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NATIONAL SCIENCE FOUNDATION AUTHORIZATION
ACT FOR FISCAL YEARS 1980 AND 1981

GOVERNMENT

DOCUMENTS

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HEARING
BEFORE THE
SUBCOMMITTEE ON
HEALTH AND SCIENTIFIC RESEARCH
OF THE
COMMITTEE ON
LABOR AND HUMAN RESOURCES
UNITED STATES SENATE

NINETY-SIXTH CONGRESS

FIRST SESSION

ON

S. 527

TO AUTHORIZE APPROPRIATIONS FOR ACTIVITIES FOR THE
NATIONAL SCIENCE FOUNDATION FOR FISCAL YEARS 1980
AND 1981, AND FOR OTHER PURPOSES

MARCH 2, 1979



Printed for the use of the Committee on Labor and Human Resources

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NATIONAL SCIENCE FOUNDATION
AUTHORIZATION ACT FOR FISCAL YEARS 1980
AND 1981

FRIDAY, MARCH 2, 1979

U.S. SENATE,
COMMITTEE ON HUMAN RESOURCES,
SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH,
Washington, D.C.

The subcommittee met, pursuant to call, in room 6226 of the Dirksen Senate Office Building, at 9:38 a.m., Senator Edward M. Kennedy (chairman of the subcommittee) presiding.

Present: Senators Kennedy, Pell, and Schweiker.

OPENING STATEMENT OF SENATOR KENNEDY

Senator KENNEDY. We will come to order. This morning we are having a hearing on the proposed budget for the National Science Foundation for fiscal years 1980 and 1981, a \$1 billion budget which the administration has submitted for the Foundation as a whole, 8.4 percent above last year's program, and, taking into account the impact of inflation, it provides for real growth of less than 1 percent of the Foundation's total program.

The budget we have before us provides for important real growth in basic research. It is a reflection of the commitment of President Carter and this administration to a concerted effort to reverse the impact of the decline in the Federal support for basic research which has characterized the period of the early seventies. And I welcome this emphasis on a note that even with this increase, together with the increases in basic research included in the budgets of other Federal agencies, basic research support is barely keeping pace with the impact of inflation.

Surveys on public attitudes toward scientific research indicate there is a strong base of public support for the programs supported by our investment in research. In a survey of general attitudes toward science and technology conducted by Opinion Research Corp., 78 percent of those polled expressed an overwhelmingly positive reaction to science and technology. When asked where they would like to see research dollars spent, the highest priority was given to improvement of health care and pollution control.

A recent Harris survey found that 91 percent of the American people believed that scientific research would be a major factor in America's success in the next 25 years.

So this morning's hearing will be devoted to looking not only at the budget levels included in the proposed budget, but at some of

the policy issues which are of major concern as we seek to strengthen science and technology and assure that we are prepared for the challenges which face us in these fields in the years ahead.

We have several new members on the subcommittee this year, and I feel it is particularly important that they have an opportunity to learn as much as possible about the Foundation's programs and policies and how they relate to the overall strength of the Nation's research effort.

We need to examine how the administration arrived at this year's budget recommendation and the extent to which the National Science Foundation is planning ahead in terms of future programs.

I want to make brief mention at this point of the fact that there are seven new nominations of scientists to serve on the National Science Board which are now pending before our full committee. Information concerning these nominees has been circulated to committee members, and I hope that we will be able to get early action in the Senate.

The Foundation has moved ahead in increasing the ability of nonscientists to participate in policy issues with scientific and technical components. I would like to hear how these programs are coming along.

The NSF is also continuing with a small, but very effective program to look at ethics and values in science and technology. This program has very limited resources, but has done an unusually fine job in getting other Federal agencies to contribute resources in jointly funded efforts.

Additional issues which I want to review include the Foundation's proposed program in science education and what is being done on behalf of women and minorities. I am particularly disturbed that the budget the administration has sent us intends to cut back on targeted programs to increase the participation of women in science.

We also want to examine the initial results of the Foundation's efforts to assure a greater participation by industrial firms in the Nation's basic research effort and to encourage closer links between academic and industrial researchers. And with regard to participation of the private sector in federally supported research activities, the Foundation's very successful program on behalf of small businesses which is now well-established deserves special praise.

I also want to bring to the special attention of the members of the subcommittee the steps the Foundation is taking to reduce the paperwork and administrative burdens which have fallen so heavily on research recipients in recent years. I hope Dr. Atkinson will elaborate on the pilot program the Foundation has initiated and tell us about its potential for use in other agencies which fund scientific research, particularly the National Institutes of Health.

[The text of S. 527 follows:]

96TH CONGRESS
1ST SESSION

S. 527

To authorize appropriations for activities for the National Science Foundation for fiscal years 1980 and 1981, and for other purposes.

IN THE SENATE OF THE UNITED STATES

MARCH 1 (legislative day, FEBRUARY 22), 1979

Mr. KENNEDY (by request) introduced the following bill; which was read twice and referred to the Committee on Human Resources

A BILL

To authorize appropriations for activities for the National Science Foundation for fiscal years 1980 and 1981, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That this Act may be cited as the "National Science Founda-
4 tion Authorization Act for Fiscal Years 1980 and 1981".

5 SEC. 2. (a) There is hereby authorized to be appropri-
6 ated to the National Science Foundation for the fiscal year
7 1980 for the following categories:

II—E

1 (1) Mathematical and Physical Sciences and Engi-
2 neering, \$295,650,000.

3 (2) Astronomical, Atmospheric, Earth and Ocean
4 Sciences, \$243,350,000.

5 (3) United States Antarctic Program,
6 \$55,000,000.

7 (4) Biological, Behavioral, and Social Sciences,
8 \$173,500,000.

9 (5) Science Education Programs, \$84,700,000.

10 (6) Applied Science and Research Applications,
11 \$62,400,000.

12 (7) Scientific, Technological, and International
13 Affairs, \$25,800,000.

14 (8) Program Development and Management,
15 \$59,600,000.

16 (b) There is hereby authorized to be appropriated to the
17 National Science Foundation for fiscal year 1981 such sums
18 as may be necessary.

19 SEC. 3. Appropriations made under authority provided
20 in sections 2 and 5 shall remain available for obligation, for
21 expenditure, or for obligation and expenditure for periods
22 specified in the Acts making the appropriations.

23 SEC. 4. From appropriations made under this Act, not
24 more than \$2,500 for fiscal year 1980 and such sums as may
25 be necessary for fiscal year 1981 may be used for official

1 consultation, representation, or other extraordinary expenses
2 upon the determination of the Director of the National Sci-
3 ence Foundation, and his determination shall be final and
4 conclusive upon the accounting officers of the Government.

5 SEC. 5. In addition to the sums authorized by section 2,
6 not more than \$6,000,000 for fiscal year 1980 and such
7 sums as may be necessary for fiscal year 1981 are authorized
8 to be appropriated for expenses of the National Science
9 Foundation incurred outside the United States, to be paid for
10 in foreign currencies that the Treasury Department deter-
11 mines to be excess to the normal requirements of the United
12 States.

13 SEC. 6. Funds may be transferred among the categories
14 listed in section 2(a), but neither the total funds transferred
15 from any category nor the total funds transferred to any cate-
16 gory may exceed 10 per centum of the amounts authorized
17 for that category in section 2, unless—

18 (A) thirty legislative days have passed after the
19 Director of the National Science Foundation or his
20 designee has transmitted to the Speaker of the House
21 of Representatives, to the President of the Senate, to
22 the Committee on Science and Technology of the
23 House of Representatives, and to the Committee on
24 Human Resources of the Senate a written report con-

1 taining a full and complete explanation of the transfer
2 and the reason for it, or

3 (B) before expiration of the thirty legislative days
4 both the Committee on Science and Technology of the
5 House and the Committee on Human Resources of the
6 Senate have written to the Director to the effect that
7 they have no objection to the proposed transfer.

Senator KENNEDY. On the international aspects of science and technology and the role which NSF plays in this area, I would also like to have an opportunity to hear from Dr. Atkinson about his own visit to China and any comments he may have with regard to scientific and technical exchanges with the People's Republic of China and with the Soviet Union.

I look forward to a productive exchange of comments and points of view this morning on these issues and others of concern to the witnesses and the members of this subcommittee. I hope that the roundtable setting we are using will encourage this process.

Senator SCHWEIKER. It is good to be able to participate today in this hearing before the Health and Scientific Research Subcommittee on the National Science Foundation. As a strong supporter of National Science Foundation programs in the past, I welcome the opportunity to listen to the witnesses describe last year's accomplishments as well as the Foundation's plans for the future. One area of particular interest to me is National Science Foundation funds for research and development. As everyone is now acutely aware, our Nation's productivity levels have seriously fallen in recent years. Since our economic well-being is in large part due to our increased rates of productivity, I am convinced that we must find ways to improve current rates.

There was a 46-percent decline in average annual productivity growth in the nonfarm business economy between the 1950-68 and the 1968-77 periods. The U.S. productivity level is our lowest in the last 100 years and is the lowest for any industrialized country.

Another area of interest in this regard has been the National Science Foundation's science education programs. We need to make sure our Nation has a constant supply of well-trained scientists and engineers.

I look forward to reviewing the testimony before us today and will have a number of questions for each witness.

Senator KENNEDY. We would be glad to hear from Dr. Atkinson, who is the Director of the National Science Foundation. He has appeared many times before the committee. We welcome him and his colleagues here this morning.

STATEMENT OF RICHARD ATKINSON, DIRECTOR, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY GEORGE PIMENTEL, DEPUTY DIRECTOR; AND GROVER MURRAY, VICE CHAIRMAN, NATIONAL SCIENCE BOARD

Dr. ATKINSON. Senator Kennedy, I am pleased by your opening statement. It's a knowledgeable statement about the Foundation and its operations. I am also pleased to have a copy of Senator Hatch's statement in support of the Foundation's activities.

Before I begin, I would like to introduce a few people from the Foundation. On my right is Dr. Grover Murray, vice chairman of the National Science Board. Dr. Hackerman, Chairman of the Board, could not be here today; he wanted to attend this meeting, but his schedule made it impossible.

On my left is Dr. George Pimentel, deputy director of the Foundation. I would also like to introduce Dr. Eloise Clark, an assistant director; Dr. John Slaughter, another assistant director—you know all of these, but I do want to call them to your attention—Dr. Jack

Sanderson, Dr. James Rutherford, Mr. Eldon Taylor, Mr. Charles Herz, general counsel of the Foundation. Dr. Krumhansl is not here this morning; he has an important conference in the west. Dr. Harvey Averch, assistant director for Scientific, Technological, and International Affairs, is in Israel, renegotiating our bilateral exchange with the Israelis.

I don't think I need to say much about the budget; you covered it quite well. The authorization request is an unusual one for the Foundation in that it is \$6 million over the billion-dollar mark—a significant milestone in the Foundation's history.

NSF's request appears in a total R. & D. budget for the Federal Government that is increased by 4.2 percent, well behind the inflation rate. The positive feature of the R. & D. budget is its special emphasis on basic research. As you know, the Foundation plays a special role in the Federal basic research effort.

I would like to call to your attention the fact that during the time of your oversight of the NSF, its percent of the Federal support for basic research has climbed from about 13 percent to about 18 percent in the current year.

Among the measures of the health of American science, there are two indicators I would like to mention.

The total national support of research and development, as a percent of the gross national product, is down about 20 percent since 1968. In the Soviet Union, it's up about 15 percent; in West Germany, there has been an increase of about 16 percent; in Japan, an increase of about 20 percent.

Senator KENNEDY. What did you say about the Soviet Union?

Dr. ATKINSON. I was pointing out that as a percent of GNP, the United States R. & D. budget is down about 20 percent between 1968 and 1978; West Germany is up 16 percent; Japan is up 20 percent.

Senator KENNEDY. And the Soviet Union is up—

Dr. ATKINSON. About 15 percent. Another interesting comparison in that decade is numbers of scientists and engineers in the work force. Many people note that the U.S. number increased during the period. On the other hand, the numbers as percentages of the work force show the United States down 13 percent, West Germany up 56 percent, Japan up 60 percent, and the Soviet Union up about 53 percent. I think we must be cognizant of these trends.

In my formal statement, and in Dr. Hackerman's statement, we described in detail some special thrusts in computer research, laser chemistry, weather and climate research, and the plant sciences. We have had spectacular success in recent years in the plant sciences. Basic research that we thought would be translated to applications long in the future, in just a short time has led to new techniques that may revolutionize agriculture.

We also have special thrusts in sub-micron research, materials research, the earth sciences and oceanography, and environmental biology. I also want to indicate that there is a special thrust for instrumentation in the Foundation's budget. The documentation on the need for instrumentation is strong. We are working on some special programs to ensure a sharing of instrumentation not only in our research universities but also a sharing with scientists in 2- and 4-year colleges.

Another special emphasis of the Foundation this year—although not large in dollars—is to strengthen relationships between industry and universities. Our industry-university cooperative research program permits industrial and university scientists to submit proposals for joint funding by the Foundation. We think it is important to maintain strong bridges between these two scientific communities; ties have weakened in recent years, and there is a need once again to ensure substantial interaction between university and industry science.

You have received several communications from us on our efforts for women and minorities. I simply will say that we have spent wisely the funds set aside in these areas, with good results. More importantly, Dr. Rutherford, has involved these areas in the broader activities of the Foundation so that our activity announcements, requests for proposals, and fellowship programs are more responsive to women and minorities.

You mentioned our special effort with regard to administrative procedures—trying to reduce the paperwork, to increase the flexibility of scientists working on NSF grants in the universities and elsewhere, while still maintaining accountability. We have made real progress, and I think we have set the pace for beneficial developments that might occur elsewhere in the Federal Government.

I will conclude by saying that the Foundation has a close and coordinating role with the Office of Science and Technology Policy, and with its director, Dr. Press. The Foundation is required to provide back-up support for OSTP, particularly in long-term policy research related to science issues. The relationship between OSTP and the Foundation in planning future activities, in coordinating budgets, and in coordinating individual projects has been excellent.

Dr. Pimentel wants me to note that Dr. Hackerman and I would like to see both of our statements entered into the record.

Senator KENNEDY. Fine.

[The prepared statements of Dr. Atkinson and Dr. Hackerman follow:]

STATEMENT OF DR. RICHARD C. ATKINSON
DIRECTOR, NATIONAL SCIENCE FOUNDATION
before the
Subcommittee on Health and Scientific Research
of the Committee on Human Resources
U.S. Senate
March 2, 1979

Mr. Chairman and Members of the Subcommittee:

I am pleased to present the National Science Foundation's budget for FY 1980. The President is asking \$1.006 billion, an increase of nearly \$77.6 million or 8.4 percent above the Foundation's program level for FY 1979. His request constitutes a significant increase for the support of basic research through NSF's programs.

Let me put those figures in a broader context. Today, only about one-eighth of the national spending for research and development is devoted to basic research. But it is in the area of basic research that Federal support plays the largest part. About two-thirds of the entire national effort in basic research depends upon Federal funding.

Most importantly, in my view, NSF provides an increasing share of the support for basic research. The Foundation now funds almost 20 percent of all Federal support for basic research, up from 14 percent a decade ago. Through NSF, more than a third of all Federal funds for the conduct of basic research go to laboratories at the nation's colleges and universities.

Mr. Chairman, this Committee and the Congress consistently recognize the contribution of basic research to the national well being. As you know, there are many reasons why science, and particularly basic research, are given high priority in the Federal budget. This morning, I want to mention just four.

First, many question whether future supplies of minerals, fresh water, and other resources will be sufficient to meet world needs. Already, oil reserves are being depleted in many areas of the world. Supplies of food and other renewable resources and their distribution are not keeping pace with world demand. Expanding populations and the growing incomes of some developing countries are adding to competition for available resources.

In this world situation, a greater investment in the types of research supported by NSF can assist in the development of new resources, substitute materials, and improved technologies, especially technologies less dependent upon oil and other scarce resources.

Second, we must continue to seek ways to improve the quality of our environment--and at a cost the nation can afford. Experience shows that environmental problems do not lend themselves to quick fixes. Much more needs to be learned about the problems, their causes, and their consequences, so that economically viable solutions can be found.

To assist in accomplishing these purposes, the NSF program for FY 1980 expands basic research into a range of environmentally-related topics, particularly several that deal with various cycles within ecosystems.

Third, if the United States is to meet growing domestic needs and challenging international competition, industrial innovation must be stimulated and economic productivity must be improved. The average annual gain in United States productivity declined from 3.3 percent in 1947-67 to only 1.8 percent in 1967-77. Recent studies suggest that a slow-down in spending for research and development contributes to this decline.

To assist efforts for innovation and greater productivity, the NSF program for FY 1980 emphasizes such areas as chemical processing, engineering, and materials research.

Fourth, studies sponsored by both public and private organizations have found a close relationship between research investment and economic growth over the long term. A study by Edward F. Denison of the Brookings Institution, for example, estimates that advances in knowledge were responsible for about one-half of United States economic growth from 1929 to 1969.

Collectively, these points provide a strong justification for moving ahead with an aggressive basic research support activity in FY 1980. I am confident that if the full program requested is funded it will assist the United States to continue its rapid advance in science and technology.

Before I discuss some of the details of the authorization request for FY 1980, I would like to address several issues of keen interest to this Committee and to the Foundation.

The Administration has undertaken a Cabinet-level study of how Federal policies can be modified to provide a more favorable climate for innovation in this country. One of the industry task forces assisting us in this effort looked carefully at Federal support of R&D. The task force concentrated on how NSF procedures could be altered to magnify the impact of Federal expenditures on the activities of the private sector. The industry representatives strongly endorsed Government support of basic research; they see such support as the foundation for industrial activity.

The industry representatives also think there could be improved linkages between the universities and the industrial communities. Such linkages have been important in the past; for example, the innovative and successful industries on Route 128 in Boston and in Palo Alto benefited from relationships with nearby university research communities.

Consequently, we believe that improving the relationships between industries and universities is an important task. We also believe that university-industry cooperation can be strengthened without modifying the authority of the NSF or altering the present balance of Foundation activity. As we complete the innovation study, we look forward to working with the NSF, other agencies and the Congress on recommendations.

Mr. Chairman, I know that you are aware of the continuing need to provide advanced scientific instrumentation and equipment for the academic research laboratories and for other qualified research institutions. Inflation and the increasingly strained financial situation for many research institutions have made it impossible for them to acquire the instrumentation and equipment needed for advanced research. As a consequence, we have a situation in which U.S. scientists are either denied the opportunity to carry out advanced research or they seek access to the necessary equipment in other countries, particularly those of Western Europe.

We have such a situation in certain areas of biology. You will be interested to learn that the Foundation received more than \$6 million in instrumentation grant proposals that were judged excellent and deserving of support which could not be supported even with the substantial increase for instrumentation and equipment funding that was available to the Foundation in FY 1978. We have these proposals on hand, and we hope to fund a percentage of them in FY 1979, but we cannot begin to meet the needs without a sustained major investment for instrumentation and equipment over the next several years.

The FY 1980 program provides for regional instrumentation centers which will also help address the instrumentation problem. Since it is impossible to provide all the costly and complicated instrumentation needed at every school, the regional instrumentation center approach is designed to make available major items of instrumentation and equipment that will permit state-of-the-art research in a region of the country.

We also have earmarked funds to provide instrumentation and equipment for non-research-oriented, four-year and two-year colleges. We are approaching this support on a pilot basis since we recognize that the scientific instrumentation needs of these institutions probably go far beyond the ability of NSF to fund. At the same time, we recognize the importance of making available in these schools the instrumentation that will permit some young faculty scientists to contribute to scientific progress.

The Foundation is continuing to pursue a variety of activities designed to increase the participation of women in science. We have supported one-day and two-day science career workshops

to encourage women college students in pursuit of scientific careers. These students are given advice on how to prepare for such careers, and they learn of job opportunities in various scientific fields. We expect about 4,500 women will participate in these workshops in FY 1980. Another 200 women who already have degrees in science, but who are not now employed in science-related fields, will participate in what we call "Science Career Facilitation Projects."

The purpose of these projects is to provide an avenue for entry or re-entry into careers in science. Another feature of our efforts to stimulate the participation of women in science is our visiting woman scientist program. About 30 women scientists will make one-day visits to junior and senior high schools to encourage girls to consider careers in science and technology.

We are also arranging for the preparation of a manual on the operation of the Visiting Women in Science activity and the development of a women's science roster. These will be available for use by other groups interested in conducting similar programs with non-Federal support. It appears now that there is a good likelihood that industries and other groups will support this kind of activity to provide girls with role models and career information.

I want to point out that Dr. Rutherford's strategy is to continue the special programs for groups such as these while placing a particular emphasis on increasing the effectiveness of the Science Education Directorate's regular programs for addressing the problem of equal access for all individuals to careers in science. We are re-examining how NSF's concerns for women in science can be appropriately addressed in all NSF programs.

Both this Committee and the House Science and Technology Committee have expressed concern that NSF undertake the support of appropriate technology. While we recognize that this is a fertile field for research, we have proceeded cautiously. Our objectives are to delineate the types of research or policy questions to be addressed and appropriate for NSF support. The Foundation's plan for support of appropriate technology activities will be integrated into a regular program structure. We expect our research and science policy activities to contribute significantly to appropriate technology efforts beginning in FY 1981.

As you know, NSF has had considerable success in developing science and technology capabilities at the state level and through the State Science Engineering and Technology Program at both the state and local levels. We have not requested continuation of the SSET Program for FY 1980 because there seems to be sufficient interest at the state and local levels for full funding by the states themselves. Still pending is the question of how long Federal funding should continue in any program designed to stimulate activities at the State level. Some believe the Federal funding should be continued for another year or two. But NSF feels that the program already has shown benefits, and expects the activities will be continued after NSF support is discontinued. I want to emphasize that the SSET Program was a sound and worthwhile effort. In NSF's view, the program achieved the objectives which we had in mind when it was established.

In another area of mutual interest to this Committee and the Foundation, progress continues in the Ethics and Values in Science and Technology program. Joint review and funding arrangements with the National Endowment for the Humanities

have proved successful. In FY 1978, nine awards were jointly funded with NEH. It appears now that the level of joint funding will be even higher in FY 1979 and FY 1980 since NEH is increasing emphases on programs dealing with ethical and value issues associated with science and technology. We have also proposed to the National Institutes of Health the establishment of a joint program along the lines of the arrangement successfully developed with the National Endowment for the Humanities. We look forward to cooperation with NIH.

In another area of the Science and Society Program, NSF plans to allocate a total of approximately \$600,000 for the funding of the first group of two or three Public Service Science Centers. These awards will meet urgent community needs and test alternative models for providing services of this kind. We believe that the Public Service Science Centers will enrich public policy at both local and regional levels by providing mechanisms for organizations needing informed ways of representing their interests in public policy debates. The Centers will provide scientific expertise clearly objective in nature, promptly and where it is most needed.

I would also like to report that the Foundation has established the first Resource Center for Science and Engineering. You will recall that in the first year of this program, FY 1977, sixteen planning grants were awarded to develop comprehensive and long-range plans for the establishment and maintenance of resource centers. In FY 1978, in a two-stage competition, the Foundation announced an award to Atlanta University to establish the first such center. The Atlanta University Resource Center for Science and Engineering, while quite new, is already involved in activities with the surrounding community and with colleges of that region. The Advisory Committee on Minority Programs in Science Education, which this Committee urged me to establish, has accepted responsibility for oversight of the evaluation of the Resource Centers Program.

Mr. Chairman, I would like now to call on Dr. Hackerman for his remarks. After his testimony, I will highlight some of the key features of our authorization request for FY 1980.

(Dr. Hackerman's Testimony to Appear Here)

Let me turn now to specific items in the NSF program for FY 1980. I intend to limit my comments to overall features of the program, indicating how they relate to the needs for increased investment in FY 1980. I plan also to cover some of our management procedures and accountability measures. Later in these hearings, NSF Assistant Directors will discuss programs in detail. For the record, Mr. Chairman, I have also included historical material on the establishment, role and purpose of NSF.

(Insert for the Record)

The National Science Foundation's budget request of one billion, six million dollars is distributed among the following nine line items of the budget:

- Mathematical and Physical Sciences and Engineering;
- Astronomical, Atmospheric, Earth, and Ocean Sciences;
- U.S. Antarctic Program;
- Biological, Behavioral, and Social Sciences;
- Applied Science and Research Applications;
- Scientific, Technological, and International Affairs;
- Program Development and Management;
- Science Education; and
- Special Foreign Currency.

Support of basic and applied research is included in all of the above activities. In the proposed budget for FY 1980, basic research totals \$828.3 million, or 11.8 percent more than the \$741 million allocated for this purpose in FY 1979. Of the total FY 1980 budget, applied research amounts to \$72.8 million, or 4 percent more than the FY 1979 amount of \$70 million.

Three budget activities--Mathematical and Physical Sciences and Engineering; Astronomical, Atmospheric, Earth, and Ocean Sciences; and Biological, Behavioral, and Social Sciences--make up \$712.5 million, or nearly 71 percent of the Foundation's total program. These are the major basic research components of NSF. They include research support for all of the science disciplines and engineering, support for six national research centers, and a major share of the support for the 29 ships of the academic research fleet.

The Foundation is responsible for the management and funding of the U.S. Antarctic Program.

Research applications is another significant area of NSF activities. Our purposes are to improve the coupling between basic and applied research and to stimulate the application of science to recognized problems.

The Foundation also has legislative responsibility for strengthening science education at all academic levels.

Additionally, the NSF program includes information science and technology; science policy research and analysis, and science resources studies.

Another important area for NSF effort is international cooperative science; our program is designed to strengthen U.S. science and to aid in achieving U.S. foreign policy objectives related to science and technology.

The Special Foreign Currency program uses credits in foreign currencies declared excess to U.S. needs by the Treasury. The Foundation uses these funds in obtaining translations of foreign scientific documents and in various cooperative research endeavors. The work funded is important and benefits the United States.

I would now like to highlight each of our major budget activities.

Mathematical and Physical Sciences and Engineering

The proposed program in the Mathematical and Physical Sciences and Engineering is increased by \$28.0 million, to a total of \$295.7 million in FY 1980. Increased emphasis is given to research underlying efforts to improve computer software and to research on submicron structures and laser chemistry. We are also expanding materials research that can improve understanding of the problems of catalysis, corrosion, wear, and brittleness of materials, as well as environment related chemistry and engineering research.

The Foundation's continuing thrust in instrumentation and equipment, to which I referred earlier, is reflected in the MPE program. Of the \$28 million increase proposed for the MPE activity, \$16.3 million, or 58 percent, is earmarked for instrumentation and equipment. This brings the total for instrumentation and equipment for the MPE activity to \$48.1 million for FY 1980.

Another feature of the MPE budget for FY 1980 is the establishment of separate budget line items for Regional Instrumentation Facilities and Industry/University Cooperative Research.

You may recall that, beginning in FY 1978, the Foundation developed and funded equipment centers as a part of the Chemical Instrumentation program. Large, complex, and expensive instrumentation is required for research in several fields. Because such instrumentation is costly and funds are limited, it is not realistic to provide state-of-the-art instrumentation to more than a few locations in the Nation.

We have found that the concept of regional instrumentation facilities is a sound approach for chemistry and for several other fields of science. I have already advised this Committee and our other authorization and appropriation committees of action taken in FY 1979 to establish Regional Instrumentation Facilities as a separate program and budget subactivity. This FY 1979 reprogramming action is reflected in the Foundation's FY 1980 budget as presented to the Congress. The amount of \$3.8 million is requested for Regional Instrumentation Facilities in MPE for FY 1980. There is another \$500,000, each, in the Astronomical, Atmospheric, Earth, and Ocean Sciences activity and the Biological, Behavioral, and Social Sciences. The total for these regional facilities amounts to \$4.8 million.

In FY 1978, regional instrumentation facilities were established at Colorado State University, the University of South Carolina, Johns Hopkins University, the University of Nebraska, the University of Pennsylvania, and the University of Arizona. We expect to establish four to six new facilities in FY 1979 and an additional three in FY 1980 at appropriate locations throughout the country.

