh look.

4. Are the methods of NSF support of teacher training as good as they should be?

There is no question that teacher-training in the sciences has improved greatly in recent years, and much of the credit for this can be traced to the Foundation. The question is, in view of the very strong demands which the future will place upon the effective teaching of science and engineering, can the job be done better? If so, how? These are difficult questions on which all branches of the Federal Government, the States and their teaching institutions, plus the private institutions must join hands to solve.

Meanwhile, the evidence is not conclusive that NSF's summer institutes are as effective as they should be—partly at least because no one has been able to determine if the training received has genuine relevance to the teacher's choice of instructional materials or whether he knows how to put them into effective use. Another question is whether sufficient support is being given to those who might wish to enter the teaching profession *at a time in their career when it would do the most good.* This is said by some experts to be the immediate postgraduate period when prospective teachers are often receptive to a

continuation of their training and are less likely to be economically overburdened.

On a collateral point, the subcommittee is not insensitive to allegations made in the past few years that teaching is suffering because of the preoccupation of many science teachers with research. Without necessarily accepting this view, the subcommittee believes it important to learn more about possible methods which could be used by the Foundation to encourage teaching through the fellowships which NSF supports—and to what extent current methods devised are sufficient or insufficient.

5. Is the Foundation's support of new curricula being carried out in the most effective manner?

Information and data secured by the subcommittee indicate that, so far as science and technology are concerned, both the Foundation and the Office of Education are making commendable progress in developing improved curricula for most educational levels. Efforts along these lines appear to be far in advance of Federal activities, in being or even contemplated, just a few years ago.

Nonetheless, certain problems remain.

Testimony provided the subcommittee, for example, suggests that there is a question as to whether support for development of educational curricula is being adequately administered and fostered. There is the allied question of whether or not competition in the field of curriculum development is as healthy as it should be. At least some of the testimony received indicates that support of curriculum development is being channeled only through a relatively small number of professional organizations or groups. It would thus seem important to scrutinize this phase of the problem more carefully, for certainly it is axiomatic that the development of new educational curricula must not be monopolized by a few. The dangers of the technical and scientific age in which we live would be enhanced many times if this situation should occur or be allowed to remain.

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