As I have indicated, the FY 1980 budget establishes Industry/University Cooperative Research as a separate budget subactivity. Leaders of the U.S. science community have recognized the need to take advantage of such cooperation. As science career opportunities in the colleges and universities level off, more and more young scientists and engineers are entering industrial laboratories. At the same time, U.S. high technology firms are facing stiffer competition from foreign companies. There is a growing need for closer collaboration between industry and university scientists so that the United States can take advantage of the most recent advances in science and technology and linkages can be strengthened between industry and university scientists.

The Foundation's Industry/University Cooperative Research effort is an attempt to stimulate such collaboration. Through this program, joint proposals submitted by researchers from a firm and a university are given special emphasis. We expect that the cooperative research supported in this program can lay the foundation for further improvements in technology and can build better linkages of the type I mentioned. These cooperative efforts are being funded through the Foundation's Mathematical and Physical Sciences and Engineering activity and its Applied Science and Research Applications activity.

In 1977 NSF funded the establishment of a national user resource center for micro-fabrication research at Cornell University. To achieve the objective of controlled reproducible micro-fabrication at this scale (well beyond the industrial state-of-the-art) requires basic research across many disciplines--materials, physics, chemistry, computer science, electrical systems science, to mention the main

components--and NSF has regularly supported these areas. Submicron techniques may allow a further major advance in the miniaturization of integrated electronic circuits for computers and communication equipment. The Foundation is supporting the establishment of submicron research capability at several universities.

Astronomical, Atmospheric, Earth, and Ocean Sciences

Much of the Foundation's environmental research is concentrated in the Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO) activity. The budget includes \$243.4 million for this activity, \$19.9 million more than the FY 1979 amount of \$223.5 million. I might emphasize that the National Science Foundation accounts for more than 65 percent of total Federal support for basic research in the environmental sciences.

The FY 1980 program provides for an extension of Deep Ocean Drilling with the drill ship, Glomar Challenger, and for continued planning of a proposed Ocean Margin Drilling Program that could, if approved, involve the use of the Glomar Explorer as a drill ship. We are intensifying research in the coastal waters. The budget provides for construction of a coastal research ship, at a cost of about \$3 million; the ship is needed to maintain the capability of the academic oceanographic research fleet.

You will note a \$750,000 reduction in the Astronomical Sciences program. It reflects winding-down of construction of the Very Large Array for radio astronomy in New Mexico; the facility is nearing completion. The FY 1980 budget includes

\$5.3 million for VLA construction, compared to \$11.5 million budgeted for this purpose in FY 1979. Partially offsetting the reduction in construction funds is the need to increase support for research operations at the Very Large Array, by \$1.1 million to a total of \$3.4 million in FY 1980. NSF also will bolster astronomy research project support and aid in obtaining instrumentation and equipment for research in astronomy.

The budget for environment-related research is increased, particularly in atmospheric chemistry, to permit funding of the second phase of a major research experiment on tropospheric aerosols and gases. Research is being expanded on weather and climate, with emphasis on severe storms. And we are increasing support for studies on the significance of ice in electrical charging of clouds and the dynamics of downdrafts, including particularly violent downbursts in the vicinity of thunderstorms.

Instrumentation and equipment support is also a major feature of the budget for AAEO for FY 1980. The additional instrumentation and equipment will greatly aid in environment-related research, especially work concerned with analysis of the sources and fates of pollutants in rivers, lakes, and coastal waters.

U.S. Antarctic Program

The budget includes \$55 million for the U.S. Antarctic Program, nearly \$4 million more than the FY 1979 level. A major part of the Antarctic request covers operations support provided by the U.S. Navy and U.S. Coast Guard. The oceans surrounding the Antarctic continent contain the world's richest source of marine protein, mainly in the form of krill, a shellfish that looks somewhat like a shrimp. Considerable research is being done on the krill.

The continent, itself, provides unusual research opportunities, especially in the atmospheric sciences and in cosmic ray research. There are indications that the continent may eventually become important because of its resource potential. The Antarctic is a gigantic heat sink, and the cold waters and air masses moving northward from Antarctica have a profound effect on much of the world's weather and climate.

Unique research opportunities in Antarctica have attracted outstanding scientists from many nations. The activities there have also demonstrated that it is possible for nations of many diverse political systems to cooperate in a constructive way for the advancement of science for peaceful purposes.

Biological, Behavioral, and Social Sciences

The proposed program in the Biological, Behavioral, and Social Sciences is increased by \$17.3 million to \$173.5 million in FY 1980. The program covers research on ecological inter-relationships of plants, animals, and micro-organisms, on the molecular basis of cell structure, on the behavior of human beings and lower animals, and on the structure and operation of social institutions.

Among the specific research emphases in FY 1980 are efforts to extend knowledge of ecosystems, especially the environmental consequences of human activities on these systems. NSF is also expanding support for basic research in the plant sciences, including studies on tissue culture and nitrogen fixation. This research should help to overcome limitations on food, fiber, and fertilizer. And NSF will also step up efforts on behavioral and neural sciences, especially research related to understanding neural pathways and brain function.

Another important feature of the research supported by this activity is studies on nutrient cycling, including the role of plants in regulating the carbon dioxide content of the atmosphere.

Our Social Science research program is held to a 5.4 percent increase in FY 1980. I should note that our support of the social sciences increased by an average of more than 10 percent per year from FY 1975 to FY 1978. We are continuing to stress areas of research that have good potential for long-term benefits, including studies on fiscal and monetary policies, research on international trade and finance, and analysis of economic instability, inflation, and employment.

We are also augmenting instrumentation and equipment support. About \$4.4 million of the proposed \$17.4 million increase for the Biological, Behavioral, and Social Sciences is for this purpose.

Applied Science and Research Applications

The budget includes \$62.4 million for Applied Science and Research Applications (ASRA), about \$400,000 less than the FY 1979 level. The year-to-year dollar comparisons for this activity need some interpretation, because the FY 1979 program includes \$6.9 million in FY 1978 deferrals. The Foundation revamped its chiefly applied research efforts in FY 1978, and the deferral was taken to permit a restructuring of research applications support.

I want to emphasize that the Applied Science and Research Applications activity includes both basic and applied research. About 62 percent, or \$45 million, of the Foundation's total applied research support of \$72.8 million in FY 1980 will be funded through the ASRA activity. Approximately \$17 million of the ASRA budget supports basic research.

There are significant shifts of emphasis within this budget activity for FY 1980. Increases are provided for research to aid the physically handicapped and for studies of specific aspects of human nutrition, particularly those concerned with the nutritional value of processed food. The Foundation's nutritional research support is limited and is part of a much larger overall Federal effort in this area.

Efforts to stimulate industry/university cooperative research are also a key feature of the Applied Science and Research Applications activity in FY 1980. A part of the

industry/university research is concerned with studies that may lead to improvements in production automation and batch processing techniques. The Foundation is also continuing strong support for earthquake hazards mitigation in FY 1980, and research in this area is increased by \$850,000, to a total of \$18.3 million.

A unique feature of the Applied Science and Research Applications activity is the program of Integrated Basic Research. Basic research projects that show real promise for contributing to rapid advances in identified problem areas are given augmented funding. In FY 1980, such funding is planned for basic research in five areas: advanced measurement investigations; deep mineral resources; biogeochemical cycles of carbon, nitrogen, and sulfur; and population redistribution.

The Applied Science and Research Applications concept is extremely important in maintaining the overall strength of NSF research support activities. Moving the results of basic research along the continuum toward practical application is a complex and difficult process. Consequently, the ASRA activity is a key to the Foundation's effort in assuring effective and prompt use of basic research results.

Scientific, Technological, and International Affairs

The Foundation is requesting \$25.8 million for international cooperative science, policy research and analysis, information science and technology, and science resources studies. These together form the Scientific, Technological, and International Affairs activity. The program is only slightly increased--about \$600,000--over the FY 1979 level.

Programs in this activity are designed to give U.S. scientists an opportunity to participate in and benefit from international scientific activities, to provide the Government with a research and analysis capability for science and

technology policy, and to improve the understanding of the transfer and dissemination of scientific and technological information. The science resources studies funded under this activity provide the principal Federal capability for collecting, interpreting, and disseminating national statistics on the human and financial resources of the science and technology enterprise.

Science Education

The Office of Education estimates that all levels of government combined will invest more than \$100 billion in education in FY 1980. The Foundation's role in the science education enterprise is that of a catalyst. That is, NSF attempts to concentrate limited resources on high-leverage points in the education process through improvements in curriculum, strengthening science teacher competence, and expansion of opportunities for people to pursue careers in science.

The budget provides \$84.7 million for Science Education in FY 1980, \$4.7 million more than the FY 1979 level. Our efforts will be concentrated chiefly on programs to strengthen science education at the junior high school level, on improving science teacher competence at both junior high school and high school levels, on increasing scientific literacy of all citizens, and on efforts to increase science career opportunities for minorities, women, and the handicapped.

Graduate fellowship and traineeship programs are being continued at the same level as in FY 1979. A total of 1,550 graduate students is to be supported, including 525 new and 1,025 continuing awards. These fellowships include the Foundation's recently authorized Minority Graduate Fellowship Program.

The Undergraduate Research Participation, Student-Originated Studies, and Science Instructional Equipment programs, which focus on improving undergraduate instruction, are included in the budget as recommended by this Committee last year. Also included are programs addressing the Foundation's long-standing concern for the quality of science education offered in two- and four-year colleges and universities.

Another feature of our science education program for FY 1980 is an important thrust in the development of instructional materials and related technologies, including research on the application of new video disc technology to science teaching.

The Foundation is also continuing to support the development of a major television program in science targeted at 8 to 12 year-olds. The program is to be aired during prime viewing time for this age group. This program is being done in collaboration with the Children's Television Workshop, the people who produced Sesame Street. We believe this program will spark the imagination of our youth and will be an effective way of motivating young people to pursue additional science activities.

Program Development and Management (PD&M)

The budget includes \$59.6 million for the PD&M activity. This activity covers NSF administrative expenses. Funds are included for support of a full-time permanent staff of 1,318, an increase of 20 from FY 1979. Also covered are the costs associated with the Foundation's peer review system and the provision of central support services needed in the Foundation's day-to-day activities. Program Development and Management expenses are 5.9 percent of the total NSF budget in FY 1980.

Special Foreign Currency

An amount of \$6.0 million in excess foreign currency is included in the budget. I have already mentioned the special nature of this program.

NSF Budget Process

Mr. Chairman, the Foundation's FY 1980 budget is the result of an extensive process. I do not plan to discuss the process in any detail in my comments today, other than to say that it included an updating of our long-range plans and a detailed zero-based budget review.

We have phased down or terminated numerous projects and programs to permit the research efforts proposed for FY 1980. Some programs that represented significant funding in the past are not funded in FY 1980. For example, during the six-year period, 1973-1978, the Foundation provided about \$6 million for support of research on integrated pest management. That research was intended to help to provide a basis for biologically safe techniques of controlling insect pests which are a threat to U.S. agriculture. The major operating responsibility for follow-on support has been transferred to the Department of Agriculture. NSF research funds are now directed to support of new basic approaches to the study of pest control.

The Foundation's research programs entitled Chemical Threats to the Environment, Community Water Management, and the State Science, Engineering, and Technology Program have been terminated. Also, the Administration shifted funding responsibility for the second phase of the Michigan State Heavy-Ion Accelerator from NSF to the Department of Energy.

The National Science Board, as Dr. Hackerman indicated, is heavily involved throughout the budget development process; the priorities reflected in the budget represent a consensus of needs and science opportunities. The priorities also reflect guidance given us by the Congress and the Administration.

Expected Research and Science Education Proposals

In terms of the Foundation's overall program, we expect to receive in excess of 25,000 research and science education proposals for funding in FY 1980. They will aggregate some \$3 billion dollars. The Foundation will use about 30,000 scientists, who volunteer their time without charge to the Government, to aid us in the review and evaluation of these proposals. The NSF budget will permit the funding of approximately \$850 million, or 28 percent of the total \$3 billion proposed. Experience shows that about 48 percent of the proposals receive some funding. The amounts granted are, in almost every case, considerably less than the amount proposed. The competition has become increasingly intense in the past decade.

Geographic Distribution

Geographic distribution of NSF awards is another issue of particular concern to the Foundation, the Congress and parts of the scientific community. The Experimental Program to Stimulate Competitive Research was approved by the Board and initiated last year. It is designed to stimulate research activity in eligible states and increase the ability of scientists in those states to compete successfully for Federal funds. Ad hoc committees are currently developing plans in the first seven states: Arkansas, Maine, Montana, North Dakota, South Carolina, South Dakota, and West Virginia.

NSF Management and Oversight

The Foundation makes awards to universities, colleges, and other qualified institutions. Grants are rarely given to individuals. This practice allows NSF to take advantage of the internal management controls of grantee institutions. We also benefit from the institutional screening of proposals before they are submitted to NSF. And there is an implied institutional commitment to the project, should an NSF award be made.

Over the past several years NSF has demonstrated that it can manage large-scale research undertakings in a thorough and cost-effective manner. The Very Large Array, an extremely complex facility for radio astronomy, is an example. The first instrument of its kind in the world, the VLA will be completed on schedule and at a total cost within 4 percent of the estimate made at the start of the project, back in 1973.

The Foundation also has full management responsibility for planning, funding, implementing, and overseeing the United States program in Antarctica. The U.S. Antarctic program requires that NSF manage both the U.S. research program in the Antarctic and a large and complicated support operation involving extensive logistical and operational support by the U.S. Navy, the Coast Guard, and a number of private contractors. The Foundation has demonstrated that it can do an effective and competent job in this demanding role.

We are also seeking ways to reduce red tape and paperwork while maintaining an effective level of accountability. Just recently the Foundation initiated an experimental "Master Grant" technique. This technique permits simplified accounting methods and makes it easier for investigators at a single institution to make the most effective use of the research dollars provided by NSF.

The Foundation has also introduced a number of innovative programs to encourage full participation of minorities, women, and the physically handicapped in science activities. As Dr. Hackerman mentioned earlier, we are also supporting an experimental program to stimulate competitive research at institutions in a number of states which have traditionally received very little support from NSF.

Since NSF has responsibility for maintaining strength in all fields of science and engineering, the research programs of other Federal agencies are of keen interest to us. As part of our management strategy, the Foundation works closely with the President's Science Adviser and the Federal agencies which support research and education. We have just completed a series of seminars with representatives of eight agencies, discussing in some detail their current and planned research programs for FY 1980. In this way we are able to avoid unnecessary duplication, and I believe that we have achieved on a Federal-wide basis a balanced set of science activities.

The Foundation has an Office of Audit and Oversight, whose chief officer reports directly to me. I rely on the office director to insure that NSF award policies and procedures are followed and that we have effective internal management control over Foundation programs and funds. The audit agencies of the Department of Health, Education, and Welfare and the Department of Defense have been assigned responsibility for making on-site financial audits of NSF awards.

The Foundation's FY 1980 program is a sound investment. It will help the United States in the overall effort to keep our science and technology capabilities among the strongest in the world. A summary budget table is attached to my statement. I urge your support of the full program.

With your permission, Mr. Chairman, I would like to have the Foundation's Budget In Brief included in the record.

Thank you, Mr. Chairman. This concludes my remarks.

NATIONAL SCIENCE FOUNDATION BUDGET SUMMARY

Obligations in Millions of Dollars

Budget Activity	FY 1978 Actual	FY 1979			FY 1980	Differences	
		FY 1979 Program Funded by Congress	Prior Year Funds Carried Over	Current Plan	New Obliga- tional Authority	New Obliga- tional Authority FY 1980/79	Total Program FY 1980/79
(1)	(2)	(3)	(4)	(5)	(6)	(6-3)	(6-5)
RESEARCH AND RELATED ACTIVITIES APPROPRIATION:							
Mathematical & Physical Sciences and Engineering	\$248.5	\$263.2	\$4.5	\$267.7	\$295.7	\$32.5	\$28.0
Astronomical, Atmospheric, Earth, and Ocean Sciences	211.6	223.0	.5	223.5	243.3	20.3	19.8
U.S. Antarctic Program	48.4	51.1	— ¹	51.1	55.0	3.9	3.9
Biological, Behavioral, and Social Sciences	141.8	155.7	.5	156.2	173.5	17.8	17.3
Applied Science and Research Applications	55.1	55.5	7.3	62.8	62.4	6.9	-0.4
Scientific, Technological, and International Affairs	23.8	24.3	.9	25.2	25.8	1.5	0.6
Program Development and Management	48.7	54.8	3.1	57.9	59.6	4.8	1.7
Subtotal	777.9	827.6	16.8	844.4	915.3	87.7	70.9
SCIENCE EDUCATION ACTIVITIES APPROPRIATION:							
Scientific Personnel Improvement	31.7	32.8	— ¹	32.8	32.9	0.1	0.1
Science Education Resources Improvement	27.9	29.1	— ¹	29.1	29.1	— ¹	— ¹
Science Education Development and Research	8.9	11.7	— ¹	11.7	15.3	3.6	3.6
Science and Society	5.4	6.4	— ¹	6.4	7.4	1.0	1.0
Subtotal	73.9	80.0	— ¹	80.0	84.7	4.7	4.7
SPECIAL FOREIGN CURRENCY APPROPRIATION:							
Total, NSF	5.4	4.0	— ¹	4.0	6.0	2.0	2.0
	857.2	911.6	16.8	928.4	1,006.0	94.4	77.6

¹ Includes \$625,000 proposed supplemental for increased paycosts of Antarctic logistics support.

² Includes \$6.9 million FY 1978 Deferral.

HISTORICAL MATERIAL ON ESTABLISHMENT, ROLE, AND PURPOSE OF THE NATIONAL SCIENCE FOUNDATION

NSF is an independent Federal agency. It accomplishes its mission primarily through grants and contracts. It operates no in-house laboratories.

More than 2,000 colleges, universities, industrial firms, and other institutions and organizations participate in NSF programs. Additionally, over 200 small business firms are involved in NSF-supported research, mostly applied research.

The Foundation was established as an outgrowth of President Franklin D. Roosevelt's desire for a science agency that could contribute to a peacetime economy by enhancing U.S. scientific strength. In 1944, President Roosevelt instructed Dr. Vannevar Bush, then Director of the Office of Scientific Research and Development, to find a way for the Nation to benefit from science in peacetime as it had in wartime and to assure U.S. scientific strength for reasons of national prosperity and security.

Dr. Bush's report, *Science, the Endless Frontier*, led to the establishment of the National Science Foundation. President Harry S. Truman signed the NSF Act in 1950. NSF's mission under the Act is to strengthen U.S. science and engineering through the support of basic research and science education programs.

In 1968, the NSF Act was amended to give the agency additional authority to support applied research and to clarify and strengthen the Foundation's responsibilities in science education, international cooperative science, and science policy. NSF is responsible for strengthening science education "at all educational levels."

NSF determines the quality of research and science education projects through a system of peer review. More than 30,000 scientists, engineers, and science educators in all parts of the United States participate in the NSF peer review process each year. They provide a yardstick for excellence, giving their views and evaluations of proposed projects. NSF staff members who are experts in science and engineering and science education make the final decision on awards.

Through contracts with university consortia, NSF supports five National Research Centers, four for Astronomy and one for Atmospheric Research. These are the National Center for Atmospheric Research, Boulder, Colorado; Kitt Peak National

Observatory, Tucson, Arizona; Cerro Tololo Inter-American Observatory, Chile; National Radio Astronomy Observatory, Green Bank, West Virginia; and the Sacramento Peak Observatory, Sunspot, New Mexico. A sixth National Research Center, the National Astronomy and Ionosphere Center, Puerto Rico is operated under contract with a single university.

NSF, by law, consists of the Director and the National Science Board. The National Science Board is the NSF policymaking body and has 25 members, including the Director as an ex officio member. The Director and Board members are appointed by the President and confirmed by the Senate for 6-year terms. The terms of the Board members are arranged so that the terms of one-third of the members expire every two years.

The Foundation has about 1,260 employees. The Director, Deputy Director, and four Assistant Directors are appointed by the President and confirmed by the Senate.

Three other Assistant Directors are appointed by the NSF Director. More than 30 percent of the NSF staff are experts in the various fields of science, engineering, and science education. About four percent of the staff are scientists serving as "rotators" from academic and other nongovernmental institutions. These rotators work for the Foundation for 1 or 2 years and then return to their home institutions. They help provide a continuous influx of up-to-date information and fresh viewpoints on the needs and opportunities for science and science education.

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

RICHARD C. ATKINSON
DIRECTOR

Dr. Richard C. Atkinson was sworn in before President Carter on June 1, 1977, as Director of the National Science Foundation. He was nominated for the position by President Carter on April 21, 1977, and unanimously confirmed by the Senate on May 3, 1977. Dr. Atkinson had been Acting Director of the Foundation since August 12, 1976. He is on leave of absence from Stanford University where he had been on the faculty since 1956.

Dr. Atkinson is an experimental psychologist and applied mathematician whose research has been concerned primarily with problems of memory and cognition. He was one of the first to transform intuitive ideas about the nature of memory into an explicit theory that could be formulated in mathematical terms. This theory has been the basis for much of the current research on human memory. The theory also has played an important role in specifying correlates between brain structures and psychological phenomena, in explaining the effects of drugs on memory, and in providing techniques for optimizing the learning process.

Dr. Atkinson's research on memory has led him to be concerned with problems of classroom learning. He was among the first to develop a computer-controlled system for instruction, whose basic features have had wide influence on the computer field and have been used in the design of commercial computer-assisted instruction programs. An important application of the computer system developed by Dr. Atkinson has been for teaching reading to elementary school children.

Dr. Atkinson was born March 19, 1929, in Oak Park, Illinois. He earned a bachelor of science degree at the University of Chicago in 1948, and a doctor of philosophy degree at Indiana University in 1955. He has been elected to membership in the National Academy of Sciences, the Institute of Medicine, the American Academy of Arts and Sciences, and the National Academy of Education. He has been a Fellow of the Center for Advanced Study in the Behavioral Sciences, a Fellow of the Guggenheim Foundation, a recipient of the Distinguished Research Award from the Social Sciences Research Council, and the Distinguished Scientific Contribution Award of the American Psychological Association. He has been awarded honorary degrees by several American universities and holds honorary memberships in a number of foreign societies and academies.

Dr. Atkinson joined the Stanford University faculty in 1956 after military service in the U.S. Army. In addition to being a Professor in the Psychology Department, he holds appointments in the School of Engineering, the School of Education, and the Institute for Mathematical Studies in the Social Sciences.

January 15, 1979

Statement of Dr. Norman Hackerman
Chairman, National Science Board
Before the Subcommittee on Health and Scientific Research
Committee on Human Resources
United States Senate
March 2, 1979

Mr. Chairman, Members of the Committee:

It is a pleasure for me to present the views of the National Science Board on the National Science Foundation's (NSF) proposed program for fiscal year 1980. As in previous years, the Board has been deeply involved in the formulation of this program. Its top priorities include continued strengthening of basic research in science and engineering, improvement of science education, and strengthening of applied research and cooperative research activities. The Board strongly endorses these and the other priorities expressed in the program for fiscal year 1980.

Recent Activities of the National Science Board

Among the Board's activities during the past year which may be of special interest to this Committee is its latest annual report. On August 2, 1978, the President transmitted to the Congress the tenth annual report of the National Science Board, Basic Research in the Mission Agencies: Agency Perspectives on the Conduct and Support of Basic Research. Other recent Board reports have dealt with the Nation's total research and development effort and the Federal Government's role in this effort. This report focuses on the basic research supported by the mission agencies of the Federal Government and their contribution to the Nation's scientific endeavor. As a result of this

review, the Board reaffirms its strong belief in the value of multiple sources for support of scientific research by the Federal Government and in the key role of the mission agencies.

The report was prepared under the direction of the Committee on Tenth NSB Report chaired by Dr. Grover E. Murray, Vice Chairman of the Board. Nine general observations are made on accomplishments, trends, problems, and issues concerning basic research supported by the Federal Government. Briefly, these are:

1. Significant additions to scientific knowledge have resulted and continue to result from Federally supported basic research. This increased knowledge is, or promises to be, of high potential in addressing national problems and concerns.
2. Over the period 1968-1977, Federal support of basic research declined in constant dollars, according to the report.

[This trend has now been reversed, and such obligations have been rising since 1978. A significant feature of the President's Budget for fiscal year 1980 is continued Government-wide growth in the funding of basic research with an estimated increase of nine percent (current dollars) over 1979, and increases of up to 17 percent for the Department of Defense and Department of Energy.

The Foundation's proposed program for 1980 includes an increase for basic research of 12 percent over 1979 and reflects the Administration's strong commitment to basic research.]

3. The mission agencies have expressed certain concerns about the funding of basic research especially about sharp yearly fluctuations in budget authority and legislative expansion of agency responsibilities without commensurate increases in funding.
4. According to the mission agencies, a number of factors have affected the emphasis on and conduct of basic research. For instance, some legislation has caused a de-emphasis of basic research in certain agencies [but note that recent data indicate a reversal of this trend]; and necessary regulations controlling the use of human subjects, animals, and dangerous drugs in research studies may affect the cost and complexity of that research.
5. Over the longer term, Federal support of basic research and the costs of such work have increased greatly, especially in universities. During the period 1953-1977, Federal support of basic research in universities increased 25 fold (current dollars); in industry it increased 5 fold. [See also note under 2 above.]
6. During the period covered by the report, 1968-1977, Federal support of basic research has shifted by field

of science. The life and physical sciences were dominant during that period. Increases in the life sciences, environmental sciences, engineering, and social sciences ranged from 67 to 98 percent (current dollars). Increases in the physical sciences and in mathematics and computer sciences were 35 and 18 percent respectively, while support of basic research in psychology (treated separately from the life and social sciences) decreased by eight percent in this period.

7. Comments by the mission agencies on the several approaches to the management of basic research are noted, as are some problems in its management.

- The factor affecting the quality of basic research projects that was considered most important was the vision and leadership of the senior officials who plan and direct the work.
- The value of the unique management services provided by university consortia was recognized.
- Clarification of the use of the procurement contract, assistance contract, cooperative agreement, and grant would assist the research community.
- Those agencies conducting in-house research report that added flexibility in Federal personnel regulations would permit more effective management of their programs.

8. Some agencies were apprehensive about efforts at coordination that might introduce elements of external direction or control. Agency perceptions of acceptable "coordination" include connotations of collaboration, correlation, and evaluation.
9. In listing priorities and gap areas in their research agendas, most agencies mentioned the need for basic research in the traditional scientific disciplines.

The report contains detailed submissions from 14 mission agencies and two other agencies of the Federal Government portray significant aspects of each agency's basic research activities and contributions of these activities to agency objectives, to science, and to the national welfare. It also includes analyses of selected aspects of Federal support of basic research, a comparative analysis of the mission agencies, and historical trends in their support of basic research.

In its annual reports, the National Science Board assesses the status and health of science and its various disciplines, including such matters as national resources and manpower. Three of the reports have been part of the science indicators series which was initiated by the Board in 1973 as a continuing effort to describe quantitatively the condition of science and research in the United States. The eleventh NSB report, Science Indicators--1978, the fourth in the indicator series, will appear later this year.

On the basis of the evidence in the annual reports and information from other sources, the National Science Board believes that the status and health of the scientific enterprise in the U.S. are good and that our effort compares satisfactorily with that of scientific communities abroad. This optimistic assessment of the health of the U.S. scientific enterprise does not mean that there are no problem areas. There is a continuing concern about the balance between supply and demand for younger scientists and engineers, especially at the doctoral level, and its possible impact on universities where much of the Nation's basic research is performed. The NSB Committee on Role of NSF in Basic Research, chaired by Dr. Alexander Rich, has brought the issue of young scientists, including young faculty, to the attention of the Board. Further study of the issue is underway, including devising corrective action if appropriate.

Other issues important to the continued vitality of U.S. science include allocation of resources among and within fields of science, and between "big" and "little" science; increasing the participation in science and engineering of groups such as women, minorities, and the handicapped; the distribution of effort among performers of research and among all regions of the Nation; and the impact of science on society, including responsiveness to the needs and demands of society. All of these issues have both immediate and longer-term implications for maintenance of a strong and healthy science base for this country. They are current and continuing areas of study by the

Board and by other groups concerned with science and science education, including other parts of the Executive Branch, the National Academy of Sciences, the National Academy of Engineering, and this Congress, including the Office of Technology Assessment.

As the policymaking body for NSF, the National Science Board is deeply involved in long-range planning for the Foundation. One facet of this has been the development by the Board, working with Foundation staff, of reviews of the status of science. The most recent of these, Status of Science Reviews--1979 (NSB-79-3), reflects the perceptions of individual NSF program managers of the current organization and development in science and engineering. It provides an overview of current directions and new opportunities in the individual fields of science supported by the National Science Foundation. The document contains a wealth of information and is designed to provide background for the Board as it provides advice and guidance in the long-range planning and budgeting processes of the Foundation, and to the Congress and others as they consider the future of the scientific enterprise. A copy of the latest Reviews will be provided for the record.

Included in the status of science reviews series is an analysis of the magnitude of the Foundation's commitments for continuing grants and major research items. At its long-range planning meeting last June, the Board examined this analysis, found it to be useful, and encouraged its further refinement and

development by NSF staff. It is a potentially valuable management tool.

During the past year, the Board considered the Foundation's role and priorities in science education. The resulting "Statement of Policy of the National Science Board Regarding Science Education" (NSB-78-150) was issued in March 1978 (Appendix). It states in part:

...where the educational process is directly dependent upon the research environment or where the scientific subject matter so dominates the educational effort that it is dependent upon the subject matter specialist, it is our judgment that the National Science Foundation should continue to be responsible for the educational programs that are now within it. On the other hand, where the objective is to maintain continuing review and revision of core curriculum programs it is our judgment that this could very well be managed as effectively by another agency.

Where the educational effort is directed at the professional practitioner of science and engineering or where the effort is to transmit to the public substantive scientific information, it is our judgment that there should be no change in the present levels of responsibility within the National Science Foundation.

In all cases, the present policy of interaction and cooperative program development with other agencies of government should be fostered.

The National Science Board Forums: Public Participation in Science Policy Formulation

In June 1976, almost three years ago, the Board held the first of a series of six regional forums. The last was held in May 1978. These meetings were undertaken as an experiment in public participation in science policy formulation, in response

to the NSF Authorization Act for fiscal year 1976 which directed the Foundation

...to facilitate the participation of members of the public in the formulation, development, and conduct of the National Science Foundation's programs, policies and priorities.

At each of the forums several Members of the Board and I discussed with the citizens of the region some science-related issues selected by individuals living in that area. These issues have included problems associated with preservation of the environment, energy resources, water, food production, and other human and social concerns.

At four of the forums, three continuing concerns of the Board were also discussed. These included the supply of and demand for younger researchers; careers in science for women, minorities, and the handicapped; and alternative performers of research. The comments concerning these issues have been of particular interest to us, and we have heard useful suggestions for new or expanded programs in these areas.

An interim report on the first three forums was prepared, and a final report dealing with the last three, and the series as a whole, is in preparation. The final report also contains information on the participants' assessment of the forums. Many suggestions or ideas have emerged at the meetings. Some relate to current NSF programs, some would require new NSF programs or a change in policy, and the remainder appear to be

appropriate for other Federal agencies. These are being trans-
mitted for action as feasible.

The Board is now examining the forums to determine if they were a suitable way to reach the public. As you know, the public is not a homogeneous group. Therefore the question arises as to which part of this public we can reach--the total population, or a more informed group possibly concerned with science policy, or a group closely associated with science, including those already involved with NSF? Is there an optimum 'public' from which the Board should seek advice on policy-making? And, should the forum mechanism or some other means be used to involve the 'public' in science policy formulation?

Nominations to the National Science Board

On January 18, 1979, President Carter submitted to the Senate for confirmation the nominations of six persons to serve on the Board. One additional nomination was submitted on January 31, 1979. Nominated were:

- Dr. Eugene H. Cota-Robles, Vice Chancellor and Professor
of Biology, University of California at Santa Cruz
- Dr. Ernestine Friedl, Professor of Anthropology,
Duke University
- Dr. Michael Kasha, Director, Institute of Molecular
Biophysics and Professor of Chemistry, Florida State
University
- Dr. Walter E. Massey, Dean of the College and Professor
of Physics, Brown University

Dr. David V. Ragone, Dean of the College of Engineering,
University of Michigan

Dr. Edwin E. Salpeter, J. G. White Professor of Physical
Sciences, Cornell University

Dr. Charles P. Slichter, Professor of Physics and in the
Center for Advanced Study, University of Illinois at
Urbana

If these nominations are confirmed, they will bring to 115 the number of individuals who will have served on the Board. Among this total are distinguished representatives of the major fields of science, medicine, engineering, agriculture, education, public affairs, research management, and industry. The majority of the Members are primarily affiliated with universities and colleges. By virtue of their service in many other sectors of the scientific community, these persons also have extensive knowledge of the requirements and problems of the various levels of education, nonprofit and nonacademic institutions, and large and small industry.

In making nominations to the National Science Board, recommendations are sought from scientific and educational organizations, and a solicitation for nominations is printed in the Federal Register. This brings responses from all over the country.

The announcement and solicitation process begins in the spring preceding the year in which vacancies will occur. The Board

receives and reviews recommendations through the summer. Late in the year all recommendations received from all sources are forwarded to the White House for consideration together with the joint recommendations of the Board and the Director. Additional nominations are, of course, made directly to the President by members of the Congress, other interested individuals or organizations. The President then makes his selection and, after appropriate clearances have been received, submits the nominations to the Senate for confirmation.

NSF Program for Fiscal Year 1980

As noted earlier, the Board has been deeply involved in the formulation of the Foundation's proposed plan for this fiscal year, and strongly endorses it. Its top priority, as determined by the National Science Board and the NSF Director, is the continued strengthening of basic research including the provision of needed research instrumentation and equipment.

The National Science Board is most appreciative of this Committee's interest in the sciences and science education, and its support of the Foundation's programs. I urge the Committee's approval of the full authorization of \$1,006 million.

APPENDIX

NSB-78-150

March 30, 1978

STATEMENT OF POLICY OF
THE NATIONAL SCIENCE BOARD
REGARDING SCIENCE EDUCATION

The National Science Foundation has priorities in Science Education that are based on its mandated responsibilities for the support of research and the utilization of scientific knowledge in technology important to national needs. The following precepts describe these priorities:

- Science Education that is dependent upon the presence of the research environment should continue to be within the National Science Foundation.
- Educational effort which is so dominated by its scientific subject matter that it is dependent upon the subject specialist for its development and for its utilization should remain within the National Science Foundation. The mode of presentation of such subject matter will, of course, continue to require the interrelated supporting effort of specialists in educational research itself.
- Education that is directed specifically at the practitioner of science--such as symposia, scholarly journals and specialized computerized information bases--should remain with the National Science Foundation.
- Educational efforts directed at the electorate, so that they may be better informed about science-related subjects important to their decisions, should continue to be the responsibility of the Foundation as a part of its programs of science for the public. As well, these public-oriented efforts serve to inform the scientist of public attitudes and purposes.

These precepts guide the choice of programs that should, in our opinion, continue to rest within the Foundation; because there they will be best served by being related to the research and technology programs from which they derive; and which are the continuing responsibility of the foundation.

In addition to the foregoing precepts, three general judgments are made:

1) The interest of the National Science Foundation in education particularly at the primary and secondary level, and to a lesser extent in those collegiate programs that are terminal programs, is more related to novel curriculum developmental efforts and the diffusion of this innovation within the educational system than they are related to programs of continuing review and revision of core curricula. This latter role can as well be served by other agencies; given the developmental and disseminating efforts of the National Science Foundation.

2) The advantage of pluralism in the support of science education is as important as the pluralism related to the support of science itself. Where the educational effort is dependent upon or dominated by the research process, it is our judgment that it should remain as a pluralistic rather than a central support base.

3) NSF is concerned with the whole of science, and, in the national interest, receives support on that basis. Education for science is a part of the whole of science. Just as NSF's concerns for science include encouraging research and technology development programs in all departments of Government, so is its concern for science education inclusive and in no sense exclusive. Because of its particular responsibility for cognizance of the national status of all of science and for the support of research in the basic disciplines of science NSF has a singular rationale for decision making in the process of allocating resources to science education.

AN OUTLINE OF SCIENCE EDUCATION ELEMENTS OF THE NSF

A. Efforts directed primarily at education

1. Primary and secondary education (see B 1&2, C 1&2).
2. Collegiate terminal education (as above).
3. Graduate/professional scientific education; to maintain the capacity and creativity of the basic sciences.
4. Practitioner directed education (post-doctoral and continuing); to maintain currency in understanding and utilization of new scientific knowledge.

5. The electorate (to be informed on issues); to improve and maintain a public understanding of science and a public participation in the process of allocating resources.

B. Basic Research Related Education

1. Programs directed at the early identification of future scientists and the support of these persons in order to continue the flow of exceptionally talented young people into the basic science disciplines for the future.
2. Cognitive learning research related to the content of the basic scientific disciplines.

C. Applied and Developmental Research Related

1. The process of innovative curriculum development should continue to be in large part a responsibility of the National Science Foundation for primary and secondary education as well as for collegiate programs not only where the identification and support of future scientists is the objective but as part of enhancement of understanding of science by the public.
2. The dissemination of innovation, including the presentation of novel curriculum organization and content to teachers, should continue to be a responsibility of the National Science Foundation where the subject content is within the disciplines supported by the research programs of the Foundation.

D. Technology Diffusion and Evaluation

1. The programs improving access to science information and technology by state and local governments and its utilization should continue to be an educational process based in the National Science Foundation.
2. The programs offering encouragement for more extensive research and development collaboration between universities and industry along with the educational efforts that are necessary to initiate and continue such programs should remain within the Foundation.

3. The informational and educational efforts directed at small businesses in attempting to improve their research participation and the diffusion of their technology should remain within the National Science Foundation.

To reiterate, where the educational process is directly dependent upon the research environment or where the scientific subject matter so dominates the educational effort that it is dependent upon the subject matter specialist, it is our judgment that the National Science Foundation should continue to be responsible for the educational programs that are now within it. On the other hand, where the objective is to maintain continuing review and revision of core curriculum programs it is our judgment that this could very well be managed as effectively by another agency.

Where the educational effort is directed at the professional practitioner of science and engineering or where the effort is to transmit to the public substantive scientific information it is our judgment that there should be no change in the present levels of responsibility within the National Science Foundation.

In all cases, the present policy of interaction and cooperative program development with other agencies of government should be fostered.

NORMAN HACKERMAN

UNIVERSITY PRESIDENT, CHEMIST.

Born Baltimore, Maryland, March 2, 1912; son of Jacob and Anna (Raffel) Hackerman; married Gene Allison Coulbourn, August 25, 1940; children--Patricia Gale, Stephen, Sally, Katherine.

A.B., Johns Hopkins University, 1932, Ph.D., 1935.

Assistant professor, Loyola College, Baltimore, 1935-39; research chemist, Colloid Corporation, 1936-40; chemist, U.S. Coast Guard, Staten Island, 1939-41; assistant professor of chemistry, Virginia Polytechnic Institute, Blacksburg, 1941-43; research chemist, Kellogg Corporation, 1944-45; assistant professor of chemistry, University of Texas, Austin, 1945-46, associate professor, 1946-50, professor, 1950-70, chairman of department, 1952-61, director, corrosion research laboratory, 1948-61, dean, research and sponsored programs, 1960-61, vice president, provost, 1961-63, vice chancellor for academic affairs, 1963-67, president, 1967-70; professor of chemistry, William Marsh Rice University, Houston, 1970--; president, 1970--; consultant in corrosion, 1946--; in surface chemistry, 1948--.

Chairman, Gordon Research Conference on Corrosion, 1950, on Chemistry at Interfaces, 1959, member, board of trustees, 1970-73; chairman, Inter Society Corrosion Committee, 1956-58; member, board on energy studies, National Academy of Sciences/National Research Council, chairman, 1974--; member, National Board on Graduate Education, 1971-76; member, National Science Board, 1968--; chairman, 1974--; chairman, council presidents University Research Association, 1973; member, environment pollution panel, President's Science Advisory Committee, 1965-66; consultant, Association Universities for Research in Astronomy, 1964--; member, science and educational advisory committee, Lawrence Berkeley Laboratory; chairman, board of trustees, Argonne Universities Association, 1969-73.

Recipient, Whitney award, National Association of Corrosion Engineers, 1956; Joseph J. Mattiello Memorial lecturer, Federation of Societies of Paint Technology, 1964; Southwest Regional award, American Chemical Society, 1965; Palladium medalist, Electrochemical Society, 1965.

Fellow, New York Academy of Sciences, American Association for the Advancement of Science; member, National Academy of Sciences, American Chemical Society (board of editors, monograph series, 1956-62, executive committee, colloid division, 1955-58), Electrochemical Society (honorary member, president, 1957-58), Faraday Society, American Association for the Advancement of Science, American Philosophical Society, National Association of Corrosion Engineers (director, 1952-55, chairman, A.B. Campbell Young Authors Award committee, 1960--), International Society for Electrochemistry, Sigma Xi, Phi Lambda Upsilon, Alpha Chi Sigma, Phi Kappa Phi.

Technical editor, Journal of the Electrochemical Society, 1950-68, editor, 1969--; interim editor, Electrochemical Technology, 1965-68, adviser, editorial board, Corrosion Science, 1965--; editorial board, Catalysis Reviews, 1968-73; contributor of numerous articles to scientific journals.

Home: President's House, William Marsh Rice University, Houston, Texas 77001.

Excerpt from Who's Who in America, 40th Edition, Volume 1

Senator KENNEDY. Dr. Murray?

Dr. MURRAY. Mr. Chairman, I would like to express Dr. Hackerman's regrets at being unable to be here. He had a previous business commitment which could not be modified when the time of this meeting was changed.

His comments have been introduced into the record, I understand. I would also like to provide for the record the document, the "Status of Science Reviews—1979," (NSB-79-3), developed by the National Science Board, working with Foundation staff. As Dr. Hackerman's statement notes, the Board has reviewed the proposed plan for fiscal year 1980, and strongly endorses it.

Senator KENNEDY. What I would like to do first is talk in some broad strokes. Then I would like to hear the others, and then try perhaps to develop some of these points in relation to the budget itself.

So I think we will proceed in that way.

I think what we saw in the early part of the 1970's, the significant reduction in research effort in some very important areas—I would like to hear your own assessment about what the impact has been to the R. & D. community from those cutbacks. And then please give us some idea why we have seen an increase in this particular budget. It's obviously one that I am strongly in support of, but I think we ought to make the justifications for the record.

And then I am interested in the next 3 to 5 years, what the projections are going to be, because all of us are mindful that these things can't be turned on and turned off. I would like to see how you anticipate the flow chart is going to go for those particular years.

With these reductions that we saw in the early 1970's, what or how has our R. & D. effort really suffered from them or if it has suffered? It is your assessment that it has.

Maybe the others will have ideas on this as well.

I would also like to hear some sort of a justification for the increases this year, the need for the priority which you have given it, the reasons for it—and what you see down the line in terms of the next 3 to 5 years, what you anticipate in terms of projections or requests of the Congress, and what is important.

Dr. ATKINSON. Senator Kennedy, there aren't simple answers to those questions, as you know. They depend on what statistics you look at. If, for example, you ask about the Federal commitment to basic research in constant dollars, President Carter's budget this year probably would exceed the 1968 figure, a fairly high figure. And I think the measures I have given you in percent of GNP or percent of the work force are important. On the other hand, it is clear that the vitality of American science is probably greater now than at any time; the excitement in the scientific community is truly unusual. But there are problems ahead in funding; we are concerned about them.

Where we should go, what the exact projections should be, I can't predict.

Senator KENNEDY. Do you think we have suffered because of the reduction in the 1970's, not keeping pace with inflation? What's your assessment as a scientist?

Dr. ATKINSON. Some of our high-technology industries—those industries with the most favorable balance of payments, and whose productivity remains high—are based on close ties to universities and close ties to basic research developments. If these ties weaken, we will see the effects in the future.

Senator KENNEDY. What can we expect in terms of your planning now over the period of the next several years? What can we expect from the NSF in terms of basic research? I know we have budgetary problems, granted, but I am interested from the scientist's point of view, the general sweep, the general need, the Nation's need—what do you plan?

Dr. PIMENTEL. One of the changes that occurred during the last decade is that other agencies reduced their participation in fundamental research and damaged somewhat the plurality which has made U.S. science so strong.

And I do believe that President Carter has directly addressed that problem. He has tried to strengthen, both last year and this year, fundamental research in the mission agencies—DOE, DOD, et cetera.

It is my belief that over the next 3 to 5 years, having re-established this plurality, an increasing emphasis on NSF as the lead agency for the long-term health of science in this country is required. As the Director indicated, our long-term economic interest is strongly connected with maintaining our position of technological leadership in the world.

Another factor of decline in the last 10 years has been the lag in the particular area of instrumentation, and this must be redressed. Movement ahead in science is increasingly dependent upon sophisticated measurement instruments, and ultimately our ability to use

these instruments permits us to address social problems with a power that we had not before.

But we must bring ourselves up to the cutting edge in instrumentation, and this won't be a single-shot affair. Over 3 to 5 years, we must make a continued effort in this area.

Senator KENNEDY. Dr. Murray, don't you have a 5-year budget projection?

Dr. MURRAY. Mr. Chairman, let me respond to that in this way. In addition to the things which Dr. Atkinson and Dr. Pimentel have said, as you are perhaps as aware as anyone in this Nation, we face many problems, not only domestic but worldwide. Two important problem areas are those of health and agriculture. I have just this week returned from a trip to Africa, and it is quite apparent that we must continue to expand our basic scientific knowledge of how to improve agricultural productivity and provide sufficient food for the increasing population of the world.

One such program to which the Foundation has contributed support is the study of pest control or, if you wish to put it in these terms, pest warfare, through integrated pest management. This is a diverse research effort, supported by the Environmental Protection Agency and the Department of Agriculture, as well as NSF, aimed at bringing agricultural practices more nearly back into ecological balance and eventually ridding the environment of many of the pesticides that have been successful in the past.

The Foundation is interested in supporting all kinds of research which will contribute to the improvement of scientific knowledge, which may ultimately be applied in the interest of the welfare of the people of this Nation and of the world.

Senator KENNEDY. But do you have a flow line for the next 3 to 5 years?

Dr. ATKINSON. We have a 5-year plan, which is——

Senator KENNEDY. That's what I would like to hear.

Dr. ATKINSON. We can provide it for you.

[This material is provided in questions submitted at the end of the hearing record.]

Dr. ATKINSON. But I want to emphasize what Dr. Pimentel has said. Our role is balanced across the Federal effort in basic research. Just what the NSF role should be each year in each field of science depends on what else is going on. In the computer field, for example, we are increasing our efforts and having a stronger impact, in part because several other agencies have gradually diminished their efforts; they see it as less central to their mission-agency responsibility.

Senator KENNEDY. This is perhaps not directly related to the subject matter, but it's a matter of enormous importance, I think, to all of us—the problems that we are facing in the country and in the economy in terms of productivity.

Do you have any kind of rough assessment in terms of what we are doing in the research area on productivity? It is enormously complicated.

But I am just interested in your own assessment as to the impact of basic research on the questions of productivity in terms of our society—the economy, industry, other aspects of our society.

Dr. ATKINSON. Senator Kennedy, until about 10 years ago all the evidence was anecdotal. In the past 10 years, a much sounder base of research has been developed. It clearly indicates, a relationship between productivity and research investments, both for individual companies and for the country as a whole. It's correlational data; it's subject to debate. In the same way, most of our early evidence on cancer and its relation to smoking was correlational. But the accumulating evidence is so persuasive that I think there is a clear tie between research investment and productivity.

The President is much concerned about this issue, and an important study is being conducted now by the Department of Commerce on the critical factors involved in industrial innovation. That study, to be released next month, is supposed to put before the President policy options related to productivity. And I can tell you that issues of research, particularly investments in the more basic research areas, are going to be carefully reviewed in that document.

Senator KENNEDY. Well, we will be very interested in that. We ought to write to the Department and get that.

Senator SCHWEIKER. Would that study, Dr. Atkinson, also have the impact of Federal regulatory procedures—is that part of it?

Dr. ATKINSON. That is considered.

Senator SCHWEIKER. And how about patent laws?

Dr. ATKINSON. Yes, Those are reviewed in the study. It is a wide-ranging study, laying out options in each of these areas.

Senator SCHWEIKER. Going back to Senator Kennedy's question, the 46 percent decline in productivity growth rate from the period of the 1950's to 1968, compared to 1968 through 1977—what is your impression as to the principal reasons for this decline in growth? What general observations do you have about the magnitude of the decline, and what are the principal factors? You mentioned the relationship of productivity to research. Is that a principal factor in your opinion?

Dr. ATKINSON. Senator Schweiker, there are several factors. I come from the Stanford University area where in the 1950's and 1960's companies were spun off in high-technology areas at an incredible rate. These companies eventually matured into major industries.

Today, about one-fourth the number of companies are being spun off.

What are the different reasons? In part, the research thrust is not so vigorous as it was at an earlier time, but that is just one factor. Investment capital is another factor. I am not really in a position to give a simple answer, but there is no question in my mind that research and development is a key factor. We have fallen behind in the amount of research this country should be doing.

Senator KENNEDY. But the relationship between the NSF and industry—you made a comment about this. And this has been something that the members of the committee have been interested in. This has been a program which has been working and has been somewhat successful. Perhaps you could elaborate on that.

Also, could you relate it to this other theme that Senator Schweiker and I are talking about in terms of productivity. Are we getting this research out? I think we are all very mindful of the

percent of research that is being done in terms of NSF and its basic kinds of research and how you transform that into other kinds of activities.

Perhaps you could talk about the relationship or cooperation between industries and universities and the role that NSF is playing.

Dr. ATKINSON. As I indicated, the technology-intensive industries, the industries with a good balance of payments, are vital industries in this country. What characterizes them, at least in my view, is a close interaction between university and industry scientists and a strong research thrust in those industries.

Now, to the extent that such interaction and thrusts decline the consequences will be unfortunate. Once again, we have to encourage the exchange of ideas between scientists working in industry and in the universities. In part, that is our concern here—to encourage more joint activity.

Another example, one important to keep in mind as we examine Commerce's suggestions for innovation, is what we call our university-industry cooperative research centers. One example is at MIT in the polymer sciences, where about 12 companies collectively contribute about \$500,000 a year to a particular MIT laboratory. In the early days, NSF also provided funds, but we have gradually reduced our funding to zero. Those 25 industries, working closely with MIT scientists, review the research going on at MIT. They indicate particular problems and the kinds of development they would like to see pursued.

I think that type of research center, heavily supported by funds from industry but with close interchange between industry and university, is useful. I would like to see more centers that would encourage this type of industry support of research in universities. This is the type of issue that will be brought forth by the Commerce study.

Senator KENNEDY. Obviously one of the concerns—as research is supported by public funding—is the need to protect the public interest as well as to encourage the transfer of this kind of information to the private sector. You mentioned earlier the Commerce Department study. Perhaps it will include some recommendations regarding patents and other factors.

This is also a matter of concern to us on the Judiciary Committee, although we really haven't reviewed it fully. We had copyright legislation 3 or 4 years ago, but it was targeted on other aspects, not on this basic issue. And it seems to me we ought to take a look at this aspect and find out whether there are impediments to innovation and the stimulation of productivity. That's an additional area which I suppose we can't really address very extensively in the time available today.

Dr. ATKINSON. Senator Kennedy, the more research an American firm does abroad, that is, outside the United States, the lower its overall tax bill is going to be. The extent to which we encourage American firms to conduct research and development outside the country is worrisome.

Senator KENNEDY. Yes, for what particular reason?

Dr. ATKINSON. The nature of our tax law. It's not related to patents; it's related to the tax structure.

Senator KENNEDY. Let me ask you what's being done with people in science. One of the very important needs in our society is for people who understand the importance of basic research, research science programs. Obviously the polls show that there is an enormous sympathy for this type of effort.

What do you see the role of the National Science Foundation in being able to develop sort of a bridge between the consumers' understanding of both the need for this type of a program—what it can mean in terms of their lives, what the complexities and the difficulties are—and having that work from sort of a two-way street, and having the scientists and the researchers have at least some kind of acquaintance and familiarity and sensitivity in the areas of concern to consumers—science and people.

Can you talk a little bit about that?

Dr. ATKINSON. Senator Kennedy, you have provided a question and an answer at the same time.

I am much concerned about the message we seem to be sending from Washington: The job market in the sciences is bleak; the sciences are not good career possibilities for young people. Nothing could be further from the truth. In a few areas of science the job market is difficult, particularly if a student wants to follow the pattern of an earlier period—receiving a Ph. D, going into a university, and starting his or her own laboratory.

But continuing opportunities suggest science is a rich field for the future. In the recent trips that I made to the Soviet Union and to China, I saw an incredible enthusiasm and commitment in those countries for drawing some of their best people into the sciences. I worry about our capability to attract the best people when we say that the future is so bleak, when the announcements are counter to what I think the facts are.

The other side of your question, American public understanding of science, is critical. The Soviets now speak knowledgeably about what they call the science and technology revolution. Starting in the 1960's, they began to realize that the concept of labor as the cutting edge of productivity was outdated. Their view now is that science and technology are really the cutting edge of productivity.

So, as we continue to move into an era increasingly characterized by the central importance of science and technology, it is not enough for a small corps of people doing the science to be familiar with science. The familiarity with science must pervade the whole society, and particularly it must be much stronger in our educational system than it is.

Senator KENNEDY. What can you people do about it and what are you doing about it?

Dr. ATKINSON. On the one hand, we have the public understanding of science programs for adults. At the same time, we are stressing science education for young people in the schools.

For example, we are funding through the Children's Television Workshop, a TV series for junior high school students, 8- to 12-year-olds, by which they are exposed to scientific concepts.

We are concerned at the Foundation that too many young people drop out of science in the junior high school years. Once out, it seems the students can never quite return to science. We think

science education in the junior high school years needs more attention.

Senator KENNEDY. Maybe you could talk a little bit about that, about science education. I think from what you have stated you have given your own sense of interest in this.

But what really is, you know, happening. We take note, for example, that there are no science educators on the Board from high school levels, not that that is a final determinant.

What changes have taken place, if any, in the area of encouraging science education? And one of the dramatic areas obviously that we have seen over a period of time is the dropout of young women in the area of science education, and that is complicated because of counseling and all the other kinds of pressures that exist in terms of high schools, which I think we have some familiarity with.

Have there been changes in terms of science education which have taken place or that will be reflected in this kind of a budget, and what can we expect, you know, from this program?

Dr. PIMENTEL. Sir, there are two particular changes that Dr. Rutherford has brought into the Science Education Directorate that I believe are directly responsive to your questions.

Senator KENNEDY. Maybe Dr. Rutherford can answer that. Would you rather answer it?

Dr. PIMENTEL. I am going to resent it if he says yes. [Laughter.]

I'll make a brief remark or two and then perhaps Dr. Rutherford can correct and amplify.

The thrust that represents the major challenge to science education in this country at this time is to make science education available to everyone, not merely to those who might elect to become scientists.

Our idea is to make science education available at an earlier age, at the pre-adolescent age. This is a time in young persons' lives when they are not yet ready to decide against science. They don't yet have the cultural imprint that causes women and minorities to consider that science is not for them. And we can reach all of the citizenry at this age level.

We also emphasize the need to raise the entire spectrum of scientific literacy in a positive way. Everyone in this country participates through our representational government in determining technological decisions that affect everyone's life. We must move everyone upward on that scientific literacy spectrum. And I believe that Dr. Rutherford's program does that.

In addition, at this particular adolescent period, we have the maximum opportunity to avoid the cultural imprint on women and minorities that science is not for them. We are addressing this point where we have the greatest leverage.

The other aspect of major change, I believe, is our emphasis on trying to understand the cognitive learning process. That's why you see in our budget such a strong emphasis on science education research and development. I do believe that Dr. Rutherford will want to amplify these remarks.

Dr. RUTHERFORD. Senator, I think that what you will not find, when you look at the Science Education section of this budget document, is a large increase in funding for science education.

What you will see, if you look down inside, is that every single program is addressing one or both of two missions. One is that which Dr. Pimentel just mentioned; that is, the broad question of scientific literacy. The other is the question of access to scientific and engineering careers. Every single program is being bent to address these two missions. Now, embedded in that, then, is an emphasis on R. & D., in order to learn what the troubles are, how to deal with them better, and how to get better materials. A second emphasis is to work with the younger children, the 10-, 15-year olds, inasmuch as 60 percent of them or more have made up their minds whether they will be scientists by grade 9.

There is one other aspect to this problem, and that is if you want to address either of these two problems, you can't do it all in the schools. And so you will see in the budget an increased emphasis on informal education—television, outreach, workshops, scientists working with people on real problems.

All of these things together, we think, over a period of time will begin to make some headway.

Senator KENNEDY. I suppose that emphasizes the sensitivity of this type of a program and the kind of uniqueness in terms of science education. I imagine that some of you would be very much concerned, that is would be grafted on to a general kind of education program and maybe be threatened.

Dr. Rutherford Well, in all of these activities it is important that scientists be involved.

Senator KENNEDY. I want to ask two quick questions. Then I want to hear from Senator Schweiker and our panel, and then come back to the basis of their observations.

One is, we saw in the papers this morning the scientists who indicated their refusal to involve themselves in an exchange with the Soviet Union. We were faced last year with a basic prohibition of funding on the floor for permitting the NSF to be an instrument for scientific exchange.

What I am interested in is whether you feel, that individual acts of conscience in terms of these types of exchange are more consistent both with scientific freedom, individual kind of a freedom, and effectiveness, rather than just a prohibition and a ban against the National Science Foundation, which we prohibited from involving themselves in scientific exchanges.

Maybe you could speak on that just briefly.

Dr. ATKINSON. Senator Kennedy, I am much in sympathy with the issues related to the document reported in the paper. I am also in sympathy with the nature of the amendment introduced last year with regard to NSF.

On the other hand, I thank this committee for examining the amendment with care and not acting favorably on it. The amendment would have placed the Foundation in an impossible situation.

If I were not a member of the administration, if I were a private citizen, I would have signed the document that appeared in the paper today.

Senator KENNEDY. Your point is, I gather, that as an individual action you think this is a stronger expression of either concern about it or indignation or outrage—whatever term you want to use with regards to the policy—and that it is better to have it done

through individual acts of conscience rather than as a matter of governmental policy determination.

Dr. ATKINSON. At this time, I would favor the individual action.

Senator KENNEDY. And how do you react to the—or do you react to the point that is raised by dissidents in the Soviet Union that their ability, from a professional point of view, to maintain some degree of awareness and understanding is continued by this type of exchange.

How do you react to that?

Dr. ATKINSON. I would hate to see us cut off all of our relationships. Those contacts are important. It's a complicated balance.

Senator KENNEDY. One that is really left more to the individual rather than to governmental policy—is that where you come out?

Dr. ATKINSON. At this point, that's where I come out.

Senator KENNEDY. Finally, there has been an increase in the administrative costs of your NSF. Will you tell us why?

Dr. ATKINSON. A significant increase?

Senator KENNEDY. Yes, I think the expenses are close to 6 percent of your budget.

Dr. ATKINSON. Yes, we view this as somewhat low.

Senator KENNEDY. The total expenditure, instead of being under 4 percent, is now close to 6, as I understand it, is that correct—for administrative costs?

Dr. ATKINSON. I don't think so. Dr. Wilson?

Dr. WILSON. It's 5.9.

Senator KENNEDY. It's 5.9? What has it been the last 4 years?

Dr. WILSON. It's been about the same, 5.9—1976, 5.8—1977, 5.7—1978, and estimated to be 6.2 in 1979.

Dr. ATKINSON. What are the reasons for the increase?

Dr. WILSON. Primarily, increased personnel costs, increased cost of travel and for consultants on the panels which have oversight responsibility over individual programs.

Senator KENNEDY. Why don't you just provide that, because we will be asked about it; give us a note on it.

[This material is provided in response to supplementary questions for the record printed at the end of the hearing.]

Dr. PIMENTEL. It's more a corrective move for a cumulative erosion, and modest too.

Senator SCHWEIKER. Dr. Atkinson, you said in your statement that 20 percent of the basic research in this country is now done through the Foundation.

Dr. ATKINSON. I meant to say, Senator Schweiker, that the Foundation receives 18 percent of the Federal budget that supports basic research.

Senator SCHWEIKER. Oh. Would you have a rough idea what that NSF effort would be in terms of all the basic research in this country?

Dr. ATKINSON. About one-eighth of the total R. & D. budget of the country, both private and Federal, is devoted to basic research. About two-thirds of the basic research budget is funded by the Federal Government, one-third by the private sector.

The private sector had a larger role in the support of basic research 15 years ago, even 10 years ago I don't have the exact

percentage decline, but the private sector has not maintained as big a portion of the total basic research funding as it once did.

In a certain sense, there is some merit to that. Clearly the private sector should be the dominant force in applied and developmental efforts. But in basic research, particularly because of the complexity and long-range implications, it makes sense for the Federal Government to have a significant role.

Senator SCHWEIKER. Why has the private role declined that much, in your opinion?

Dr. ATKINSON. Senator Schweiker, if a company is trying to maximize profits over a 5-year period, it just does not make a great deal of sense to spend much of the research and development dollar in basic research. The company really should be spending its dollars on those items that are going to pay off in 5 years. I think many businesses are trying to maximize short-term profits; they are not looking down the road 20 years or so.

What all their reasons are, I don't know. I think private business is recognizing this problem, and some of the strongest support for the Foundation has appeared in recent years from the industrial sector.

Senator SCHWEIKER. How much applied research do you do through the National Science Foundation?

Dr. ATKINSON. We have a small applied science effort in the Foundation. Of course, so do other agencies of the Federal Government.

Senator SCHWEIKER. What is your effort directed toward?

Dr. ATKINSON. There are some targeted areas, but there is also an open window for a part of the effort. In general, we look at problems where there is no direct, mission-agency responsibility, but where there are good ideas for applied science that will move the basic research into some application at a faster rate.

Obviously, if an applied science proposal comes to us and it should be sent to the Department of Energy or the Department of Agriculture, we direct the proposal to those departments. But if the proposal doesn't have a natural home somewhere else in the government yet clearly is a good idea and should be pursued, we pursue it.

Now, there are exceptions. We have an unusual set of contacts with the university community. In some instances, through such contacts we may do a better job of applied science research support than certain other agencies. And we may devote part of our effort in applied science to such projects.

Senator SCHWEIKER. We commented earlier and have seen the charts on the growth of the Soviet Union's research effort.

And I wonder, where the Soviet Government has made a conscious effort to increase its research effort. Are there any other factors, in your mind, that account for this increase that we should be cognizant of, aside from just a general government policy of elevating their effort in this area?

Dr. PIMENTEL. One factor emerged in a forum conducted by Mr. Baruch for the Commerce Department. It concerns direct Federal support of research in industry.

In the forum, comments were invited from industrial and public interest groups. The industrial group, with strong representation

from both small business and large business firms, emphasized the belief that it is important to strengthen the coupling between industrial scientists and university scientists. They held that the long-term health of industry—small industry as well as large—and the country's overall economic health depend on such stronger coupling.

The industrial group also expressed a desire to have industrial scientists play a somewhat larger role in determining the research agenda of the country.

We believe that some of the programs of the Foundation respond directly to these two points. We have the industry-university cooperative program that is responsive to the desire for stronger coupling. And we hope to see it grow and become a healthy activity. Dr. Atkinson has mentioned some of the other activities that bring industry into an active role in the university setting.

We are also hunting for ways to respond to the other desire: To enlarge the role played by industry in setting the research agenda.

Senator SCHWEIKER. That coupling you are talking about, is that your resource center for science and engineering that we just established, or is that something different?

Dr. ATKINSON. No, that is different.

Dr. PIMENTEL. We have a program in which joint proposals from university and industrial scientists for the conduct of basic research, either in the industrial laboratory or the university laboratory, meet a criterion of special merit that causes us to favor funding.

Senator SCHWEIKER. Let me ask the same question in terms of our country's research effort relative to that of West Germany and Japan.

Are there any factors that are pre-eminent in West Germany and Japan that, in line with the trends on the charts here before us, we ought to be cognizant of in government policies?

Dr. PIMENTEL. I can respond in part. I refer to a point that came up in the Commerce Department's public forum. Some proposals, made by industrial people for Federal support of industrial research activities in the university setting, posed some difficulties in our particular system because we insist upon accountability for the use of public funds.

In the open discussion that followed, Dr. Menden, science attache from West Germany, outlined a program somewhat similar to ours. They had grappled with the problem of getting industrial participation and still maintaining accountability. I believe that program is one we will want to look at and perhaps learn from.

In the Japanese economic situation, we find there—for complicated economic reasons I can't address, Senator—much more venture capital is available for adventurous and innovative industrial development. They simply have more capital available to explore new ideas. We must look again at why they are able to come up with more capital than we.

I believe that is a correct statement I am making.

Senator SCHWEIKER. Dr. Atkinson, do you want to comment on this?

Dr. ATKINSON. No, I think I've covered that subject.

Senator SCHWEIKER. I followed with interest your implementation of the regional instrumentation facilities program, and I was impressed with the awareness that NSF has shown in its program solicitation for round two and the need to focus on basic research.

And I am also aware of the broad review that you are undertaking to determine to what extent NSF-funded equipment is being used to advance fundamental knowledge, and what policies can be formulated to limit unfair competition by NSF grant recipients with the private sector.

We have had some discussions on this, Dr. Atkinson, in terms of the small private sector research institutions feeling that the non-profit sector sometimes has an advantage.

For the record, would you comment on that general problem and explain what you are doing—and, I might say, I am impressed that you have been responsive to some concern in this area.

Dr. ATKINSON. In our original planning for regional instrumentation facilities, we didn't consider broadly the possible inputs of small business and industry. But after our first solicitation, we had several discussions with small business and industry representatives. Our new program announcement clearly opens the door to competition for those facilities. I believe that is satisfactory to all sides.

Dr. PIMENTEL. I have participated in discussions with representatives of small industry who are interested in providing services rather than actually making use of federally supported scientific instrumentation.

I think the discussions that Dr. Krumhansl and I have had, with the industrial people reassured them that we highly value industrial participation in the development of sophisticated instrumentation, and we do not wish any of our policies to inhibit or constrain at all that development.

When we see any opportunity for industrial facilities to provide the needed instrumentation, we will be careful to honor, protect, and encourage it. I do believe that our discussions have been educational for us and reassuring to them.

Senator SCHWEIKER. I have another question that really deals with the same point. A lot of the smaller businesses have really had trouble in meeting requests for bids or requests for proposals from the Federal Government because of sheer paperwork problems. I know you folks, in your latest innovation, came out with a proposal limited to 20 pages. And while that may seem like a lot, that's a real milestone and record of reduction of paperwork for the Federal Government. And the small businesses were elated with that.

Their reaction just shows you how this kind of thing really impacts on small businesses that don't have the capacity and the capability of a big staff for in-depth back-up to fill these forms out.

So I want to commend you and say you have been responsive, and I hope we can get some other departments and areas of the Government to be equally sensitive to this problem.

Dr. ATKINSON. Senator Schweiker, I would just like to add that we have done something rather unusual this year. It may strike you as odd when you first hear it, but competition for research funding has been so severe in recent years that proposals have

gotten substantially longer. So this year we imposed a 15-page limit on the description of research projects. The appendix and budget may be as long as the investigator wants, but the description of the research project, except in special circumstances, must be limited to 15 pages. We think it makes great sense; the scientific community has received it well. And it will be interesting to see if any other agencies follow suit.

Dr. PIMENTEL. There are other dimensions in which we have simplified paperwork. We have developed, on an experimental basis, a master grant proposal which we believe will reduce again the amount of paper generated by a person who wishes to conduct research and, I might add, the amount of paper that the Government itself generates in order to respond appropriately to the needs for accountability.

Senator SCHWEIKER. I did notice in your budget that there was a decrease of about \$500,000 in the Minorities, Women, and Physically Handicapped science program.

I wonder if you would comment on that and what your thrust is in terms of that program.

Dr. ATKINSON. That is in Dr. Rutherford's area, and I would like him to comment.

Dr. RUTHERFORD. Well, Senator, there was a small reduction, but it was because we were moving funds around in our regular non-targeted programs. If you were to make an analysis of all science education funds that during that year will in fact go to support one aspect or another of women-in-science and minorities-in-science activities, you'll see that the total amount is up.

But in that program which was experimental, we felt that we had learned enough there so that we could move some of those funds elsewhere.

So it isn't less of a commitment; it's just a different way of using our funds.

Senator SCHWEIKER. Have we learned enough in this program, Dr. Rutherford, to apply it to other government activities and other government proposals for research. Can we utilize this knowledge to help women, minorities and the handicapped in other government programs?

Dr. RUTHERFORD. Well, we have learned some things, certainly some things that will help us. And in fact just yesterday I reported to the Federal Interagency Committee on Education on what we had developed in the way of knowledge and ways of dealing with the problem in the cases of both minorities and women. The response was quite good on the part of several other agencies to see if they could develop similar approaches.

Senator KENNEDY. Do you know what is being spent on minorities and women in the other sectors, in the other programs?

Dr. RUTHERFORD. Within the Foundation?

Senator KENNEDY. Yes

Dr. RUTHERFORD. Well, we are examining it.

Senator KENNEDY. Well, how can you say it's increased, then, in response to Senator Schweiker's question?

Dr. ATKINSON. I think he was referring to a cross-cut in science education.

Senator KENNEDY. Not in the women and minorities then?

Dr. ATKINSON. That's in the science education program.

Dr. PIMENTEL. Let me reply why I think Dr. Rutherford is a little reluctant to just add up some numbers and come out with an answer. I mentioned earlier with perhaps what sounded like an evangelistic feeling—because I feel it—the program aimed at early adolescents. I believe the program addresses the question of helping women get into science as well as we can, but we cannot say that the entire program is directed toward women and minorities, because it has a broader range, too.

One thing I personally have learned in education at the university is that we can try to solve the problem too late. Once the cultural imprint is there—once a woman has decided that she is expected to be poor in mathematics—it is very, very difficult to dislodge. Consequently I believe that movement of attention to women and minorities in other programs is a substantial response to this legitimate need.

Senator SCHWEIKER. One final question. During the debate in the last session of the Congress on legislation to raise the mandatory retirement age, one of the real problems that was discussed by our committee was the problem of limited positions on college and university faculties.

I guess my question to you is, in view of what Congress has done—and we are all responsible for it obviously—do you feel this new law, with the higher mandatory retirement age, will severely limit the number of young scientists who are coming up through the academic route from obtaining good positions and professorships.

Dr. ATKINSON. Senator Schweiker, that is an important issue for the National Science Foundation. Much of what is basic research in this country is done in universities. In order to ensure a solid core of scientists to conduct this work, we must have a flow of young scientists into the universities.

Right now we are still on an increasing curve in the number of people of college age. But in 1981 we will hit the peak, and in the following 12 years, we will have a 19 percent drop in the number of college-age people. That is going to affect dramatically the ability of small colleges, even many universities, to keep their doors open, and it's going to affect dramatically the prospects for new faculty coming into the system.

Obviously, the age 70 limitation changes that picture somewhat. But a bigger issue is the number of young people flowing into our university faculties. We have looked at that issue; it's complicated, with tremendous variations from one field of science to another. Of course, it affects the humanities, too.

But after a series of studies—some by us, some by other groups—we do not have enough evidence at hand to come to a clear view as to what should be done. It's also clear that the worst problems are going to start in about 5 or 6 years. So we are shooting to have a much clearer view next year. We are mounting a major study in-house, and we have asked the National Academy of Sciences to conduct a study. I have been told that the National Endowment for the Humanities has asked the Academy for a follow-on study relating to the humanities in the universities. It's a major issue for the country and one that we must address.

Senator SCHWEIKER. Thank you.

Senator KENNEDY. Senator Pell?

Senator PELL. I regret that I wasn't here earlier, and that I have to leave at 11 to start a hearing at the Foreign Relations Committee. But I just wanted to express not only my interest, but keen interest in the work that the committee and the NSF has been doing. I hope that for the record you will be able to submit some explanation as to what you are doing to follow through on IDOE—the International Decade of Ocean Exploration which wraps up this year. Let us know what your budget is and what you intend to do to follow up on that decade so it will not be a decade that was wasted.

I wish I could be with you for the whole morning, and regret that I must leave.

Senator KENNEDY. Thank you. Dr. Hornig?

**STATEMENT OF LILLI S. HORNIG, EXECUTIVE DIRECTOR,
HIGHER EDUCATION RESOURCE SERVICES, WELLESLEY, MASS.**

Senator KENNEDY. I thought with the comments on women in science, it might be an appropriate introduction. We are delighted to have you here.

Senator PELL. And she's a Rhode Islander, too.

Dr. HORNIG. Thank you, I claim both Rhode Island and—
Senator Kennedy And Massachusetts.

Senator SCHWEIKER. Can't we work Pennsylvania in there somehow?

Dr. HORNIG. I very much appreciate the opportunity, Senator Kennedy, you have given me to comment on Federal policies and programs concerning women in science, particularly as they relate to the National Science Foundation, and a number of the programs that have been under discussion here this morning.

I have spent many years working on these issues as a professor in the chemistry department at Trinity College here in Washington, later as director of Higher Education Resource Services, and also as chair of the committee on the Education and Employment of Women in Science and Engineering of the National Academy of Sciences.

This latter group is just completing a report on the status of women scientists in academe which we will be pleased to transmit to the subcommittee in a few days.

My remarks today are addressed to possible programs for ameliorating the continuing under-utilization of women's scientific training and talents in the national science effort.

As has been mentioned several times this morning, science has traditionally been considered an unsuitable field for women and the efforts to change that view are very recent.

Today about one-tenth of all scientists holding a Ph.D are women, and the proportion is increasing each year. Women have entered advanced training in steeply rising numbers in the last decade, and now obtain about a fifth of all science doctorates.

This dramatic increase is due not simply to a changing social climate, although that has a large part in it, but very explicitly to the movement toward equal undergraduate and graduate admissions and the greater accessibility of fellowships and loan support.

The latter change has resulted directly from congressional initiatives in title VII of the 1964 Civil Rights Act, although sex got into that rather by accident; title IX of the 1972 Higher Education Amendments with which Senator Pell was closely involved; and the equality-in-credit statute.

However, men continue to be advantaged in both education and employment. Throughout the educational process, as Dr. Pimentel commented, fewer girls and women continue in science at each stage of training, despite demonstrated equal ability. They receive little encouragement to do otherwise and need only look ahead to women's employment opportunities in science to confirm the judgment that this has not been a promising field for them.

Women scientists are unemployed 3 to 5 times as often as men with the same education and ability. About one-fifth of them cannot find employment as scientists at all and must work in other fields.

Women scientists' average salaries started out last year about \$1,500 lower than men's, and the differential grows over time to something of the order of \$10,000 annually.

Now, all of this is true despite the relative shortfall in our scientific workforce, with comparison to other nations to which Dr. Atkinson alluded.

I might suggest that a very rapid way to increase that workforce is to include more women in it; they are already here, fully trained.

Now, all this is evidence that Federal equal opportunity policy has not yet been carried out effectively in the scientific community. There has been marked improvement in the last few years, however, with much better employment opportunities in academic institutions, despite the overall downward pressures in that sector, and with the doubling of industrial employment of women scientists.

Unfortunately, Federal laboratories and agencies have not shared in this progress. Less than 5 percent of all women scientists are employed there, but only 3 percent of recent Ph. D's. This already low participation is further aggravated by unequal treatment on the job. For example, in the Department of Energy and in its predecessor, the Energy Research and Development Agency, 85 percent of all male professionals were above Grade 12 but only 12 percent of similar women. Conversely, 8 percent of those men, but less than 1 percent of the women, were at the top two grades.

In the academic sector, the distribution of women scientists is similarly skewed.

Almost half of all academic male scientists are full professors, but only about one-tenth of the women. There are no differences in ability between men and women scientists which might explain such very different rates of progress. They are equally capable.

The scientific community at large has long looked to the National Science Foundation for leadership in science programs, and the NSF has been responsive to emerging needs and has stimulated and supported many important advances.

Leadership in the area of women's programs has been very slow to develop, although we are very much aware of the recent upswing in that area.

All of its research and education programs, of course, have always been open to women in principle, and most have in fact included them, but no special effort to encourage participation by women, either in science education or in research, were made until the last 3 years. Growing awareness in recent years by NSF of the need to tap women as a source of scientific talent has been reflected in the establishment of a separate although very small pilot program for women in science.

Current appointments of women to NSF advisory committees have risen so they are now in good balance with the availability of women scientists.

Both congressional oversight and Foundation leadership played a crucial role in these developments.

The proposed establishment of part-time post-doctoral fellowships is an excellent step. It responds very constructively to the growing problems that young families face in combining their professional aspirations and their parenting obligations.

A further desirable step would be provision of portable fellowships to enable professional families to stay together when only one spouse can find a suitable academic position in the very depressed academic labor market.

The proposal to reduce the small targeted programs for women in favor of incorporating a focus on women in all of NSF's programs is sound in principle, I believe, but, to my mind, it is an idea whose time has not yet come. For many years, since the equal opportunity in education and employment policies were mandated NSF has had ample opportunity to develop such a focus for minorities as well as women in all of its programs.

Now, to do this kind of thing effectively requires the development of a staff cognizant of the problems and an advisory apparatus within the scientific community which is responsive to the needs of affected groups. I believe it's true that all programs that have been developed in NSF have just this kind of support.

Neither of these mechanisms is now in place in programs for women nor, I believe, for minorities. Until they are it seems unwise to decrease the only program which is now designated for women.

In that connection, I would like to remind you that the title IX fellowship program which was established under a statute designed for women's educational equity was in fact converted into a minority fellowship program instead.

In science education programs, which have figured so prominently here this morning, at both school and college levels, there are many excellent ways to involve girls and women which have not yet been taken advantage of.

School programs, for instance, especially at the junior high and high school levels, where they are elective programs, should not be funded unless they can demonstrate that equal proportions of girls and boys will participate. That simple requirement would greatly increase girls' involvement in science and would be entirely consistent with the obligations of affirmative action in title IX.

To my knowledge, this has not even been considered.

Similar conditions should be attached to undergraduate research participation programs and could also be extended to advanced research programs.

More generally, in the area of science education, I would like to comment that one of the problems girls and minorities face in that area is a certain rigidity of thinking on the part of scientists about how science education should be conducted. There tends to be a very pronounced sequential character to science training, and there are good, sound internal reasons for that, but we have not yet experimented with how much we can loosen up that lockstep approach and provide access at many different levels to people who come late to the recognition that this is something they would like to do.

So far the scientific community has rather passively accepted the cumulative attrition of women from successive levels of science education for too many years. It has generally not even experimented with active efforts to recruit and retain women. One field where such efforts have been made, with dramatic success, is engineering. Faced with declining enrollments 11 years ago, engineering schools have actively sought women students and increased their enrollments tenfold since that time.

In connection with science education programs, I believe that the interests of women would be best served by retaining these programs within the National Science Foundation. This location would preserve the vital link between active scientific research and the teaching of science at all levels which has proved so beneficial. The high school science programs developed under NSF sponsorship about 20 years ago were one of the real success stories of secondary education. Their quality derived from the active involvement of the scientific community which could not be easily duplicated under the aegis of the proposed Department of Education. With the growing interest of that scientific community in women's education, we believe that a continuing close tie of science education to NSF would most rapidly accomplish the integration of women into science. Conversely, because so many women scientists are involved in education, severing these programs would also cut off a great many women from their connection with active science.

All the evidence we have points to the need for specific targeted programs to also increase participation in advanced research by both minorities and women.

I would like to emphasize that while we all have an abiding interest in science education, the cutting edge of science lies with advanced research and not with elementary and secondary education, but women are known to be underrepresented in research. For example, women now submit an unduly small proportion of research grant proposals—not because they cannot do research or don't want to, but because most institutional regulations do not allow non-tenured staff to submit proposals. The vast majority of women scientists are not tenured, and cannot apply. Mechanisms for making such applications possible could be developed readily by NSF in cooperation with universities. I am well aware of reasons why it is difficult internally for universities to allow nontenured staff to pursue research proposals, but I do believe mechanisms can be worked out. If they were in place, they could well produce quite

a dramatic increase in research proposals from women resulting in their better integration in the overall research enterprise.

There is also an urgent need for programs to update and keep current the research skills of scientists who teach in smaller institutions in situations where independent research programs may not be feasible. That group includes both men and women and it is growing larger in comparison to scientists at research universities because of the decreasing possibilities for tenure there.

Women scientists are predominantly employed in such nonresearch colleges and universities. Their scientific potential would be better utilized and their teaching enhanced by the fostering of cooperative research programs with larger universities, and ideally also with industrial laboratories.

Women scientists would benefit in general from enhanced cooperation between academe and industry, through opportunities to become consultants as well as directly by improving access to industrial employment. Business and industry employ a quarter of all male scientists with Ph. D.'s, but still only 7 percent of such women, despite dramatic recent progress. Clearly this is an employment area that needs cultivation—

Senator KENNEDY. Yet they do better than the Federal Government did.

Ms. HORNIG. Yes, I believe only about 5 percent of all women scientists are in the Federal Government.

Senator SCHWEIKER. If they are not in the private sector, where are they?

In other words, you say business employs only 7 percent, and where are the other 93 percent?

Ms. HORNIG. There are about 7 percent, in industry, about 5 percent in the Federal Government, and about two-thirds of the female scientists are employed in academe, leaving about 20 percent either unemployed or not working as scientists. A higher proportion of women than men work in academe, but in different positions. They hold almost all the very lowest positions.

Senator SCHWEIKER. That is about 65 percent?

Ms. HORNIG. It is approximately that.

Senator SCHWEIKER. What would the comparable male figure be in academic positions?

Ms. HORNIG. About 55 or 58 perhaps.

Senator KENNEDY. Of course, those are very specialized. Even in an area like the universities, those are much more targeted, are they not, into social scientists, life sciences rather than engineers, physical scientists, environmental scientists, is that not so?

Ms. HORNIG. Engineering, mathematics, and physical scientists account for probably close to half of all the scientists in academe.

Senator KENNEDY. The point on this chart, and then we will proceed, we have even listing the full-time scientists and the engineers of the 50 leading private institutions in employment of scientists and engineers in the field, January 1978, engineers, a comparable example, Harvard has 48, which 1 is a woman, and Cornell 316 of which 8 are women, and MIT, 752 of which 9 are women. Then it continues down to Columbia, University of Southern California is 168 of which none are women [indicating on chart].

Ms. HORNIG. You are right. I misunderstood your question slightly. I thought you were asking about all scientists in academe.

Senator KENNEDY. Northwestern University, 133 of which 42 are women. I will put this in the record.

[The chart referred to follows:]

TABLE B-30. FULL-TIME SCIENTISTS AND ENGINEERS AT 50 LEADING PUBLIC UNIVERSITIES
IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS BY FIELD AND SEX: JANUARY 1978

	TOTAL, ALL FIELDS		ENGINEERS	PHYSICAL SCIENTISTS	ENVIRON- MENTAL SCIENTISTS	MATH. AND COMPUTER SCIENTISTS	LIFE SCIENTISTS	PSYCHOLOGISTS	SOCIAL SCIENTISTS
INSTITUTIONAL RANKING	GRAND TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN
TOTAL, ALL PUBLIC INSTITUTIONS	168355 26144	18391	406 18314	1501 6424	406 18197	2579 6516	12965 12299	3001 29580	5286
1 UNIV OF WISCONSIN-MADISON	2965 714	281	16 230	29 195	35 188	9 1573	472 159	62 339	91
2 UNIVERSITY OF MINNESOTA	2901 657	184	0 153	8 62	3 139	11 1718	315 128	25 517	95
3 UNIVERSITY OF MICHIGAN	2728 746	368	24 260	37 95	4 110	11 1434	537 151	52 310	81
4 OHIO STATE UNIVERSITY	2361 469	280	10 156	8 50	2 114	6 1434	398 48	6 279	99
5 TEXAS A & M UNIVERSITY	2072 98	346	6 97	4 77	3 109	6 1032	21 41	7 370	51
6 UNIV ILLINOIS URBANA	2046 453	371	81 263	46 65	15 202	52 808	132 173	44 364	83
7 UNIVERSITY OF FLORIDA	1998 305	212	2 65	0 27	0 65	4 1478	280 41	8 100	11
8 LOUISIANA ST UNIV SYSTEM	1978 463	967	0 49	2 117	21 1440	408 41	8 128	20 81	
9 UNIVERSITY OF WASHINGTON	1964 341	289	6 114	5 171	11 78	4 1074	273 47	13 191	29
10 PENNSYLVANIA STATE UNIV	1903 159	448	8 198	9 88	4 195	27 697	66 73	19 204	26
TOTAL 1ST 10 INSTS.	22906 4205	2886	153 1632	148 879	81 1317	151 12488	2902 902	244 2802	526
11 UNIV OF TEXAS AT AUSTIN	1680 343	239	27 399	33 144	25 154	18 214	68 139	51 391	121
12 PURDUE UNIV ALL CAMPUSES	1626 174	331	3 202	10 25	1 192	18 952	110 90	20 204	12
13 MICHIGAN STATE UNIVERSITY	1601 207	116	0 177	7 35	0 129	12 756	132 112	22 276	34
14 N C STATE UNIV AT RALEIGH	1563 122	287	5 74	6 23	2 127	8 851	86 22	7 179	28
15 UNIVERSITY OF ARIZONA	1499 215	158	0 241	10 105	7 113	15 569	28 78	19 215	36
16 U OF CAL LOS ANGELES	1386 204	149	3 127	4 43	2 67	3 744	148 60	12 196	32
17 RUTGERS THE STATE UNIV	1356 257	95	1 147	18 45	2 180	27 371	64 122	32 396	113
18 UNIVERSITY OF IOWA	1340 196	68	0 70	2 14	0 61	8 927	163 33	5 167	18
19 UNIVERSITY OF COLORADO	1264 99	135	2 208	5 39	0 80	7 579	60 63	7 160	18
20 U OF CAL BERKELEY	1260 158	271	4 173	9 28	2 76	4 443	91 44	11 225	37
TOTAL 1ST 20 INSTS.	37481 6180	4735	198 3450	252 1380	122 2496	271 18544	3932 1665	430 5211	975
21 UNIV OF HO COLLEGE PARK	1239 173	163	6 268	15 15	4 137	15 361	69 78	23 217	41
22 UNIVERSITY OF UTAH	1238 195	132	5 125	4 81	7 71	4 654	149 40	4 135	22
23 UNIV OF KENTUCKY ALL CAM	1225 130	148	0 112	16 94	4 119	19 528	56 67	19 197	16
24 UNIVERSITY OF GEORGIA	1151 76	29	0 82	2 53	4 70	9 647	25 102	18 188	18
25 IOWA ST U OF SCI & TECH	1147 120	29	0 81	4 45	1 90	4 418	46 40	8 163	50
26 UNIV OF MISSOURI COLUMBIA	1140 103	120	0 74	4 19	0 50	2 717	83 30	5 130	9
27 U OF CAL DAVIS	1113 103	124	3 63	2 19	0 37	3 715	67 15	2 140	25
28 UNIVERSITY OF CONNECTICUT	1097 246	80	0 91	8 23	1 52	5 519	114 113	33 219	65
29 UNIV OF NC AT CHAPEL HILL	1092 119	0	0 122	9 58	2 80	7 685	82 43	9 104	10
30 OREGON STATE UNIVERSITY	1066 127	141	1 97	4 124	6 74	9 501	77 21	9 108	21
TOTAL 1ST 30 INSTS.	46989 7572	5982	220 4565	320 1871	151 3276	349 24289	4720 2214	560 6792	1252
31 UNIV OF HAWAII-MANOA	1028 171	74	3 92	9 83	8 44	2 467	116 38	4 230	29
32 WEST VIRGINIA UNIVERSITY	1009 161	101	2 35	1 16	1 47	11 341	42 23	3 446	101
33 TEMPLE UNIVERSITY	1000 171	22	2 46	2 19	3 83	10 557	83 116	32 157	39
34 GEORGIA INSTITUTE OF TECH	997 52	583	16 165	8 14	0 93	10 20	2 11	4 111	12
35 VA POLYTECH INST & ST U	972 50	14	6 89	1 45	1 108	13 369	12 25	4 107	11
36 UNIV ALABAMA BIRMINGHAM	951 154	248	6 28	1 4	0 45	9 756	121 68	17 36	4
37 U OF CAL SAN DIEGO	933 79	54	0 150	6 197	11 35	1 405	43 17	1 75	17
38 U OF CAL SAN FRANCISCO	933 297	0	0 33	2 0	0 0	0 885	227 0	0 15	8
39 VIRGINIA COMMONWELTH UNIV	907 107	0	0 16	0 0	0 46	2 671	65 33	6 141	36
40 COLORADO STATE UNIVERSITY	875 42	144	1 55	0 48	0 72	4 449	29 26	1 81	7
TOTAL 1ST 40 INSTS.	58594 8796	7223	252 5254	350 2297	177 3849	411 29209	5460 2571	632 8191	1514
41 KANSAS ST UNIVERSITY	832 108	117	1 50	0 13	0 48	2 503	97 16	1 85	7
42 U OF ILL MEDICAL CENTER	820 273	0	0 16	2 0	0 0	0 791	268 13	3 0	0
43 UNIVERSITY OF CINCINNATI	814 122	106	1 51	2 14	1 33	1 534	110 24	1 52	6
44 INDIANA U-PURDUE U INOPLS	802 205	40	3 34	3 4	0 30	3 622	179 32	6 40	11
45 AUBURN UNIVERSITY	790 57	170	1 51	4 13	1 58	6 357	27 20	4 121	14
46 U TEX CAR CTR MDA H & TI	785 401	11	0 53	21 0	0 39	14 482	366 0	0 0	0
47 UNIVERSITY OF ARKANSAS	784 171	73	0 44	2 10	0 24	2 413	31 19	2 201	134
48 CLEVELAND UNIVERSITY	783 39	134	3 59	2 6	0 75	9 415	16 15	3 79	6
49 UNIV OF NEBRASKA - LINCLN	744 27	130	0 86	7 23	0 57	6 257	8 24	1 67	5
50 U TENNESSEE KNOXVILLE	718 126	157	2 102	5 25	0 75	11 163	69 52	9 144	30
TOTAL 1ST 50 INSTS.	66466 10325	8161	263 5800	398 2405	179 4288	465 34046	6631 2786	662 8980	1727
TOTAL ALL OTHER INSTS.	101899 15819	10230	143 12514	1103 4019	227 13909	2114 31114	6334 9513	2339 20600	3559

NOTE: TABLE DOES NOT INCLUDE ANY LEADING INSTITUTION THAT (1) REQUIRED NATIONAL SCIENCE FOUNDATION ESTIMATES IN 1978, OR (2) REQUESTED THAT ITS DATA BE HELD CONFIDENTIAL.

SOURCE: NATIONAL SCIENCE FOUNDATION.

excerpted from: Human Resources for Scientific Activities at Universities and Colleges, January 1978

Technical Notes and Detailed Statistical Tables
Surveys of Science Resources Series, National Science Foundation, NSF 78-318

TABLE B-31. FULL-TIME SCIENTISTS AND ENGINEERS AT 50 LEADING PRIVATE UNIVERSITIES
IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS BY FIELD AND SEX: JANUARY 1978

	TOTAL ALL FIELDS	ENGINEERS	PHYSICAL SCIENTISTS	ENVIRON- MENTAL SCIENTISTS	MATH. AND COMPUTER SCIENTISTS	LIFE SCIENTISTS	PSYCHOLOGISTS	SOCIAL SCIENTISTS
INSTITUTIONAL RANKING	GRAND TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN	TOTAL WOMEN
TOTAL, ALL PRIVATE INSTITUTIONS	72734 12542	6210 187	9547 942	1685 154	6120 884	32078 6806	5063 1300	12031 2269
1 HARVARD UNIVERSITY	3385 559	48 1	237 43	36 4	51 8	2837 478	33 8	143 17
2 CORNELL UNIVERSITY	2585 467	316 8	205 10	26 3	40 2	1490 281	29 7	475 156
3 MASS INST OF TECHNOLOGY	2032 307	752 59	470 58	94 13	126 8	374 128	41 16	175 25
4 JOHNS HOPKINS UNIVERSITY	1991 356	55 1	83 5	32 1	63 15	1611 301	29 7	118 24
5 YALE UNIVERSITY	1601 335	56 3	122 5	27 2	58 2	1119 285	41 13	178 25
6 STANFORD UNIVERSITY	1584 293	268 8	167 8	49 5	68 3	917 244	30 10	85 15
7 COLUMBIA UNIV MAIN DIV	1567 342	109 2	153 13	176 32	31 2	826 230	20 3	292 40
8 UNIV OF SOUTH CALIFORNIA	1456 221	168 0	137 13	16 0	89 10	775 143	84 15	187 40
9 DUKE UNIVERSITY	1349 201	94 0	76 6	18 2	33 0	1005 176	34 3	129 14
10 UNIVERSITY OF CHICAGO	1303 236	37 1	193 18	42 1	61 2	798 193	34 9	136 12
TOTAL 1ST 10 INSTS.	18853 3315	1863 83	1843 179	516 63	620 52	11752 2459	375 91	1884 388
11 NEW YORK UNIVERSITY	1289 267	2 0	87 8	2 0	95 9	861 198	95 32	147 20
12 CASE WESTERN RESERVE UNIV	1261 205	109 6	85 4	8 0	41 1	942 178	21 3	55 13
13 WASHINGTON UNIVERSITY	1114 225	62 0	61 5	11 3	34 0	906 205	19 2	71 10
14 UNIVERSITY OF MIAMI	1021 196	45 0	44 1	88 5	26 2	682 159	33 4	103 25
15 UNIVERSITY OF ROCHESTER	1000 112	42 1	177 2	6 0	56 1	560 91	75 10	84 7
16 YESHIVA UNIVERSITY	940 206	9 0	64 10	0 0	17 4	749 159	48 19	53 14
17 NORTHWESTERN UNIVERSITY	838 171	133 42	121 10	10 0	56 9	390 91	20 7	108 12
18 CALIFORNIA INST OF TECH	899 51	144 3	215 12	133 15	50 0	99 13	2 1	56 7
19 BAYLOR COLLEGE OF MED	684 218	17 0	11 3	0 0	5 1	625 206	10 4	16 4
20 BOSTON UNIVERSITY	647 108	19 1	76 7	9 0	21 2	384 55	73 29	85 14
TOTAL 1ST 20 INSTS.	28396 5074	2445 136	2784 241	783 86	1021 81	17930 3814	771 202	2662 514
21 GEORGE WASHINGTON UNIV	632 122	92 0	37 3	11 2	64 6	257 57	34 10	137 44
22 PRINCETON UNIVERSITY	592 82	134 4	156 16	30 4	70 6	54 24	36 9	112 19
23 NEW YORK MEDICAL COLLEGE	559 124	0 0	0 0	0 0	0 0	569 124	0 0	0 0
24 SYRACUSE UNIVERSITY	517 51	91 1	64 3	11 0	86 10	36 6	85 9	164 22
25 CARNEGIE-MELLON UNIV	497 65	150 8	126 11	0 0	77 6	74 21	34 13	36 6
26 TULANE UNIVERSITY	489 78	51 0	43 5	6 1	33 7	240 35	26 10	90 23
27 BRIGHAM YOUNG UNIVERSITY	431 17	68 1	61 0	11 0	57 4	85 6	40 3	109 3
28 MED COLLEGE OF WISCONSIN	420 39	6 0	0 0	0 0	0 0	388 38	23 1	3 0
29 ST LOUIS UNIV	419 36	13 0	33 2	15 1	19 1	283 27	20 3	36 4
30 ROCKEFELLER UNIVERSITY	381 61	4 0	34 1	0 0	10 0	274 46	59 14	0 0
TOTAL 1ST 30 INSTS.	33343 5751	3054 150	3338 282	867 94	1437 118	20190 4198	1108 274	3349 635
31 NORTHEASTERN UNIVERSITY	377 37	99 1	79 3	5 0	47 5	51 6	26 7	70 15
32 WAKE FOREST UNIVERSITY	377 40	2 0	18 0	0 0	17 2	288 28	20 6	32 4
33 BROWN UNIVERSITY	367 33	56 2	71 5	19 1	54 1	77 12	19 3	71 9
34 UNIVERSITY OF DAYTON	342 27	123 1	84 6	5 2	54 6	20 3	20 4	36 5
35 DARTMOUTH COLLEGE	341 27	28 0	44 2	10 0	27 3	148 15	22 2	62 5
36 RENSSELAER POLY INST	329 14	164 0	83 7	7 0	33 0	15 4	9 1	18 2
37 UNIVERSITY OF NOTRE DAME	319 16	70 0	89 0	6 0	33 1	44 4	19 2	58 5
38 LOYOLA UNIVERSITY	301 42	0 0	19 0	0 0	15 0	185 24	31 6	51 12
39 LEHIGH UNIVERSITY	295 10	127 1	43 0	11 0	46 0	13 1	11 1	44 7
40 TUFTS UNIVERSITY	285 50	35 0	34 1	3 0	18 5	140 30	16 3	39 11
TOTAL 1ST 40 INSTS.	36676 6047	3758 155	3902 310	933 97	1781 141	21171 4325	1301 309	3830 710
41 FAIRLEIGH DICKINSON UNIV	283 50	26 1	35 2	5 1	28 4	96 22	40 11	53 9
42 RICE UNIVERSITY	283 17	83 5	89 3	15 0	23 1	29 5	9 2	35 1
43 HANNEHMAN MED COL & HOSP	280 37	1 0	8 0	0 0	1 0	247 29	20 7	3 1
44 CREIGHTON UNIVERSITY	261 30	0 0	15 1	0 0	8 1	215 25	10 2	15 1
45 THOM JEFFERSON UNIV	254 30	0 0	8 0	0 0	1 0	237 28	8 2	0 0
46 ALBANY MED COLLEGE	254 58	1 0	0 0	0 0	2 0	244 55	3 1	4 2
47 LONG ISLAND UNIVERSITY	254 45	0 0	43 3	16 3	34 5	47 6	48 16	60 12
48 MARQUETTE UNIVERSITY	233 18	45 0	27 0	0 0	21 3	91 8	13 5	36 2
49 RUSH UNIVERSITY	225 41	0 0	0 0	0 0	0 0	214 36	11 5	0 0
50 POLYTECHNIC INST OF N Y	222 12	144 1	35 3	0 0	28 2	5 4	3 1	7 1
TOTAL 1ST 50 INSTS.	39225 6385	4064 162	4162 322	969 101	1925 157	22596 4543	1466 361	4043 739
TOTAL ALL OTHER INSTS.	33509 6157	2146 25	5385 620	716 53	4195 727	9482 2263	3597 939	7988 1530

NOTE: TABLE DOES NOT INCLUDE ANY LEADING INSTITUTION THAT (1) REQUIRED NATIONAL SCIENCE FOUNDATION ESTIMATES IN 1978;
OR (2) REQUESTED THAT ITS DATA BE HELD CONFIDENTIAL.

SOURCE: NATIONAL SCIENCE FOUNDATION.

excerpted from: Human Resources for Scientific Activities at Universities and
Colleges, January 1978Technical Notes and Detailed Statistical Tables
Surveys of Science Resources Series, National Science Foundation, NSF 78-318

Senator KENNEDY. I think the interesting point here is some universities like MIT and Northwestern have shown where they have made a very significant effort to try and bring women onto the faculty.

Ms. HORNIG. I believe that is true. I think MIT has made an outstanding effort in appointing women scientists.

Senator KENNEDY. This same pattern, I think, is true in physical science and environmental science. You find one or two universities that have made very significant advances in the private and the public sector. I think it shows quality universities can do exceedingly well if they develop that kind of a program. I think these are the kinds of efforts and initiatives we would like to see in the NSF.

Maybe I could ask you to give a brief summary. We want to make sure we hear from the others.

Ms. HORNIG. I am essentially finished, sir. I just want to add that much of the recent progress that women scientists have made is traceable to Congressional initiatives in fostering equal access to education and employment. Yet the implementation of equal opportunity, especially in science, has been decidedly uneven and could be greatly enhanced by congressional oversight especially in the Federal agencies and laboratories. More thought needs to be given also to closer linkages between affirmative action and Federal grants to science programs. These programs are for the most part closely dependent on public moneys but their benefits, in the form of professional opportunities, do not now accrue equally to women. More effective monitoring of equity in access and especially in salaries is needed.

The pool of scientific talent on which our preeminence in science and technology rests can only improve in both size and quality as we broaden the educational base on which it draws. Senator Kennedy's legislative initiatives and public encouragement have done much already to bring women into that pool in greater numbers. I am very grateful for that help, and hope that some of the suggestions I have made today may be useful.

[The prepared statement of Ms. Hornig follows:]

The Status of Women in Science

Testimony Submitted to the
Subcommittee on Health and Scientific Research
of the U.S. Senate Committee on Human Resources

by

Lilli S. Hornig

Executive Director, Higher Education Resource Services
Wellesley College, Wellesley, Massachusetts

March 2, 1979

I would like to thank the Subcommittee on Health and Scientific Research for this opportunity to comment on Federal policies and programs concerning women in science, particularly as they relate to the National Science Foundation. I have spent many years working on these issues, as a chemistry professor and department chair at Trinity College and later as director of Higher Education Resource Services and as chairperson of the Committee on the Education and Employment of Women in Science and Engineering of the National Academy of Sciences. This group is just completing a report on the status of women scientists in academe which we will be pleased to transmit to the Subcommittee in a few days. My remarks today are addressed to possible programs for ameliorating the continuing underutilization of women's scientific training and talent in the national science effort.

Science has traditionally been considered an unsuitable field for women, and efforts to change that view are very recent. Today about one eighth of all scientists holding the Ph.D. are women and the proportion is increasing each year. Women have entered advanced training in steeply rising numbers in the last decade and now obtain a quarter of all science doctorates. This dramatic increase is due not simply to a changing social climate but very explicitly to the movement toward equal undergraduate and graduate admissions and the greater accessibility of fellowship and loan support. The latter changes resulted directly from Congressional initiatives in Title VII of the 1964 Civil Rights Act, Title IX of the 1972 Higher Education Amendments, and equal credit statutes.

Men continue to be advantaged in both education and employment, however. Throughout the educational process, fewer girls and women continue in science at each stage of training despite their demonstrated equal ability. They receive little encouragement to do otherwise, and need only look ahead to women's employment opportunities in science to confirm the judgment that this has not been a promising field for them. Women scientists are unemployed three to five times as often as men with the same education and ability. About one-fifth of them cannot find employment as scientists at all and must work in other fields. Women scientists' average salaries start out \$1300 lower than men's and the differential grows over time to nearly \$10,000 annually.

All this is evidence that Federal equal opportunity policies have not yet been carried out effectively in the scientific community. There has been marked improvement in the last few years, however, with much better employment opportunities in academic institutions despite the overall downward pressures in that sector, and with a doubling of industrial employment for women scientists. Unfortunately, Federal laboratories and agencies have not shared in this progress; less than 5% of all women scientists are employed there, but only 3% of recent Ph.D.s. This already low participation is further aggravated by unequal treatment on the job. For example, in the Department of Energy and its predecessor, the Energy Research and Development Agency, 85% of all male professionals were above Grade 12 but only 12% of women. Conversely, 8% of men but less than 1% of women were at the top two grades. In the academic sector the distribution of women scientists is similarly skewed: almost half of male academic

scientists are full professors, but only about one-tenth of the women. There are no differences in ability between men and women scientists which might explain such very different rates of progress - they are equally capable.

The scientific community at large has long looked to the National Science Foundation for leadership in science programs, and the NSF has been responsive to emerging needs and has stimulated and supported many important advances. Its leadership in the area of women's programs has been very slow to develop, however. While all of its research and education programs have always been open to women, and most have in fact included them, no special efforts to encourage participation by women either in science education or in research were made until the last three years. Growing awareness in recent years by NSF of the need to tap women as a source of scientific talent has been reflected in the establishment of a separate, though much too small, pilot program for Women in Science. Concurrently, appointments of women to NSF Advisory Committees have risen so that they are now in good balance with the availability of women scientists. Both Congressional oversight and Foundation leadership have played a crucial role in these developments.

The proposed establishment of part-time postdoctoral fellowships is also an excellent step. It responds constructively to the growing problems young families face in combining professional aspirations and parenting obligations. A further desirable step would be provision of portable fellowships to enable professional families to stay together when only one spouse can find a suitable academic position in the prospective depressed academic labor market.

The proposal to reduce the small targeted program for women in favor of incorporating a focus on women in all of NSF's programs is sound in principle but to my mind it is an idea whose time has not yet come. For many years since equal opportunity in education and employment became national policy, NSF has had the opportunity to develop such a focus, for minorities as well as women, in its general programs. To do this effectively requires the development of staff cognizant of the problems, and an advisory apparatus within the scientific community which is responsive to the needs of affected groups. Neither of these mechanisms is now in place. Until they are, it seems unwise to decrease the only program now designated for women. In this connection it should be recalled that the Title IX Fellowship Program, which was established under a statute designed for women's educational equity, was converted into a minority fellowship program instead.

In science education programs at both school and college levels there are many excellent ways to involve girls and women which have not been taken advantage of. School programs, for instance, especially at junior high and high school levels, should not be funded unless they can demonstrate that equal proportions of girls and boys will participate. That simple requirement would greatly increase girls' involvement in science and would be entirely consistent with the obligations of Affirmative Action and Title IX. To my knowledge it has not even been considered. Similar conditions should be attached to undergraduate research participation programs, and can also be extended to advanced research programs.

The scientific community has passively accepted the cumulative attrition of women from successive levels of science education for too

many years. It has generally not even experimented with active efforts to recruit and retain women. One field where such efforts have been made, with dramatic success, is engineering. Faced with declining enrollments ten years ago, engineering schools have actively sought women students and increased their enrollments tenfold since that time.

In connection with science education programs, I believe that the interests of women would be best served by retaining these programs within the National Science Foundation. This location would preserve the vital link between active scientific research and the teaching of science at all levels which has proved so beneficial. The high school science programs developed under NSF sponsorship about twenty years ago were one of the real success stories of secondary education. Their quality derived from the active involvement of the scientific community which could not be easily duplicated under the aegis of the proposed Department of Education. With the growing interest of that scientific community in women's education, we believe that a continuing close tie of science education to NSF would most rapidly accomplish the integration of women into science. Conversely, because so many women scientists are involved in education, severing these programs would also cut off a great many women from their connection with active science.

All the evidence we have points to the need for specific targeted programs to also increase participation in advanced research by both minorities and women. For example, women now submit an unduly small proportion of research grant proposals - not because they can't do research, but because most institutional regulations do not allow non-tenured ~~faculty~~

~~and~~ staff to submit proposals. The vast majority of women scientists are not tenured, and can't apply. Mechanisms for making such applications possible could be developed readily by NSF in cooperation with universities. These could well produce a dramatic increase in research proposals from women, resulting in their better integration in the overall research enterprise.

There is also an urgent need for programs to update and keep current the research skills of scientists who teach in smaller institutions in situations where independent research programs may not be feasible. Women scientists are predominantly employed in such colleges and universities. Their scientific potential would be better utilized and their teaching enhanced by the fostering of cooperative research programs with larger universities, and ideally also with industrial laboratories.

Women scientists would benefit in general from enhanced cooperation between academe and industry, through opportunities to become consultants as well as directly by improving access to industrial employment. Business and industry employ a quarter of all male scientists with Ph.D.s but still only 7% of such women, despite dramatic recent progress. Clearly this is an employment area that needs cultivation, but to meet its needs, the graduate education of scientists will require some reshaping of its present goals. The traditional form of graduate training often results in professors cloning themselves, and with the present prospects for academic employment that is not good for either female or male students. Federal programs to encourage and foster the renewal of ties between higher education and industry, and some reorientation of graduate training to facilitate employment, are an urgent need.

Much of the recent progress women scientists have made is traceable to Congressional initiatives in fostering equal access to education and employment. Yet the implementation of equal opportunity, especially in science, has been decidedly uneven and could be greatly enhanced by Congressional oversight especially in the Federal agencies and laboratories. More thought needs to be given also to closer linkages between affirmative action and Federal grants to science programs. These programs are for the most part closely dependent on public monies but their benefits, in the form of professional opportunities, do not now accrue equally to women. More effective monitoring of equity in access and especially in salaries is needed.

The pool of scientific talent on which our preeminence in science and technology rests can only improve in both size and quality as we broaden the educational base on which it draws. Senator Kennedy's legislative initiatives and public encouragement have done much already to bring women into that pool in greater numbers. I am very grateful for that help, and hope that some of the suggestions I have made today may be useful.

Senator KENNEDY. We are looking forward to working with you on our legislation. Very helpful.

Ms. HORNIG. Thank you.

Senator KENNEDY. Maybe we can hear from the other witnesses and then come back to some more questions.

Dr. Partridge, vice president for research, University of Utah, Association of American Universities, the National Association of State Universities and Land-Grant Colleges, and the American Council on Education.

We will include all the statements in the record.

STATEMENT OF WILLIAM PARTRIDGE, VICE PRESIDENT, UNIVERSITY OF UTAH, ON BEHALF OF THE ASSOCIATION OF AMERICAN UNIVERSITIES, THE NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES, AND THE AMERICAN COUNCIL ON EDUCATION

Dr. PARTRIDGE. As you mentioned, Mr. Chairman, I represent the Association of American Universities, the National Association of State Universities and Land-Grant Colleges and the American Council on Education. Though we cannot speak for every individual organization, I think this position paper will reflect most of their feelings.

First, we want to commend the President for sustaining the commitment to strong basic research programs in the National

Science Foundation and across the leading mission agencies in a difficult budget year. If adopted, the total budget would provide a 9 percent Government-wide increase in basic science sufficient to meet the added costs of inflation, and we hope a small margin for real growth as well. Our continued world leadership in science and technology rests upon these basic research programs and upon the variety of crucial university research activities which they support.

We are very gratified that the administration has seen fit to continue along the course set last year by recommending small, but real increases in the budget for the basic research programs sponsored by the National Science Foundation and the mission agencies. The efforts of the administration are a significant beginning and we applaud them. Much remains to be done, however, to restore stability and balance to this vital and fragile system.

If approved, the budget will reinforce efforts intended to reverse a hurtful and prolonged decline, from 1968 through 1977 in Government support of basic research, a decline estimated to approximate 20 percent in real terms during that period of time.

Sitting on the campus, many things are happening that give us a great deal of concern. An example is the nuclear magnetics residence field. The principle for that field was discovered by a member of the United States, who also received the Nobel Prize, and for a few years most of the work done in this field was done in the United States. The equipment was developed in the United States.

Recently, most of the equipment for that industry has moved overseas. As we try to get replacement equipment in that field, we find that the United States seems to be losing the competition edge it once had. We also see a resulting problem in the training of new people because universities are not able to keep up with the requirements for replacing obsolete equipment. Our contacts in industry complain to us about students we are training because we do not have the up-to-date equipment which they will be using in these fields and in their work when they leave the universities. That is a serious problem we are faced with.

We wonder whether the United States will be able to compete with the decline that we have had in basic research funding. Dr. Weisner, president of MIT, in a talk last fall indicated that Japan is making every effort to take over the leadership in the semiconductor and computer industries. He says the Japanese have initiated an effort to develop and exploit the next generation of electronic chips. In talking with people in industry, he finds that the United States has limited qualified manpower to develop these new technologies. It is very problematical whether we can keep up with the commitment the Japanese have made in the next years.

We very strongly support Dr. Atkinson's statement that the National Science Foundation and its basic research budget is a capital investment in the future. It should be treated that way.

I would add that in this area a sustained commitment of higher education to excellence in research and training is itself vital to the national interest.

The reasons that are commonly cited in support of the underlying logic of the 1980 budget are valid and widely known:

Although the direct relationship between basic research and its applications is not always clear, it is generally agreed that our health, economic growth, industrial productivity, the development and management of our resource base, the quality of our environment and the solution to the problems that confront us, all depend upon progress made through basic research.

Because the time between discovery and application is often long and unpredictable, the economic incentives of the marketplace will produce neither the amount nor the breadth of basic science we need.

Mission agencies need the findings and products of basic research to carry out their responsibilities.

Only the Federal Government can provide the stable, predictable support that is essential to the conduct of economic and productive basic research programs.

We hope that this committee will continue to support this view of the Federal role. It supported the budget objectives for 1980, on top of the beginning made last year, would help to correct a major weakness in our science policy—the vacillation in attitude toward the responsibility of the Federal Government for basic research. Decisions made this year will either cause us to lose our new-found momentum or enable us to continue our efforts to recoup from a prolonged period of disruption and stagnation, restoring essential stability to the system that produces vital scientific and technological capital for the Nation.

If we are to succeed in keeping up with the ever accelerating pace of change, we need to invest for tomorrow or risk losing in the future. Other countries understand this. We cannot assume that our present edge in some areas of science and technology can be held merely by wishing for it since severe challenges are being mounted in other countries. We face the real possibility of further erosion of our leadership in many areas. Our ability to compete in the future will continue to depend upon our abilities to produce and to develop new knowledge and to educate or train people to the highest levels. Our competitiveness rests upon the spectrum of basic research programs funded by the mission agencies, and particularly, by the National Science Foundation.

Dr. William J. Perry, president of the National Academy of Engineering addressed this subject in a talk given to the academy on November 2, 1978. In his speech—a copy is attached—he pointed out that there is increasing concern that America is in danger of losing its technological leadership. After pointing out that “national expenditure for R. & D. in proportion to GNP have fallen from 2.92 percent in 1965 to about 2.32 percent in 1975,” while the same percentage for West Germany and Japan have increased, he showed the effect of this decrease in our capacity for technological innovation on the U.S. balance of trade.

“The impact of innovation in the U. S. balance of trade is illustrated by the performance of both R. & D.-intensive and non-R. & D. intensive industries examined in the period from 1960 to 1976. According to Department of Commerce reports, the R. & D. intensive industries produced a \$5.9 billion positive trade balance in 1960, while corresponding non R. & D. intensive industries had a negative \$179 million balance. In 1976, the trade balance of the R. & D. intensive industries grew to a positive \$29 billion, while the non-R. & D. intensive produced a \$16.5 billion deficit. Imagine the impact on the balance of payments, the strength of

the dollar, inflation—our national economic well-being—if R. & D. intensive industry were not producing a sizable inflow of international trade to offset the costs of imported oil and the negative balance in other sectors.”

In comparison with industry, universities perform a small, but highly creative and objective research, education and training role. The programs supported by NSG, often in combination with two or more of the mission agencies, are the vital force in the best of our basic research. We urge this subcommittee to sustain the effort begun last year by providing for the full \$828.3 million requested for NSF basic research programs.

We also support the continued commitment to NSF to strong programs of applied research. More needs to be done to stimulate closer research relationships between universities and industry. There seems to be agreement on that point in Government and industry as well as among universities. Last year NSF began an important initiative to stimulate such ties. The initial response from both universities and industry indicates that something important is happening here which deserves attention and support. The NSF program is a small, but promising start, and we urge your support for it.

As I look across the array of programs supported by the NSF in my own university, I see many which are bringing important, original contributions to human knowledge. Among these are studies in nearly every field of science from chemistry to engineering and from biology to the social sciences. Investigators are studying tropospheric divergence in order to better understand the processes which cause our weather, the crystallization of polymers, light scattering of large molecules, and the structures of new materials which may allow us to improve or develop new materials for uses that we cannot presently foresee. One group of investigators has built an array of large 5-foot-diameter mirrors focused on photomultipliers across several miles of desert in western Utah to study the origin of cosmic rays and the effect of their collisions with gaseous molecules in the upper atmosphere. The project has been labeled the “fly’s eye” because it operates like a large multifaceted eye on the desert, staring into space. Such research may provide a new set of data regarding the origin and dynamics of the universe and the effects of extraterrestrial processes on our planet.

Although the health of academic science is generally good, there are problem areas. One of the most pressing is the deterioration and obsolescence of our scientific instrumentation, equipment, and facilities. This problem was pointed out in a recent editorial in *Science*, October 27, 1978, a copy is attached. I, therefore, especially call your attention to the increases proposed for instrumentation and equipment. For 2 years, NSF and the administration have responded to the documented decline in the quality of instrumentation. Augmented funding has been budgeted to provide researchers with the scientific instruments and equipment they need, but in some cases this has not even compensated for the loss of instrumentation support in related but more applied scientific agencies. The NSF effort has been continued this year.

In our view, the proposed increase is badly needed. During the sixties the laboratories of the Nation were splendidly instrumented and this contributed significantly to the then increasing preemi-

nence in science. The view developed, however, that since the laboratories were fully equipped, the scale of support could drop. Between 1966 and 1976 the proportion of NSF project grant funds allocated to permanent equipment dropped from about 11 to about 5 percent. Funds for equipment from other sources also dropped at the same time; for example, during this same period funds for the biotechnology resource program of the NIH which funds major equipment centers in the country has dropped by over 40 percent in constant dollars. All of this has happened at a time when the sophistication and associated costs of individual instruments was rapidly rising. Thus, many university laboratories have not kept pace with recent instrumental developments and our students are being trained on obsolete and often malfunctioning equipment. The cost to maintain older equipment is also rapidly increasing, and university budgets for such expenses are in serious difficulty. Responses from American industry have indicated their concern with this problem, as our ability to compete technologically with other nations can be seriously handicapped if we do not maintain a constant source of graduates familiar with the latest techniques and scientific advances in such an important area as instrumentation. Thus, while the quality of instrumentation in university laboratories has declined sharply, the installation of large facilities required to work on the frontiers of many branches of science has lagged. Even our very best equipped laboratories have not been spared this creeping obsolescence.

Studies conducted for the National Science Board and others of the health of science in this country have reported on repeated occasions that the deterioration of instrumentation is a major threat to the continuing vitality of basic research. For instance, last year the "State of Academic Science", a report by Smith and Karlesky, clearly showed that deterioration of scientific equipment is of great concern to the scientists of the Nation. This view is reinforced in "Research Universities and the National Interest," a report from 15 university presidents, in which the backlog of instrumentation needs as of 1978 was estimated at \$275 million. We strongly urge the subcommittee to authorize the funds to permit the upgrading of instrumentation and equipment as provided for in the President's budget. It is essential that this be done while not allowing other more applied and mission-oriented agencies to decrease their commitment to instrumental support. If the only effect of increasing the NSF support is to decrease commitment elsewhere, the problem of academic instrumentation will not be properly addressed.

There is a second, more difficult problem ahead: In the coming decade, how will we provide for a steady flow of talented young faculty into the Nation's leading science, engineering, social science, and I would add humanities, departments? Quality research and training programs require a steady infusion of fresh talent and new ideas. In many institutions, however, the 1980's will be marked by declining enrollments, low faculty turnover, a faculty growing older, and diminished career opportunities for young faculty. This problem has been exacerbated in Utah with the passage of legislation this month removing all age restrictions regarding retirement of faculty in Utah's system of higher education. Similar

legislation has already been enacted in California and several other States. These initiatives are in addition to the more general impact of prior congressional legislation to increase a mandatory retirement age from 65 to 70. Special steps may be needed to assure the continued placement in key departments of a certain number of the most talented individuals, otherwise the next decade will witness an absolute decline in the general scope and scale of our institutions' intellectual capabilities.

The administration and others recognize the potential seriousness of the problem. Dr. Frank Press, the President's Science Adviser; Dr. Richard Atkinson, Director of the National Science Foundation; and Dr. Norman Hackerman, Chairman of the National Science Board, are studying it. In addition, several higher education associations have undertaken to formulate approaches to the problem. The Association of American Universities is conducting a survey of its members to gather specific information that will be useful in developing targeted solutions.

Analyses already completed indicate that this may not be a large scale problem that will require vast sums to solve. It may be a relatively small, highly focused problem, but one sufficiently severe to require targeted new Federal initiatives. The complexity of the problem demands detailed analysis and careful planning. We will assist and support the administration in this task and keep this committee and your staff informed of our efforts, which we hope will be helpful.

Turning to the science education program, let me begin with the fellowship and traineeship program. Competition for NSF graduate fellowship is keen. Only 1 out of 13 applicants will receive a fellowship. Graduate fellowships are budgeted at the reduced fiscal year 1979 level of \$10.8 million. NSF estimates that only 425 fellowships will be awarded in fiscal year 1980—down from 500 just a few years ago. An additional 1,500 applicants will be awarded "honorable mention"—a designation intended to attract other forms of support. In addition to a decline in the number of fellowship awards, no adjustment has been made for 8 years in the fellowship stipend—\$3,900—and in the cost-of-education allowance—\$3,400. Both have been significantly eroded by inflation, and adjustments are obviously long overdue.

The NSF graduate fellowship in science and engineering are the only awards now offered by the Federal Government for the support of graduate students which are based on a national merit competition. They represent an important symbolic commitment of the Federal Government to excellence in graduate training and they are an important source of support for our most talented students.

We urge the committee to restore the number of fellowships to at least 500. We also recommend an adjustment in the stipend rate to at least \$6,000 and an increase in the cost-of-education allowance to \$5,500. The minorities, women, and physically handicapped in science programs are also important initiatives and we fully support them. A major restructuring of the postdoctoral fellowship program is also proposed to provide for part-time fellowships. This program may be needed, but the case made for it, in our view, is unclear.

We hope that the committee will carefully review this particular proposal.

The science education development and research program is budgeted to increase \$3.6 million or 31 percent. Most of these funds will support additional research in science education. We fully endorse these proposals. We regret, however, that most of the undergraduate science education programs are either held constant or reduced. Again this year, the budget for these programs does not offset the effects of inflation. We urge the committee to sustain support for undergraduate science education and to protect these programs from further cuts and inflationary erosion.

It may be, Mr. Chairman, that the Science Education Directorate is suffering this year from the uncertainty now clouding its future. As you know, the administration proposes to move most of the Science Education Directorate to a new Department of Education. The shift of the science education program is strongly opposed by the three higher education associations which I represent. To insure that these scarce resources are used in the most productive and efficient way, it is essential, in our view, that the programs remain closely tied to the Foundation's research programs. I want to add, Mr. Chairman, that the higher education community commends and thanks you for your effective leadership in that effort last year. The Senate Committee on Human Resources, in its input on the NSF Authorization Act for Fiscal Year 1979 and 1980—Senate Report 95-851—strongly opposed the transfer. We hope the committee takes the same position this year.

In conclusion, Mr. Chairman, we strongly support the strategy of the administration to strengthen the basic research program of the NSF and the mission agencies. The Nation's colleges and research universities which are represented by these associations vigorously support the NSF budget. They stand ready to be of assistance to you and to the members of this subcommittee as you consider the issues before you.

I want to close with one observation. Support of basic, scientific and technological research and development is the most important investment that the Nation can make toward its future economic progress, prosperity and security. In that effort, research conducted in academic laboratories is a relatively modest, but indispensable, part of the whole. The welfare of our citizens in the coming decades and on into the next century is closely bound up in the research and training programs of the National Science Foundation. Indeed, these programs are a vital national investment.

I also want to take this opportunity, Mr. Chairman, to convey to you and your staff our appreciation for your continued leadership and support on behalf of basic research and science education programs and for your courtesy in hearing this testimony. I will be pleased to respond to any questions you may have.

Senator KENNEDY. Thank you.

[The prepared statement of Dr. Partridge follows:]

TESTIMONY

on the

FY 1980 Authorization for the

NATIONAL SCIENCE FOUNDATION

before the

Subcommittee on Health and Scientific Research

of the

Committee on Human Resources

United States Senate

by

William Partridge
Vice President for Research
University of Utah

on behalf of the

American Council on Education
Association of American Universities
and
National Association of State Universities
and Land-Grant Colleges

March 2, 1979

Mr. Chairman and Members of the Committee:

My name is William Partridge and I am Vice President of the University of Utah. My testimony today is on behalf of the Association of American Universities, the National Association of State Universities and Land-Grant Colleges, and the American Council on Education. The member institutions of these organizations perform practically all of the basic research and related graduate training in the country, as well as most of the undergraduate education. While none of these associations, nor I as an individual, can speak for each of its members, I can present to you certain broad conclusions about the FY 1980 budget of the National Science Foundation that I am sure virtually all members would support.

Basic Research Support

I want to take this opportunity, Mr. Chairman, to commend President Carter for sustaining the commitment to strong basic research programs in the National Science Foundation and across the leading mission agencies in a difficult budget year. If adopted, the total budget would provide a 9% government-wide increase in basic science sufficient to meet the added costs of inflation, and, we hope, a small margin for real growth as well. Our continued world leadership in science and technology rests upon these basic research programs and the variety of crucial university research activities which they support.

We are very gratified that the Administration has seen fit to continue along the course set last year by recommending small, but real increases in the budget for the basic research programs sponsored by the National Science Foundation and the mission agencies. The efforts of the administration are

a significant beginning and we applaud them. Much remains to be done, however, to restore stability and balance to this vital and fragile system.

If approved, the budget will reinforce efforts intended to reverse a hurtful and prolonged decline, from 1968 through 1977 in government support of basic research, a decline estimated to approximate 20 percent in real terms during that period of time. That this decline was permitted to occur suggests a misunderstanding, in my view, about the value of scientific and technological research to the nation's economic, military, and political future.

Furthermore, basic research cannot serve its legitimate role in an atmosphere that is wildly oscillating. One cannot turn knowledge, nor its discovery, on and off like a light bulb. Contributions of basic research to society can best be made through a long-range approach that recognizes a time lag between discovery and implementation of knowledge. Sometimes the positive effects to society lag ten to twenty years behind discovery of new knowledge. A case in point is found in current laser technology. The initial discovery and early experiments more than thirty years ago were first perceived as a scientific phenomena of major impact to the military but with limited application in other fields. Today, laser technology has enjoyed widespread applications in medicine, communications and other fields too numerous to mention but which have become pervasive in our technological society.

The Administration's support of a 1980 basic research budget of the kind requested requires of all of us in higher education a reciprocal commitment not only to do our very best with the funds we have available, but also to do a better job of explaining the nature of our research programs and their value to society. Basic research performed by our nation's universities and colleges can be diminished only at risk to our country's

capacity to sustain and assure its world position in science and technology as well as our strong economic base. In his testimony before you, Dr. Richard Atkinson, Director of the National Science Foundation, said that federal support of basic research and especially of the National Science Foundation, is "a capital investment in the national future." I agree with that view completely. I would add that in this area, a sustained commitment of higher education to excellence in research and training is itself vital to the national interest.

The reasons that are commonly cited in support of the underlying logic of the 1980 budget are valid and widely known:

- Although the direct relationship between basic research and its applications is not always clear, it is generally agreed that our health, economic growth, industrial productivity, the development and management of our resource base, the quality of our environment and the solution to the problems that confront us, all depend upon progress made through basic research.
- Because the time between discovery and application is often long and unpredictable, the economic incentives of the marketplace will produce neither the amount nor the breadth of basic science we need.
- Mission agencies need the findings and products of basic research to carry out their responsibilities.
- Only the federal government can provide the stable, predictable support that is essential to the conduct of economic and productive basic research programs.

We hope that this Committee will continue to support this view of the federal role. The budget objectives for 1980 on top of the beginning made last year, would help to correct a major weakness in our science policy-- the vacillation in attitude towards the responsibility of the federal government for basic research. Decisions made this year will either cause us to lose our new-found momentum or enable us to continue our efforts to recoup from a prolonged period of disruption and stagnation, restoring essential stability to the system that produces vital scientific and technological capital for the nation.

If we are to succeed in keeping up with the ever-accelerating pace of change, we invest for tomorrow or lose in the future. Other countries understand this. We cannot assume that our present edge in some areas of science and technology can be held merely by wishing for it since severe challenges are being mounted in other countries and we face the real possibility of further erosion of our leadership in many areas. Our ability to compete in the future will continue to depend upon our abilities to produce and to develop new knowledge and to educate or train people to the highest levels. Our competitiveness rests upon the spectrum of basic research programs funded by the mission agencies, and particularly, by the National Science Foundation.

Dr. William J. Perry, President of the National Academy of Engineering addressed this subject in a talk given to the Academy on November 2, 1978. In his speech (copy attached), he pointed out that there is increasing concern that America is in danger of losing its technological leadership. After pointing out that "national expenditures for R & D in proportion to

GNP have fallen from 2.92 percent in 1965 to about 2.32 percent in 1975," while the same percentages for West Germany and Japan have increased, he showed the effect of this decrease in our capacity for technological innovation on the U. S. balance of trade.

"The impact of innovation in the U.S. balance of trade is illustrated by the performance of both R&D-intensive and non-R&D intensive industries examined in the period from 1960-1976. According to Department of Commerce Reports, the R&D intensive industries produced a \$5.9 billion positive trade balance in 1960, while corresponding non-R&D intensive industries had a negative \$179 million balance. In 1976, the trade balance of the R&D-intensive industries grew to a positive \$29 billion, while the non-R&D-intensive produced a \$16.5 billion deficit. Imagine the impact on the balance of payments, the strength of the dollar, inflation--our national economic well being--if R&D intensive industry were not producing a sizeable inflow of international trade to offset the costs of imported oil and the negative balance in other sectors."

In comparison with industry, universities perform a small, but highly creative and objective research, education and training role. The programs supported by NSF, often in combination with two or more of the mission agencies, are the vital force in the best of our basic research. We urge this subcommittee to sustain the effort begun last year by providing for the full \$28.3 million requested for NSF basic research programs.

We also support the continued commitment to NSF to strong programs of applied research. More needs to be done to stimulate closer research relationships between universities and industry. There seems to be agreement on that point in government and industry as well as among universities. Last year NSF began an important initiative to stimulate such ties. The initial response from both universities and industry indicates that something important is happening here which deserves attention and support. The NSF program is a small, but promising start, and we urge your support for it.

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Instrumentation

Although the health of academic science is generally good, there are problem areas. One of the most pressing is the deterioration and obsolescence of our scientific instrumentation, equipment, and facilities. This problem was pointed out in a recent Editorial in Science, October 27, 1978 (copy is attached). I, therefore, especially call your attention to the increases proposed for instrumentation and equipment. For two years, NSF and the Administration have responded to the documented decline in the quality of instrumentation. Augmented funding has been budgeted to provide researchers with the scientific instruments and equipment they need, but in some cases this has not even compensated for the loss of instrumentation support in related but more applied scientific agencies. The NSF effort has been continued this year.

In our view, the proposed increase is badly needed. During the 60's, the laboratories of the nation were splendidly instrumented and this contributed significantly to the then increasing preeminence in science. The view developed, however, that since the laboratories were fully equipped, the scale of support could drop. Between 1966 and 1976 the proportion of NSF project grant funds allocated to permanent equipment dropped from about 11 to about 5 percent. Funds for equipment from other sources also dropped at the same time; e.g., during this same period funds for the Biotechnology Resource Program of the NIH which funds major equipment centers in the country has dropped by over 40 percent in constant dollars. All of this has happened at a time when the sophistication and associated costs of individual instruments was rapidly rising. Thus, many university laboratories have not kept pace with recent instrumental developments and our students are being trained on obsolete and often malfunctioning equipment. The cost to maintain older equipment is also rapidly increasing, and University budgets for such expenses are in serious difficulty. Responses from American industry have indicated their concern with this problem, as our ability to compete technologically with other nations can be seriously handicapped if we do not maintain a constant source of graduates familiar with the latest techniques and scientific advances in such an important area as instrumentation. Thus, while the quality of instrumentation in University laboratories has declined sharply, the installation of large facilities required to work on the frontiers of many branches of science has lagged. Even our very best equipped laboratories have not been spared this "creeping obsolescence."

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of basic research. For instance, last year The State of Academic Science, a report by Smith and Karlesky, clearly showed that deterioration of scientific equipment is of great concern to the scientists of the nation. This view is reinforced in Research Universities and the National Interest. A Report from Fifteen University Presidents, in which the backlog of instrumentation needs as of 1978 was estimated at \$275 million. We strongly urge the Subcommittee to authorize the funds to permit the upgrading of instrumentation and equipment as provided for in the President's budget. It is essential that this be done while not allowing other more applied and mission oriented agencies to decrease their commitment to instrumental support. If the only effect of increasing the NSF support is to decrease commitment elsewhere, the problem of academic instrumentation will not be properly addressed.

Young Faculty

There is a second, more difficult problem ahead: In the coming decade, how will we provide for a steady flow of talented young faculty into the nation's leading science, engineering, social science, and I would add humanities, departments? Quality research and training programs require a steady infusion of fresh talent and new ideas. In many institutions, however, the 1980's will be marked by declining enrollments, low faculty turnover, a faculty growing older, and diminished career opportunities for young faculty. This problem has been exacerbated in Utah with the passage of legislation this month removing all age restrictions regarding retirement of faculty in Utah's system of higher education. Similar legislation has already been enacted in California and several other states. These initiatives are in addition to the more general impact of prior Congressional legislation to increase a mandatory retirement age from 65 to 70. Special steps may be

needed to assure the continued placement in key departments of a certain number of the most talented individuals, otherwise the next decade will witness an absolute decline in the general scope and scale of our institutions' intellectual capabilities.

The Administration and others recognize the potential seriousness of the problem. Dr. Frank Press, the President's Science Advisor, Dr. Richard Atkinson, Director of the National Science Foundation, and Dr. Norman Hackerson, Chairman of the National Science Board, are studying it. In addition, several higher education associations have undertaken to formulate approaches to the problem. The Association of American Universities is conducting a survey of its members to gather specific information that will be useful in developing targeted solutions.

Analyses already completed indicate that this may not be a large scale problem which will require vast sums to solve. It may be a relatively small, highly-focused problem, but one sufficiently severe to require targeted new federal initiatives. The complexity of the problem demands detailed analysis and careful planning. We will assist and support the Administration in this task and keep this Committee and your staff informed of our efforts, which we hope will be helpful.

Science Education

Turning to the science education program, let me begin with the fellowship and traineeship programs. Competition for NSF graduate fellowships is keen. Only one out of thirteen applicants will receive a fellowship. Graduate fellowships are budgeted at the reduced FY 1979 level of \$10.8 million. NSF estimates that only 425 fellowships will be awarded in FY 1980--down from 500 just a few years ago. An additional 1500 applicants will be awarded

"Honorable Mention" - a designation intended to attract other forms of support.

In addition to a decline in the number of fellowship awards, no adjustment has been made for eight years in the fellowship stipend (\$3900) and in the cost-of-education allowance (\$3400). Both have been significantly eroded by inflation, and adjustments are obviously long overdue.

The NSF graduate fellowships in science and engineering are the only awards now offered by the federal government for the support of graduate students which are based on a national merit competition. They represent an important symbolic commitment of the federal government to excellence in graduate training and they are an important source of support for our most talented students.

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does not offset the effects of inflation. We urge the Committee to sustain support for undergraduate science education and to protect these programs from further cuts and inflationary erosion.

It may be, Mr. Chairman, that the Science Education Directorate is suffering this year from the uncertainty now clouding its future. As you know, the Administration proposes to move most of the Science Education Directorate to a new Department of Education. The shift of the science education program is strongly opposed by the three higher education associations which I represent. To insure that these scarce resources are used in the most productive and efficient way, it is essential, in our view, that the programs remain closely tied to the Foundation's research programs. I want to add, Mr. Chairman, that the higher education community commends and thanks you for your effective leadership in that effort last year. The Senate Committee on Human Resources, in its input on the NSF Authorization Act for Fiscal Year 1979 and 1980 (S. Rpt. 95-851) strongly opposed the transfer. We hope the Committee takes the same position this year.

Conclusion

In conclusion, Mr. Chairman, we strongly support the strategy of the Administration to strengthen the basic research programs of the NSF and the mission agencies. The nation's colleges and research universities which are represented by these associations vigorously support the NSF budget. They stand ready to be of assistance to you and to the members of this Subcommittee as you consider the issues before you.

I want to close with one observation. Support of basic, scientific and technological research and development is the most important investment that

the nation can make toward its future economic progress, prosperity and security. In that effort, research conducted in academic laboratories is a relatively modest, but indispensable, part of the whole. The welfare of our citizens in the coming decades and on into the next century is closely bound up in the research and training programs of the National Science Foundation. Indeed, these programs are a vital national investment.

I also want to take this opportunity, Mr. Chairman, to convey to you and your staff our appreciation for your continued leadership and support on behalf of basic research and science education programs and for your courtesy in hearing this testimony. I will be pleased to respond to any questions you may have.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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Instrumentation Funding

New measures are urgently required to bring under control the accelerating decline in the quality, quantity, and development of scientific research instruments in the United States. The main cause of the deterioration of equipment is lack of adequate funds for maintaining and updating it. Two major factors contribute to this lack. There has been a marked rise in replacement costs over the past decade due to inflation and to greater sophistication of the equipment. Simultaneously, there has been a decrease in the funds available for equipment, due to the effective 19 percent decline in federal expenditures for basic research combined with pressures to use the available research budgets to maintain existing operations despite the increased cost of personnel and supplies. Thus attention should be given to funding policies that will permit increased efficiency and cost effectiveness in the utilization of existing advanced instrumentation.

In the present tight money climate, the decline in the quality of scientific equipment can be reversed only by increasing the opportunities for sharing of technological resources. A significant shift in the distribution of funds available for instrumentation and a restructuring of funding policies are needed to achieve this goal. Existing avenues for the funding of costly instrumentation include both categorical grants and shared resources. Categorical grants, which are designed to further specific projects, neither mandate the sharing of instrumentation acquired under their terms nor provide for the cost of sharing—that is, the costs resulting from increased use. Instrumentation facilities funded as shared resources do not suffer from lack of use when the operational funds include an adequate provision for the cost of sharing. A properly managed shared resource best ensures both utilization of the instrumentation and maximum access to it.

Existing funding patterns are at variance with the need for wider sharing of resources. The Division of Research Resources of the National Institutes of Health (NIH) has had a constant level of funding since 1967. Since the rate of inflation in equipment costs in many cases exceeded 100 percent over this period, the net decrease in instrumentation funding far exceeds the estimated 19 percent decline in the support of basic research. The Division of Chemical Instrumentation of the National Science Foundation (NSF) recently announced an instrumentation program to establish regional laboratories. Although this is a commendatory beginning, no ongoing funding for full implementation has yet been secured. No specific provision exists within the NSF to fund major instrumentation for biological research.

We strongly endorse the NSF chemical instrumentation program and recommend that a parallel program be established for biological instrumentation. We further recommend that the NIH Division of Research Resources be revitalized, at least to its earlier levels of activity. A three- to fivefold increase in these budgets will be needed to prevent a continuing decline in the utilization of advanced technology and technological innovation in the United States. We would prefer to see a net increase in the appropriations earmarked to meet instrumentation needs. Barring such a possibility, it may be essential to change the distribution of the national R & D appropriation.

It is therefore recommended that the renewal and development of scientific equipment be specifically and primarily (although not exclusively) mandated to the divisions of federal granting agencies responsible for the establishment and maintenance of shared resources. At present these are the NIH Division of Research Resources and the NSF Division of Chemical Instrumentation; an NSF Division of Biological Instrumentation should be added. A substantial increase in their budgets should be mandated by Congress.—E. R. BLOUT, *Harvard Medical School, Boston, Massachusetts 02115*; D. M. GRANT, *University of Utah, Salt Lake City 84112*; O. JARDETSKY, *Stanford University, Stanford, California 94305*; W. D. PHILLIPS, *Washington University, St. Louis, Missouri 63130*; K. R. PORTER, *University of Colorado, Boulder 80302* (Ad Hoc Committee on Instrumentation Funding)

THE BRIDGE

NATIONAL ACADEMY OF ENGINEERING



Volume 8 Number 4

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The Honorable William J. Perry delivering the address at the 1978 Annual Banquet of the National Academy of Engineering

Technological Innovation in America

William J. Perry

Technological innovation is firmly rooted in America's tradition, from Benjamin Franklin to Thomas Edison. It has played a key role in giving our country world leadership in the aerospace, chemical and electronics industries. These industries, together with agriculture—which itself has benefitted from technological innovation—have provided strong, positive trade balances to more than offset our large, negative trade balance in labor intensive industries.

But there is increasing concern that America is in danger of losing its technological leadership. Basic research performed by U.S. industry has declined in real terms since the mid-1960's; measured in 1972 dollars, expenditures declined from about \$800 million in 1965 to \$570 million in 1975. In the same time period, the purchasing power of the Department of Defense (DOD) technology base program was eroded by about 50 percent.

continued on page 5

Highlights of NAE Annual Meeting

The 1978 Annual Meeting of the National Academy of Engineering was highlighted by the following activities:

October 31

—First International Convocation of Academies of Engineering and similar organizations. Members of the NAE Council and representatives of invited foreign academies and similar organizations attended this activity conceived and organized by the NAE. (Further information on page 10.)

November 1

—Business Session and Founders Lecture, "The National Climate for Innovation," delivered by George M. Low, President, Rensselaer Polytechnic Institute. Attended by 208 members and 11 foreign associates.

—Reception honoring NAE members and foreign associates elected in 1978. Attended by 477 members and guests.

November 2

—Technical Session on Hydrocarbon Fuel Supplies, Problems and Promises. Attended by 259 members, guests, and others.

—NAE Annual Reception and Banquet—Speaker, The Honorable William J. Perry. Attended by 396 members and guests.

BUSINESS SESSION

The Business Session opened with a film depicting the construction of a large deep water oil drilling platform of the Exxon Corporation erected in the Santa Barbara Channel off the coast of California. The technology

continued

TECHNOLOGICAL INNOVATION IN AMERICA
continued from page 1

National expenditures for R&D in proportion to GNP have fallen from 2.92 percent in 1965 to about 2.32 percent in 1975. In the same decade, West Germany raised R&D expenditures from 1.72 percent to 2.25 percent of GNP, while Japan increased from 1.55 percent to about 2 percent.

A further sign of declining technological leadership is the rate of productivity increase in the U.S., which is below that of the other major industrial nations and at the lowest level in a century. These signs of decline and their causes have been well described, earlier this year by Roy Anderson of Lockheed in a address at the Wings Club of New York, and just yesterday by George Low in his address to this group.

I would like to focus on the role of government in stimulating technological innovation, and in doing so will address four fundamental questions:

- Why is technological innovation important?
- Are we losing our ability to innovate?
- What are the ingredients of successful innovation?

697-9111

Dr. William James Perry was nominated by President Jimmy Carter to be Under Secretary of Defense for Research and Engineering and was sworn in to office on November 4, 1977.

As Under Secretary he is the principal advisor and assistant to the Secretary of Defense for Department of Defense scientific and technical matters; basic and applied research; development and acquisition of weapon systems; communications; command and control; atomic energy; and intelligence resources. He serves as the focal point for all test and evaluation matters. He has also been designated the Defense Acquisition Executive. As such, he is responsible for effectively integrating the acquisition of defense systems and equipment within the Department of Defense.

Dr. Perry is one of the founders of ESL, Incorporated, Sunnyvale, California, and was serving as President of ESL when nominated on March 11, 1977, to direct Defense Research and Engineering. Besides his management duties, he engaged in analysis of missile systems and the design of electronic reconnaissance systems. His technical specialties include partial differential equations, propagation theory, and statistical decision theory.

Prior to establishing ESL, Inc. in January 1964, Dr. Perry spent 10 years with Sylvania Electric Products, Inc., Mountain View, California, where he was Director of the Electronic Defense Laboratories. He was mathematics instructor at Pennsylvania State University and a part-time lecturer in mathematics at the University of Santa Clara.

The presentation printed here, *Technological Innovation in America*, was delivered at the Annual Meeting Banquet of the National Academy of Engineering on November 2, 1978.

Dr. Perry was elected to the Academy in 1970.

- How can the government stimulate future technological innovation?

Importance of Innovation

In my view, technological innovation is the key to our ultimate ability to realize national goals. It is central to real economic growth, to our national security, and to our political influence. According to a 1977 Department of Commerce report, 45% of this nation's economic growth from 1929 to 1969 can be attributed to innovation.

The impact of innovation in the U.S. balance of trade is illustrated by the performance of both R&D-intensive and non-R&D intensive industries examined in the period from 1960-1976. According to Department of Commerce Reports, the R&D intensive industries produced a \$5.9 billion positive trade balance in 1960, while corresponding non-R&D-intensive industries had a negative \$179 million balance. In 1976, the trade balance of the R&D-intensive industries grew to a positive \$29 billion, while the non-R&D-intensive produced a \$16.5 billion deficit. Imagine the impact on the balance of payments, the strength of the dollar, inflation—our national economic well being—if R&D intensive industry were not producing a sizeable inflow of international trade to offset the costs of imported oil and the negative balance in other sectors.

On a personal basis, innovation has been important to me in my two different careers. In 1964 I left a large company, Sylvania Electric Products, where I was director of the Electronic Defense Laboratories, to found ESL, Incorporated. In the thirteen years that followed, I saw ESL grow from 5 to over 1000 employees, with annual sales growing to \$60 million. Technological innovation played a major role in this growth, allowing ESL to compete successfully with larger firms by identifying narrow, but high leverage endeavors where we could focus our efforts.

Today, innovation remains central to my responsibilities, but I am now dealing with a scope of activities three orders of magnitude greater than when I was running a company. As the DoD Acquisition Executive—supervising research, development and acquisition of systems for the DoD—I advise the Secretary of Defense on capital budget decisions involving an annual procurement budget of over \$30 billion and a research and development budget of about \$12 billion.

The Department of Defense is like most large businesses, in that many of our critical decisions relate to capital budget items. But the impact of our decisions has especially long term implications. It takes six to

ten years to introduce a new weapon into our inventories, and the systems we develop often have a lifetime of twenty or thirty years. Therefore, capital budgeting decisions which we make today must look ahead beyond the end of this century. In this environment, we place a premium on research and development in support of innovation—innovation in government technical laboratories and acquisition agencies, but largely innovation in the private sector.

The score of my responsibilities in the DOD does not allow me to apply the same type of hands-on management I could apply in a small company. My efforts are focused instead on conceiving and directing an investment strategy in our ongoing competition with the Soviet Union. While the analogy between such a strategy and a business investment strategy is flawed, it does provide a useful framework for comparison.

In our continuing competition with the Soviet Union, we are faced with a competitor who is spending some 25-40 percent more on defense, and has been maintaining a 4-5 percent real growth in defense expenditures for more than a decade. In investment, Soviet expenditures exceed ours by roughly 75%. The result is a distinct Soviet production advantage, typically two or three-to-one in many categories of equipment.

But this advantage applied largely to *evolutionary* systems which are compatible with the Soviet Union and its socio-economic structure. The U.S. advantage lies in a broad technological and industrial base which can support *revolutionary* systems. This advantage can be effectively exploited in our long term competition if we are successful in selectively developing, identifying and applying high leverage technology. Technological innovation is at the core of such a strategy, and as such, is central to the DOD and our national defense.

Are We Losing Our Edge?

Measuring innovation and its impact is something we have grappled with for some time. Our confidence in most absolute measures is not high, but I think we have adequate confidence in the major trends. Probably the most direct measure of trends is the number and distribution of major innovations presented by year and by country of market introduction. Of the total innovations accounted for in the U.S., U.K., France, West Germany and Japan, the U.S. average was about 75 percent in the 1950's; dropping to 57 percent from 1968 to 1973. So there is evidence of a decline in innovation relative to the other countries studied.

The ultimate indicator of innovation is produc-

tivity—a measure of the efficiency in converting resources into valuable goods and services. U.S. productivity growth can be compared with that of other countries using the general measure of output per man-hour. International comparisons of productivity are difficult because of differences in sources and methodology, and limitations in available data. Therefore, small differences in productivity between nations over short time periods are probably not as significant as long term trends.

In terms of output per man-hour in manufacturing, U.S. productivity grew about 55 percent from 1960 to 1976. This gain was the smallest of 6 countries studied for this time period, and more than five times less than increases in Japan (290 percent), which had the largest gains. France had a gain of about 120 percent; West Germany - 140 percent; U.K. - 60 percent; and Canada - 80 percent.

But the U.S. started from a relatively high level of productivity in 1960, so it is not unreasonable to expect higher growth rates from countries continuing their recovery from WW II. Using an index of 100 for the U.S. productivity in 1976, comparative 1976 productivity in France was 83; West Germany - 77; Japan - 61; U.K. - 56 and Canada - 91. So the U.S. is still the world leader in productivity although our rate of productivity growth is lower than that of most nations studied.

The long term productivity growth rate for the U.S. during the 16-year period from 1960-1976 was about 2.7 percent per year. In the ten year interval from 1966-76, the growth rate was 2.1 percent per year. This average 2.1 percent growth rate was maintained from 1971-1976 as well.

So there has been a slight decrease in the absolute rate of productivity growth in the U.S. While this trend is worrisome, the evidence of a major lag in productivity is not compelling. The principal conclusion I draw is that the absolute rate of productivity growth in the U.S. has declined somewhat in the last decade, but that the effect of this decline is minor in comparison to the accelerated productivity growth of other industrial nations in their recovery from WW II.

Ingredients of Successful Innovation

To examine the ingredients of successful innovation in America, I will review a case study beginning with the transistor and extending into the development of the integrated circuit.

This story really starts back in 1926 when a comprehensive theory of semiconductors was developed. The theory had little impact or relevance because

semiconductors of sufficient purity were not available or even conceived to be possible to produce.

By the early 1940's, a firm foundation for the study of semiconductors started to emerge in the basic research department at Bell Laboratories. This work led to methods of producing pure crystals of silicon and germanium, and doping them with controlled amounts of impurities to produce semiconductors with desired characteristics.

Early in 1946, William Shockley proposed an experiment to obtain electronic amplification using a semiconductor. Experimental tests proved negative—and it appeared that the effect was at least a thousand times smaller than expected from Shockley's calculations. After two years of dedicated work involving a combination of "pure" science and practical implementation, transistor action was demonstrated in a series of experiments in December of 1947.

The demonstration of the transistor effect depended on pre-existing science and could not have been formulated without a foundation of work dating back 20 years. Additional ingredients critical to this work included the availability of appropriate materials and an understanding of the interaction of these materials with electric fields. But the final achievement, in which minority carriers were used to control amplification, was unexpected and produced the major breakthrough.

Unlike the transistor (and most other fundamental innovations) the development of the integrated circuit is a story of a conceptual process that was recognized by many, and in fact, predicted.

For example, G. W. A. Dummer of Great Britain stated at a 1952 Washington, D.C. Electronics Components Symposium:

With the advent of the transistor and the work in semiconductors generally, it seems now possible to envisage electronic equipment in a solid block with no layers of insulating, conducting, rectifying and amplifying materials, the electrical functions being connected directly by cutting out areas of the various layers.

Although the precise effect of Dummer's prediction on subsequent U.S. research is difficult to trace, the idea was certainly not forgotten in the U.K. In April 1957, the then Royal Radar Establishment (RRE) placed a contract to develop a "semiconductor integrated circuit." In September of that year, Dummer exhibited a metal model demonstrating how silicon crystals might be shaped to control properties in a typical transistor circuit.

What Dummer in 1952 had called "a peep into the future" was realized in 1958 when the first crude "integrated" circuit was actually built—but it didn't

take place in England. The event occurred in the United States, at Texas Instruments, where project leader Jack Kilby would apparently not even learn of Dummer or his prediction until the early 1960's. And by then the first commercial integrated circuits were being churned out, and the U.S. was on its way to dominating the world in this revolutionary new technology. Kilby is credited with conceiving and constructing the first working integrated circuit. Boy Noyce, one of eight founders of Fairchild Semiconductor and presently chairman of Intel, is credited for his sophistication of the integrated circuit for more specialized use, particularly in industry.

Of special interest in this story is why the integrated circuit was invented here in the U.S. and not in the U.K. One reason is that semiconductor technology existed here in 1952. This was not so in the U.K. Secondly, the DoD—the Air Force in particular—realized the importance of micro-miniaturization, and provided direct support for much of the R&D that stimulated the development of integrated circuits. Perhaps more importantly, the DoD provided demand pull by serving as a customer for the new circuits. Unlike most other breakthroughs, the integrated circuit was a programmed, but revolutionary step developed in response to a need.

Dummer, now semi-retired reminisces in writing about why this happened here and not there:

It is worth remembering that the giant American electronics companies (with few exceptions) were formed since the war by a relatively few enterprising electronics engineers setting up on their own with either their own capital or risk capital from a bank. Often, a Government contract would start them off. Hard work was necessary and the large home market was a great asset, but the climate of innovation was such that any advanced technical product could be sold.... The American system of encouraging employees to hold shares in their company is one which should be emulated, as a part-share in the firm's prosperity gives a sense of increased responsibility.... Successful businesses are almost always dependent on a few people who are innovative and enthusiasts.

Examining the ingredients for success in this case study, I agree with the factors identified by Dummer. The fundamental exploitation of integrated circuits was accomplished not by large electronic companies, but by small firms with personal innovation incentives.

I would like to examine the unique ingredients in this case study in each of four phases: basic research, inventions (development of new products), marketing and long-term exploitation.

Basic research in universities and large companies

played a significant role in development of the transistor and a less significant role in the development of the integrated circuit. But Europe and the Soviet Union have similar basic research structures and capabilities, and there appears to be no underlying U.S. advantage here.

In the next two phases—development of new products and marketing—there is clear evidence of an underlying U.S. advantage. This advantage was most often displayed in the leadership of the small firm. The climate for successful innovation at this level is unique in the U.S. There is no analog in the Soviet Union; and in Europe the climate is inhibited by a tax structure which greatly limits the fundamental incentive—profit.

While profit may not be the principal motivation for the individual starting a new firm, I know from personal experience that profit is needed to attract the investment capital necessary for product development and successful marketing. The availability of investment capital is influenced by many factors; a key factor being long term product exploitation to produce profits for reinvestment.

The U.S. had previously been the world leader in long-term product exploitation by large companies—a result of manufacturing and distribution efficiency developed in WW II. But we are losing this edge. Japan has been extremely effective in large scale exploitation of American innovation. They have successfully focused their industry to exploit the transistor in radios, and the integrated circuit in large scale production of TVs and calculators. Western Europe is also making progress. Retaining our edge in large scale and long-term product exploitation is a key ingredient in sustaining a climate for innovation through reinvestment of profits.

Sustaining Future Innovation

In my view, the American spirit and ingenuity which support innovation are still here. But our ability for long-term exploitation of innovation is diminishing. There are a number of steps which the government can take in response.

One step is to improve the climate for entrepreneurship. A tax structure which allows for a reasonable return will help in motivating not only the entrepreneur, but the investor who supplies the necessary capital. We are moving in this direction with recent legislation at the Federal level.

Another step is to improve the climate for manufacturing—especially in relation to competing in the world market. Government should be a partner instead of an adversary in support of our world-wide business. Government can support international trade

and improve the climate for export of finished products through a supportive regulatory and tax structure. On the other hand, Government can protect our manufacturing advantages by regulating the export of significant production technology.

The Government can also provide direct stimulus through funding for R&D.

President Carter has recognized the erosion of the overall investment in basic research during the past decade and emphasized greater support for basic research to sustain the technical innovations which are fundamental to our economic well being and our national security.

The DOD technology base program is the source of research, technology and components that can be directed toward future military systems. The purchasing power of this program has eroded by about fifty percent during the ten year period prior to 1975. During the same period, the contractual research effort fell by sixty percent in real terms.

I believe it is imperative to reverse that trend. Therefore, I have recommended a sustained rate of real growth in the DOD technology base budget: ten percent per year for basic research and five percent per year for exploratory development. This growth should be maintained for five to ten years to restore the technology base funding level to what it was in the early 1960's.

Application of this funding should be considered in the context of the investment strategy for our ongoing competition with the Soviet Union. The U.S. has a fundamental advantage in this competition as a result of our broad technological and industrial base. In many cases we can simply apply technology developed for commercial applications to future military systems. Where there are gaps in terms of military applications, we can fill those gaps with DOD funding.

But most importantly, we need to exploit our advantage in developing *revolutionary* systems. We can do this by being selective and spending boldly on technologies which have high military effectiveness—getting this technology from the laboratory into the field in perhaps half the normal time.

An example is our program in Very High Speed Integrated circuits (VHSI). As you well know, the story of the integrated circuit (IC) did not end with its invention in 1958. From 1958 through 1965, the DOD remained the principal customer for ICs with more than seventy percent of the total market share. Beyond 1965, the commercial market for the IC began to blossom.

Today, the annual IC market exceeds \$2.5 billion, with a DOD portion of less than 7%. Self-initiated advancement by industry resulted in development of

the microprocessor and large scale integration (LSI).

The same chip which makes possible the \$5 pocket calculator or digital watch in the commercial sector offers profound advantages in military systems as well. Rough estimates of savings in the DoD as a result of ICs exceeds \$1 billion per year. So we in DoD are reaping the rewards of self-initiated industrial innovation, a step that was encouraged by our earlier investment in the basic integrated circuit.

But the direction of the IC industry is now diverging from future DoD needs. Commercial needs are directed to low speed multi-function chips as opposed to real time, high speed signal processing. The industry is reluctant to make custom chips for DoD with MILSPEC qualification or radiation hardness. These problems, which limit the application of LSI in DoD, can be expected to be worse with very large scale integration (VLSI).

Our goal is to exploit the revolutionary advantages of high speed, very large scale integration by introducing VHSI in military systems at least five years ahead of present projections. This should reverse the present situation in which DoD lags commercial exploitation by two to five years. The DoD VHSI program will involve expenditures of over \$150 million over a 6 year time period. The program will include initial smaller contracts to universities, industry and not for profit corporations with experience in chip design and architecture. This will be complemented by funding to supporting equipment suppliers (e.g., lithography and testing), and larger funding to the IC industry to establish pilot production.

We will be aiming to provide ICs with one hundred times the throughput of present ICs, allowing new and important military applications (e.g., avionics, surveillance, electronic warfare and communications). Alternatively, we could replace 100 or more present ICs with a single VHSI IC, with at least a ten-fold reduction in size, weight, power consumption and failure rate. The eventual result will be reduced life cycle costs as well as revolutionary new opportunities.

While the DoD VHSI effort will be small in comparison to the total R&D in support of commercial ICs, we feel that the VHSI program can have a catalytic effect similar to that experienced in the 1960s. DoD was the catalyst then, supplying funding for essential feasibility demonstrations and providing a small but sufficient market. We expect the VHSI program to have a similar effect.

Summary

In summary, it is apparent that technological innovation has been great for America (and conversely)! As a people, we still have the innovative spark needed to

conceive, develop and market new products. But as a nation, there are signs of stagnation—not so much in an absolute sense, but relative to most other industrial nations. Perhaps the most serious signs of stagnation are in the long term, international exploitation of innovation.

The Government can and should play a role in maintaining a national climate for technological innovation. The first step is recognizing the national importance of innovation and the ingredients which contribute to sustain it. A balanced tax and regulatory structure can serve to support rather than impede innovation and improve our ability to sustain long term, world-wide exploitation.

President Carter has recognized the importance of innovation and has been working with the Congress to improve the national tax structure. He has directed a Domestic Policy Review of Industrial Innovation, recognizing the fact that the Federal Government can significantly influence both the ability and the motivation for individual firms to innovate.

This review will involve 30 Federal departments and agencies, including the Department of Defense. The output will help the President focus on those aspects of industrial innovation which he deems most significant to national needs, and provide specific strategies in support of selected goals. I believe this review offers a unique opportunity to improve the climate for innovation in America, and the DoD will be an active participant.

We in the DoD recognize the importance of technological innovation in developing revolutionary new systems. We plan a sustained effort to expand our technology base programs, and are prepared to spend boldly to accelerate deployment of technologies which can significantly improve military effectiveness.

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Ruth D. Kaplan, *Editor*

The National Academy of Engineering is a private organization established in 1964 to sponsor engineering programs aimed at meeting the national needs; to encourage engineering research; to advise the federal government, upon request, in matters of engineering; and to recognize distinguished engineers.

Senator KENNEDY. We will hear from Doctor Wilson now.

STATEMENT OF DR. LAUREN R. WILSON, DEAN OF ACADEMIC AFFAIRS AND PROFESSOR OF CHEMISTRY, OHIO WESLEYAN UNIVERSITY, ON BEHALF OF THE GREAT LAKES COLLEGES ASSOCIATION, THE NATIONAL ASSOCIATION OF INDEPENDENT COLLEGES AND UNIVERSITIES, AND THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES

Dr. WILSON. Senator Kennedy and Senator Schweiker, we appreciate the opportunity to be here. I am here today representing the Great Lakes Colleges Association, the more than 800 members of the National Association of Independent Colleges and Universities, and the 375 members of the American Association of the State Colleges and Universities.

I am here to speak on some of the issues involving the National Science Foundation's support of science education, and to express our overriding concern with the declining priority which science education seems to hold within the National Science Foundation.

The carving of the fiscal 1980 budget provides an accurate measure of priorities and by this test, science education has not fared well. We note with alarm the 78.4 percent reduction in real dollars spent for science education from the 1968 level while funding for basic research has increased 95.6 percent.

Please do not misunderstand us. We agree with Dr. Pimentel's point earlier that the NSF should be the lead agency for the development of science in this country. We also agree with the point that science education and scientific research can most properly proceed in the same agency, and I will say something to that effect in a little more detail in a minute.

In the past, this subcommittee of the Congress has consistently served the best interests of science education by questioning the ultimate goals of specific NFS science education programs and the levels of funding requested for these programs. We urge you to continue to raise such fundamental issues.

I speak to you as a science teacher and a science researcher. I have devoted a large part of my professional life to science education in a liberal arts college. In this role, I have spent varying proportions of my time preparing future scientists and sharing the excitement, precision, and potential of science with those who have no science career ambitions but who wish to understand better the world they live in and the ethical concerns surrounding scientific issues. The other side of my professional career has been a research commitment augmented by some 15 years' involvement with outstanding undergraduates. Both my teaching and my research have been greatly enhanced by frequent leaves in order to immerse myself in prolonged research activity and to broaden my knowledge beyond that of graduate school studies.

I wish to address four major issues and then comment on specific items in the proposed fiscal 1980 NSF budget. These points are: (1) The role of science education in our society; (2) the interdependencies of scientific and science education; (3) the significance of "little science"; and (4) the erosion of support for proven science education programs to increase innovation programs.

The public debates on cloning and DNA modification, solar and nuclear energy, laetrile and fluorocarbons give clear evidence of the national interest in scientific issues. Virtually every public policy decision taken by elected officials calls for an understanding of the basic tenets of science. The quality of life, and possibly the perpetuation of our society, depends upon a population with a basic understanding and appreciation of scientific concepts. Science education on the precollege and undergraduate levels must provide this understanding and appreciation for the general citizenry. That science education requires a commitment of resources and the guidance of a Federal agency in which these goals are held in highest esteem.

Undergraduate science education programs of today prepare the talented group who become the scientists of tomorrow, the teachers who carry out quality science programs in the elementary and secondary schools, and those who receive their last course in science during their undergraduate years.

Congress recognized the interdependence of the science education and scientific research functions when it formed the National Science Foundation and charged it "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." Congress has continuously fostered the concept that neither can proceed effectively or efficiently without the other. Together they provide the knowledge and manpower which are essential to solve specific scientific problems.

Our firm belief in this mutually beneficial interdependence leads us to assert three specific policy positions.

One: First, we wish to record our strong opposition to any reorganization in the Federal Government which would transfer only the science education section of the National Science Foundation to another education-oriented department. In my own experience, I often find that the interplay of research ideas spins off into a valuable application or example for my teaching. Artificial separation of the teaching and research aspects of science at the Federal level obstructs the promotion of high quality science education at all levels.

Another example which supports our position is the positive impact which the leading scientific talent of one generation can have upon the education of another. This is beautifully revealed in the chemical education material study—CHEMS—course. This course, designed by distinguished chemical researchers and teachers, including Dr. George Pimentel, currently the Deputy Director of the National Science Foundation, featured a markedly different, more interactive approach to the study of high school chemistry. Nearly a generation of young people have profited from this innovative approach to chemical education. In physics, the physical science study course—PSSC—and in biology, the biological science study course—BSSC—were also developed by teaching and research scientists with the encouragement and support of NSF.

We agree with the testimony Senator Kennedy recently delivered before the Senate Committee on Governmental Affairs that it is not in the best interests of either basic research or science education to transfer the science education programs of the National Science Foundation to a Department of Education.

Two: This same principle of the importance of close connection between science education and scientific research suggests the need to remedy now a sore wound, trivial though it may sound. For some years the NSF science education directorate staff has been quartered in a part of Washington distant from the main Foundation offices. Symbolically, they are second-class citizens. Not only is there a loss of valuable staff time spent traveling back and forth for scheduled conferences, but the loss of those daily opportunities for cross-fertilization between scientists concerned with basic research policy and those concerned with science education policy is grievous. Science education staff and programs at the NSF need to be rescued from "second-class citizenship," for the good of the whole basic science enterprise.

Three: Finally, we assert that science education at all levels will improve when the NSF, either at its own initiative or at the direction of the Congress, recognizes a greater parity in the support of science education and scientific research programs.

The budgetary proposal of the NSF does not adequately support the science education portion of the agency's congressional mandate. In 1967, science education expenditure represented 82.1 percent of the basic research budget. In the proposed 1980 NSF budget, science education has tumbled to only 9.5 percent of the amount requested for basic research.

We feel that the once parallel trends in funding for science education and scientific research which existed into the early seventies have now disappeared, and we would urge that this parallelism be recreated, that the appropriate level be reached, and that they then proceed together.

Senator KENNEDY. What are the implications of that kind of flow line?

Dr. WILSON. In terms of science education?

Senator KENNEDY. Yes.

Dr. WILSON. I think there are a number of indications.

One certainly, I think, deals with the topic Dr. Hornig mentioned, and that is the involvement of women and minorities. I think there are really two components. That is, minority people who simply have been outside the influence of science education, it seems, certainly as one would measure it by number——

Senator KENNEDY. They were not in it when we were spending a good deal more money on it.

Dr. WILSON. My own experience, when we had programs in undergraduate research, more money in basic science, about 50 percent of our majors were women. That has fallen off substantially.

The Foundation people have identified an early involvement of equal opportunity and encouragement, which I think that is very crucial. Studies would support that. Studies show that decisions on whether to be a scientist or not occur fairly early in one's academic progress, at least in middle schools. I think that is an important component.

We are recommending, as is in our statement, a greater increase in the area of funding for women and minorities than the Foundation has proposed.

I think the other implication is that in order to prepare the best qualified people to proceed in science, we have to have strong

elementary, secondary, and undergraduate programs in order to have them move into the graduate programs to do specialized research.

We also support what is sometimes called "little science." That is, research activity available for people who are not at very large research installations, and who can develop smaller scale research projects. Some of these are not really small scale in importance. It is increasingly difficult for scientists in independent colleges, where there are no graduate programs, to obtain funding for research.

Some of us have been able to pick up support from our own institutions, from the Research Corporation, the Petroleum, Research Fund, the American Chemical Society, and these are very important components. Still there needs to be Federal support and encouragement.

We also think that within the science education component of the National Science Foundation that there has been a marked increase of interest in innovation, in science education.

We would urge this committee to ask the Foundation to continue to give support as well to those programs which have traditionally produced high quality scientists who can then move on into the graduate level of research, and subsequently into the work force in science and industry and in academics.

I wish to comment upon the set-aside program for small research instrumentation grants this subcommittee recommended that the Foundation establish in fiscal 1978. The language called for funding for small instruments, costing \$25,000 or less, with attention to the needs of 2 and 4 year colleges. Last year NSF was urged to continue this program by setting aside 15 percent of total funds for research instrumentation for a small research instrumentation grants program. The NSF administration of this program has been extraordinarily loose. The bulk of the funds awarded in fiscal 1978 found their way to established research grantees and not the young Ph. D's described in the set-aside instruction, and the amount spent was nowhere near the recommended 15 percent. We observe that 15 percent of the fiscal 1978 research instrumentation budget of \$56.8 million was \$8.52 million. NSF expended only \$390,300, a mere 0.7 percent.

In its mandate to the NSF, the Congress stated that the NSF "should * * * initiate and support * * * programs to strengthen * * * science education at all levels." We submit that the inclusion of the word "support" and not merely "initiate" clearly calls for continuing attention and action. The trend noted by this observer is that the Foundation is steadily abandoning support programs in favor of innovation programs. I strongly believe that we need to preserve both types of programs.

Innovation programs are needed to cope with crises. For instance, the problems minorities, women and the handicapped have in entering the sciences today call for innovation response. We deplore the cutback recommended in this program in the current budget and the rationale that NSF will absorb the effort by skewing other program guidelines. Clearly defined programs will keep goals visible and ease NSF's accountability to Congress.

Support programs within the National Science Foundation are those which award on a competitive basis funds to help science

departments meet certain present needs: updated curricula and materials and teachers trained to use them are necessary to the elementary and secondary schools; a qualified faculty and reliable, up-to-date instructional scientific equipment are needed for good undergraduate science education.

We do not reject the rationale for innovation programs but do protest a distortion of the NSF mission for science education which would make innovation programs the only allowable programs or even the predominant. We suggest that approximately equal shares of the science education budget be apportioned between the support and innovation categories.

I now examine certain portions of the NSC science education budget for fiscal 1980. In this discussion, I am employing a classification scheme which roughly approximates the type of program support needed to continue quality science education: science faculty development, instrumentation for science education and curriculum improvement.

The typical undergraduate science faculty member is a decade or two out of graduate school and post-doctoral experience and in an environment of restricted mobility. In my opinion, the only real access for the conscientious teacher-researcher to the expanding frontiers of science is a leave program to study in depth and to sharpen research skills for an extended period of time spent at a graduate or research institution or industrial site. This form of faculty renewal has been supported by the program entitled Science Faculty Professional Development (SFPD), which is omitted from the fiscal 1980 budget and is to be replaced by two new programs, one entitled "Institutes and Conferences" and a second called "Industrial Research Participation." The first of these somewhat revives an earlier NSF program which was subsequently phased out; the second is a substantial narrowing of the SFPD program.

As a chemist, I have attended and led several workshops and conferences and generally found them useful when devoted to very specific subject or skill areas, for example, Piaget learning, environmental chemistry education. However, they do not provide a suitable substitute for a longer leave in which one can immerse oneself in a research problem and develop a reading and study program. I cite my own exhilarating year's leave at the Oak Ridge National Laboratory. I not only conducted research in surface chemistry but in that period of time and that environment I formulated the basis of my current research and developed a new, multidisciplinary approach to chemical education for nonscience majors. I believe this could not possibly have occurred with even several fragmented summers of conferences or workshops.

The continuation of the SFPD program has a multiplying effect for NSF dollars. Most institutions provide sabbatical leave programs which require only a modest supplement from NSF funds to change a routine leave into a spectacular one.

While both of the replacement programs proposed by NSF may be useful, we believe neither provides the flexibility or depth of the SFPD program. We strongly recommend reauthorization at the \$5 million level.

In Doctor Atkinson's recent presentation of the NSF budget for 1980, the need for increased support for research instrumentation and equipment was specifically identified. He pointed out that a major effort to help universities and colleges obtain research instruments had begun in fiscal 1978 and must be continued for several years. The arguments used to support increased funding for research instrumentation apply with even greater intensity to instrumentation used for science teaching. The hands-on approach so crucial in undergraduate science instruction extracts a heavy toll from the normal lifetime of equipment. But without this experience the nonscience majors would never savour at firsthand the exhilaration of a new discovery, and our career-oriented science majors would have the disadvantage of having to spend time at graduate school learning about equipment.

The most vital of the NSF programs in this area has been the instructional scientific equipment program (ISEP). Its funding has remained level during the years in which the National Science Board has endorsed the policy shift from support programs to innovation programs, and actually decreased when inflation is taken into account. For fiscal 1980, NSF has proposed a status quo budget of \$3.5 million for the program. We strongly recommend this subcommittee increase the level of funding by, at the very least, 50 percent to retain some semblance of parity with the research instrumentation request. Additional money should be made available for equipment replacement as well as new items and for this we would recommend an additional \$4 million, for a total ISEP budget of \$9 million.

From the perspective of my institution and others like it, one of the most important programs to enhance science education is the comprehensive assistance to undergraduate science education—CAUSE program. Curriculum needs vary from campus to campus and this program requires careful self-study of science and/or social science curricular needs to design a proposal. On my campus, our CAUSE grant enabled us to upgrade computer hardware and course content. The result has been an explosion of usage by students in the social sciences and their enthusiasm is now reaching students in the humanities.

We regret that NSF has recommended a decrease in funds for this program. We hope you will recommend \$15 million for CAUSE in fiscal 1980.

Time does not permit my commenting in detail on other NSF programs. I append a schedule of suggested authorization levels for specific programs within the science education budget portion of NSF's budget.

We would like to mention one other concern which we hope you will examine. The National Science Board's composition has been consistently skewed by an underrepresentation of those scientists involved in the teaching enterprise at any but the graduate level, a fact not unrelated to the continued inadequacies of the Board's pronouncements on science education policy. Would a smaller and more representative group be more efficient and more effective?

Perhaps I will conclude at this moment by simply saying that we do believe the budget proposed by the National Science Foundation for science education is inadequate, and we are not at any point

trying to oppose the support for basic research, because we understand and support this vital component in this country. We just reassert that without strong science education programs we cannot produce scientists who understand, who are capable of dealing with sophisticated graduate research. This brings us to one of our most important concerns, which parallels the research one, and that is what about money for scientific instrumentation?

Certainly, the toll on instruments of the neophytes and undergraduate schools is substantially greater. We think hands-on policy for instrumentation is crucial in good science education.

Thank you, Senators. We appreciate the opportunity to talk to you.

Senator KENNEDY. Thank you.

[The prepared statement of Dr. Wilson follows:]

Statement by

Dr. Lauren R. Wilson

Dean of Academic Affairs

and

Professor of Chemistry

Ohio Wesleyan University

On Behalf of

The Great Lakes Colleges Association

and

The National Association of Independent Collèges and Universities

Before the

Subcommittee on Health and Scientific Research

Senate Committee on Labor and Human Resources

6226 Dirksen Senate Office Building

March 2, 1979

Senator Kennedy and Members of the Subcommittee:

Thank you for the opportunity to testify before you on the National Science Foundation fiscal 1980 budget request. Today I am representing the member colleges of the Great Lakes Colleges Association and the more than 800 members of the National Association of Independent Colleges and Universities to speak to certain issues involved in the National Science Foundation's support of science education and express our overriding concern with the declining priority which science education seems to hold within the National Science Foundation. The carving of the fiscal 1980 budget provides an accurate measure of priorities and by this test, science education has not fared well. We note with alarm the 78.4 per cent reduction in real dollars spent for science education from the 1968 level while funding for basic research has increased 95.6 per cent. (See Appendix A.)

In the past, this Subcommittee of the Congress has consistently served the best interests of science education by questioning the ultimate goals of specific NSF science education programs and the levels of funding requested for these programs. We urge you to continue to raise such fundamental issues.

I speak to you as a science teacher and a science researcher. I have devoted a large part of my professional life to science education in a liberal arts college. In this role, I have spent varying proportions of my time preparing future scientists and sharing the excitement, precision, and potential of science with those who have no science career ambitions but who wish to understand better the world they live in and the ethical concerns surrounding scientific issues. The other side of my professional career has been a research commitment augmented by some fifteen years' involvement with outstanding undergraduates. Both

*

The Great Lakes Colleges Association member colleges are: Albion College, Antioch University, Denison University, DePauw University, Earlham College, Hope College, Kalamazoo College, Kenyon College, Oberlin College, Ohio Wesleyan University, Wabash College, The College of Wooster.

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my teaching and my research have been greatly enhanced by frequent leaves in order to immerse myself in prolonged research activity and to broaden my knowledge beyond that of graduate school studies.

I wish to address four major issues and then comment on specific items in the proposed fiscal 1980 NSF budget. These points are:

1. The role of science education in our society.
2. The interdependence of scientific research and science education.
3. The significance of "little science."
4. The erosion of support for proven science education programs to increase innovation programs.

The Role of Science Education

The public debates on cloning and DNA modification, solar and nuclear energy, laetrile and fluorocarbons give clear evidence of the national interest in scientific issues. Virtually every public policy decision taken by elected officials calls for an understanding of the basic tenets of science. The quality of life, and possibly the perpetuation of our society, depends upon a population with a basic understanding and appreciation of scientific concepts. Science education on the pre-college and undergraduate levels must provide this understanding and appreciation for the general citizenry. That science education requires a commitment of resources and the guidance of a Federal agency in which these goals are held in highest esteem.

Undergraduate science education programs of today prepare the talented group who become the scientists of tomorrow, the teachers who carry out quality science programs in the elementary and secondary schools, and those who receive their last course in science during their undergraduate years.

The Interdependence of Scientific Research and Science Education

Congress recognized the interdependence of the science education and scientific research functions when it formed the National Science Foundation and

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charged it "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." Congress has continuously fostered the concept that neither can proceed effectively or efficiently without the other. Together they provide the knowledge and manpower which are essential to solve specific scientific problems.

Our firm belief in this mutually beneficial interdependence leads us to assert three specific policy positions.

1. First, we wish to record our strong opposition to any reorganization in the Federal government which would transfer only the science education section of the National Science Foundation to another education-oriented department. In my own experience, I often find that the interplay of research ideas spins off into a valuable application or example for my teaching. Artificial separation of the teaching and research aspects of science at the Federal level obstructs the promotion of high quality science education at all levels. Another example which supports our position is the positive impact which the leading scientific talent of one generation can have upon the education of another. This is beautifully revealed in the Chemical Education Material Study (CHEMS) course. This course, designed by distinguished chemical researchers and teachers, including Dr. George Pimentel, currently the Deputy Director of the National Science Foundation, featured a markedly different, more interactive approach to the study of high school chemistry. Nearly a generation of young people have profited from this innovative approach to chemical education. In physics, the Physical Science Study Course (PSSC), and in biology, the Biological Science Study Course (BSSC), were also developed by teaching and research scientists with the encouragement and support of NSF.

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We agree with the testimony Senator Kennedy recently delivered before the Senate Committee on Governmental Affairs that it is not in the best interests of either basic research or science education to transfer the science education programs of the National Science Foundation to a Department of Education.

2. This same principle of the importance of close connection between science education and scientific research suggests the need to remedy now a sore wound, trivial though it may sound. For some years the NSF Science Education Directorate staff has been quartered in a part of Washington distant from the main Foundation offices. Symbolically, they are second class citizens. Not only is there a loss of valuable staff time spent traveling back and forth for scheduled conferences, but the loss of those daily opportunities for cross-fertilization between scientists concerned with basic research policy and those concerned with science education policy is grievous. Science education staff and programs at the NSF need to be rescued from "second class citizenship," for the good of the whole basic science enterprise.

3. Finally, we assert that science education at all levels will improve when the NSF, either at its own initiative or at the direction of the Congress, recognizes a greater parity in the support of science education and scientific research programs.

The budgetary proposal of the NSF does not adequately support the science education portion of the agency's Congressional mandate. In 1967, science education expenditures represented 82.1 per cent of the basic research budget. In the proposed 1980 NSF budget, science education has tumbled to only 9.5 per cent of the amount requested for basic research. Once parallel budget trends in funding which existed into the early 70's have become frighteningly divergent in the past

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few years. (See Appendix B.) This shortsightedness in support of quality science education at the undergraduate and earlier levels will soon erode the very research effort which the NSF desires to expand. We hope that this Subcommittee will specify a long-term objective to improve this ratio so that science education resources are at 33 per cent of resources committed to basic research in any given fiscal year.

Support for "Little Science"

The third major point of my testimony is related to the importance of what is sometimes called "little science." While "big science" with its teams of researchers, massive and costly equipment and huge quantities of resources is both necessary and important in our society, it has submerged the importance of "little science." Many important discoveries have come from "little science" -- carried out by a single researcher utilizing modest equipment and an equally modest budget. This type of research may involve undergraduate students and is a natural integration of science education with the in-depth knowledge and skills required for significant research. "Little science" researchers are found on college and university campuses of all sizes and all over the country. Their work may be supported by their home college or university, the Research Corporation, the Petroleum Research Fund, and so forth, but it is rarely funded by the NSF basic research grants program. I submit that two major reasons exist for this lack of Federal support for "little science." The first is a certain bias of some reviewers because the absence of a cadre of graduate students slows down the rate at which work is completed and publication appears; the second, reviewers may deem the modest project budgets of a few thousand dollars to indicate that the research is insignificant.

Because "little science" research can take place on any college or university campus and also from the viewpoint of undergraduate colleges deeply committed to research as part of the achievement of teaching excellence, we urge you to

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develop a strategy to enhance the opportunity for "little science" research at all sizes of institutions. The cost of and potential for "little science" research varies markedly among the disciplines. However, we believe appropriate formulae can be developed to set aside a reasonable share of basic research support for projects which fall in the "little science" category.

I wish to comment upon the set-aside program of small research instrumentation grants this Subcommittee recommended that the Foundation establish in fiscal 1978. The language called for "funding for small instruments, costing \$25,000 or less, with attention to the needs of 2- and 4-year colleges."^{1/} Last year NSF was urged to continue this program by "setting aside 15 per cent of total funds for research instrumentation for a small research instrumentation grants program . . .".^{2/} The NSF administration of this program has been extraordinarily loose. The bulk of the funds awarded in fiscal 1978 found their way to established research grantees and not the "young Ph.D.'s" described in the set-aside instruction, and the amount spent was no where near the recommended fifteen per cent. We observe that fifteen per cent of the fiscal 1978 research instrumentation budget of \$56.8 million was \$8.52 million. NSF expended only \$390,300, a mere 0.7 per cent.

Support versus Innovation

In its mandate to the NSF, the Congress stated that the NSF "should . . . initiate and support . . . programs to strengthen . . . science education at all levels." We submit that the inclusion of the word "support" (and not merely "initiate") clearly calls for continuing attention and action. The trend noted by this observer is that the Foundation is steadily abandoning support programs

^{1/} Senate Report 95-851, page 25.

^{2/} Ibid., page 25.

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in favor of innovation programs. I strongly believe that we need to preserve both types of programs.

Innovation programs are needed to cope with crises. For instance, the problems minorities, women and the handicapped have in entering the sciences today call for innovation response. We deplore the cutback recommended in this program in the current budget and the rationale that NSF will absorb the effort by skewing other program guidelines. Clearly-defined programs will keep goals visible and ease NSF's accountability to Congress.

Support programs within the National Science Foundation are those which award on a competitive basis funds to help science departments meet certain present needs: updated curricula and materials and teachers trained to use them are necessary to the elementary and secondary schools; a qualified faculty and reliable, up-to-date instructional scientific equipment are needed for good undergraduate science education.

We do not reject the rationale for innovation programs but do protest a distortion of the NSF mission for science education which would make innovation programs the only allowable programs or even the predominant. We suggest that approximately equal shares of the science education budget might be apportioned between the support and innovation categories.

I now examine certain portions of the NSF science education budget for fiscal 1980. In this discussion, I am employing a classification scheme which roughly approximates the type of program support needed to continue quality science education: science faculty development, instrumentation for science education and curriculum improvement.

Science Faculty Development

The typical undergraduate science faculty member is a decade or two out of graduate school and postdoctoral experience and in an environment of restricted

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mobility. In my opinion, the only real access for the conscientious teacher/researcher to the expanding frontiers of science is a leave program to study in depth and to sharpen research skills for an extended period of time spent at a graduate or research institution or industrial site. This form of faculty renewal has been supported by the program entitled Science Faculty Professional Development (SFPD), which is omitted from the fiscal 1980 budget and is to be replaced by two new programs, one entitled "Institutes and Conferences" and a second called "Industrial Research Participation." The first of these somewhat revives an earlier NSF program which was subsequently phased out; the second is a substantial narrowing of the SFPD program.

As a chemist, I have attended and led several workshops and conferences and generally found them useful when devoted to very specific subject or skill areas (e.g., Piaget learning, environmental chemistry education). However, they do not provide a suitable substitute for a longer leave in which one can immerse oneself in a research problem and develop a reading and study program. I cite my own exhilarating year's leave at the Oak Ridge National Laboratory. I not only conducted research in surface chemistry but in that period of time and that environment I formulated the basis of my current research and developed a new, multidisciplinary approach to chemical education for nonscience majors. I believe this could not possibly have occurred with even several fragmented summers of conferences or workshops.

The continuation of the SFPD program has a multiplying effect for NSF dollars. Most institutions provide sabbatical leave programs which require only a modest supplement from NSF funds to change a routine leave into a spectacular one.

While both of the replacement programs proposed by NSF may be useful, we believe neither provides the flexibility or depth of the SFPD program. We strongly recommend reauthorization at the \$5.0 million level.

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Instrumentation for Science Education

In Dr. Atkinson's recent presentation of the NSF budget for 1980,^{1/} the need for increased support for research instrumentation and equipment was specifically identified. He pointed out that a major effort to help universities and colleges obtain research instruments had begun in fiscal 1978 and must be continued for several years. The arguments used to support increased funding for research instrumentation apply with even greater intensity to instrumentation used for science teaching. The hands-on approach so crucial in undergraduate science instruction extracts a heavy toll from the normal lifetime of equipment. But without this experience the nonscience majors would never savour at first-hand the exhilaration of a new discovery, and our career-oriented science majors would have the disadvantage of having to spend time at graduate school learning about equipment.

The most vital of the NSF programs in this area has been the Instructional Scientific Equipment Program (ISEP). Its funding has remained level during the years in which the National Science Board has endorsed the policy shift from support programs to innovation programs and actually decreased when inflation is taken into account. For fiscal 1980, NSF has proposed a status quo budget of \$3.5 million for the program. We strongly recommend this Subcommittee increase the level of funding by, at the very least, fifty per cent to retain some semblance of parity with the research instrumentation request. Additional money should be made available for equipment replacement as well as new items and for this we would recommend an additional \$4.0 million, for a total ISEP budget of \$9.0 million.

^{1/}
Statement of Richard C. Atkinson before the House Subcommittee on Science, Research and Technology, February 13, 1979.

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Curriculum Improvement

From the perspective of my institution and others like it, one of the most important programs to enhance science education is the Comprehensive Assistance to Undergraduate Science Education (CAUSE) program. Curriculum needs vary from campus to campus and this program requires careful self-study of science and/or social science curricular needs to design a proposal. On my campus, our CAUSE grant enabled us to upgrade computer hardware and course content. The result has been an explosion of usage by students in the social sciences and their enthusiasm is now reaching students in the humanities.

We regret that NSF has recommended a decrease in funds for this program. We hope you will recommend \$15.0 million for CAUSE in fiscal 1980.

Time does not permit my commenting in detail on other NSF programs. I append a schedule of suggested authorization levels for specific programs within the science education budget portion of NSF's budget. (See Appendix C.)

* * * * *

We would like to mention one other concern which we hope you will examine. The National Science Board's composition has been consistently skewed by an underrepresentation of those scientists involved in the teaching enterprise at any but the graduate level, a fact not unrelated to the continued inadequacies of the Board's pronouncements on science education policy. (See Appendix D.) Would a smaller and more representative group be more efficient and more effective?

Senator KENNEDY. Mr. Storaska, Pennsbury, Pa.

Senator SCHWEIKER. I want to say Dan a high school teacher there in science, Mr. Chairman, and has worked for 10 years in this capacity. He has been in the National Science Foundation Institute programs, and can shed some light on the problems science teachers face today. I am very pleased to have him here from my home State of Pennsylvania.

**STATEMENT OF DANNY B. STORASKA, TEACHER OF SCIENCE,
PENNSBURY SCHOOL DISTRICT, FALLSINGTON, PA.**

Mr. STORASKA. Thank you. I would like to thank you for personally giving public high school science teachers a chance to respond in these areas.

I have been teaching for 14 years, and I am currently president of our local education association, which represents approximately 700 teachers. The building I teach in has an enrollment of 2,100 students and is comprised of just the 11th and 12th grades. The district itself has approximately 12,000 students in grades K through 12.

I have attended six National Science Foundation Summer Institutes in the summers of 1967-71 and 1973. Over that same period of time my teaching assignment changed from regular physics until I eventually taught all honors physics courses—Pennsbury's most rigorous physics course. It was a tremendous challenge for me and one that would have been very difficult to meet without the NSF Institutes. There is no doubt in my mind that they made me a better teacher.

We had a student at that time in Pennsbury who far excelled in the fields of science and math, and by the time she had completed her 11th year, she had taken every advanced science and math course that Pennsbury offered. She would have gone on to college at that time but was not quite as strong in her social studies and wanted another year at the high school level. In science and math in her 12th year, she had independent studies. I taught that girl differential equations that year from the exact same text that I had used when I attended a graduate NSF Institute at Clarkson College of Technology. She went on to a successful engineering career.

I also noticed during teaching classes that when students asked questions, I rarely had to research them. My knowledge in the field of physics, even though I had majored in physics and math in my undergraduate studies, had doubled—even tripled. It was a great time to teach science. The SAT scores were high. We were caught up in the space race and science and technology was on everyone's mind. Pennsbury had between five and six full-time physics teachers. Physics was a tough course and everyone knew it, but the students still signed up. People felt a real need for the discipline of physics, and others like it.

Today, at Pennsbury, I teach photo science. My classes went from four honors physics courses in the early 1970's to five photo science today. We are down to about one and one half physics teachers from the previous six, and we offer no honors physics at the high school level, even though our total enrollment is almost the same.

Senator KENNEDY. How typical is that in your region and nationally?

Mr. STORASKA. I believe that is very typical.

Senator KENNEDY. Doctor Wilson, I see you nodding your head. Do you agree with that?

Dr. WILSON. I agree.

Mr. STORASKA. We offer other courses now in science.

Senator SCHWEIKER. What would be a few of the other new science courses?

Mr. STORASKA. We switched from physics generally at the high school to biology and environmental courses. We also have a course that is offered—people technology environment—which was initiated because of an NSF institute grant I received and consequently studied under at the State University of New York, at Stony Brook, but there is a commonality among these new science courses. The bulk of them are half-year or semester courses. In a word they are easier. They require less homework. We suffer from grade inflation.

I cannot remember the last time I saw or heard of a science fair.

The NSF Institutes have all but disappeared, but I would be hard put if I were asked to show a causal relationship between the lack of Institutes and what is happening in today's science classes.

Senator KENNEDY. How much of this is the falling off of interest by the students? They are just not willing? How much is the failure to be more creative and imaginative in presenting these courses in an interesting kind of way? I remember in high school taking that physics course was just something else again, even at that time.

Mr. STORASKA. I think the College Entrance Examination Board gave the best explanation as to what is happening and why. What they have said is that students are spending too much time watching television. Outside pressures such as oil shortages and wars have made school life seem much less significant, a place where you mark time until you get to college or find you a job.

The tremendous increase in single-parent households have dumped problems on students that many adults would have trouble bearing. Schools have responded by offering easier courses which require less homework, which in turn tends to reinforce the idea that homework and school may not be all that important.

I don't for a minute believe that the problems found in schools are only school-bases problems. They are a reflection of the problems found in today's society. Education is, however, such an integral part of American society that we cannot afford to wait until the proper societal solutions are stumbled upon.

Senator KENNEDY. Does that mean we ought to be redoubling our efforts in these areas, to try and hold on to the degree of interest that exists there and try to reestablish it? Is that what you are saying in terms of science education?

Mr. STORASKA. I believe there is a solution in the near future; it is just that we—meaning the majority of the people in this country—have not recognized it as yet.

There is another race beyond the space race to be won. We are going to need more engineers, more scientists, more physicists, and more chemists. We are going to have the same single-minded deter-

mination that this country had when it won the race to the Moon. There is not going to be as much time to indulge in other problems. I believe we are going to need the National Science Foundation to duplicate its results of the 1960, again.

This country must be made fully aware of and solve the problem of alternative energy sources. The NSF could lead the way in the solution by reestablishing Institutes to retrain teachers in the areas of energy sources, pollution, and environment. All three areas are interwoven. Courses such as environmental chemistry, environmental pollution, and consumer science are examples of what I am referring to. Considering that each teacher works with 100 students per year, it is difficult to deny the impact that retraining 100,000 teachers will have on those 10 million students per year.

Since the demise of the National Science Foundation Institutes, the opportunities for science teachers to improve their knowledge base has also declined. I sincerely request this subcommittee to call upon Congress to provide the funds to return the Institutes to their former importance so that a new generation of scientific advances can be made. This is needed for the good of the Nation, our schools, our teachers, and our future citizens—our students.

I wish to thank the subcommittee for taking time to listen to me, and I hope you can help return the study of science to its former stature.

I would also agree with you, Senator Kennedy, that a science teacher ought to be included on the National Science Foundation Board.

Senator SCHWEIKER. You said, Dan, that the problem you define is society based, as opposed to school based. I concur with that. My question then is if we beef up the NSF program, the Institutes, the things that you feel have been helpful in the past, will that really solve the problem?

In other words, I am not disagreeing they should be beefed up. But in view of your analysis, I tend to agree, this is society problem here, and not just a school problem.

Mr. STORASKA. I believe the NSF Institutes had a direct impact on society in the 1960's. Retraining teachers in areas considered important then influenced societal values. A few years back if you were to ask student's what they were going to be when they grew up you might have heard some of them say "an astronaut." I am proposing we use the same methods today that worked so well before. We will know if we are successful when a student answering the some question today responds by saying he/she would like to be a solar engineer.

[The prepared statement of Mr. Storaska follows:]

Testimony

of

Danny B. Storaska

Teacher of Science

Pennsbury School District

Fallsington, Pennsylvania

Before

the

Sub-Committee on Health and Scientific Research

of the

Human Resources Committee

of the

United States Senate

March 2, 1979

Washington, D. C.

My name is Danny B. Storaska. I am a science teacher in the Pennsbury School District which is located in Pennsylvania about 25 miles northeast of Philadelphia. I have been teaching for 14 years and I am currently President of our local education association which represents approximately 700 teachers. The building I teach in has an enrollment of 2100 students and is comprised of just the 11th and 12th grades. The district itself has approximately 12,000 students in grades K through 12.

I have attended six National Science Foundation Summer Institutes in the summers of 1967, 68, 69, 70, 71, and 73. Over that same period of time my teaching assignment changed from regular physics until I eventually taught all honors physics courses--Pennsbury's most rigorous physics course. It was a tremendous challenge for me, and one that would have been very difficult to meet without the NSF Institutes. There is no doubt in my mind that they made me a better teacher.

We had a student at that time in Pennsbury that far excelled in the fields of science and math and by the time she had completed her 11th year, she had taken every advanced science and math course that Pennsbury offered. She would have gone on to college at that time, but was not quite as strong in her social studies and wanted another year at the high school level. In science and math in her 12th year, she had independent studies. I taught that girl differential equations that year from the exact same text that I had used when I attended a graduate NSF Institute at Clarkson College of Technology. She went on to a successful engineering career.

I also noticed during teaching classes that when students asked questions, I rarely had to research them. My knowledge in the field of physics, even though I had majored in physics and math in my undergraduate studies, had doubled--even tripled. It was a great time to teach science. The SAT scores were high. We were caught up in the space race and science and technology was on everyone's mind. Pennsbury had between five and six full-time physics teachers. Physics was a tough course and everyone knew it, but the students still signed up. People felt a real need for the discipline of physics, and others like it.

Today, at Pennsbury, I teach photo science. My classes went from four honors physics courses in the early 1970's to 5 photo science today. We are down to about one and one half physics teachers from the previous six, and we offer no honors physics at the high school even though our total enrollment is almost the same. We offer many new science courses, the bulk of them being half-year or semester courses. In a word, they are easier. They require less homework. We suffer from grade inflation. I can't remember the last time I saw or heard of a science fair.

The NSF institutes have all but disappeared, but I think I would be hard put if I were asked to show a causal relationship between the lack of institutes and what's happening in today's science classes. The best explanation that I know of has been offered by the College Entrance Examination Board while trying to determine what has caused the decline in the SAT scores. Too much television has cut into the time students spend on homework. Outside pressures such as oil shortages and wars have made school life seem much less significant; a place where you mark time until you get to college or find your job. The tremendous increase in single-parent households have dumped problems on students that many

adults would have trouble bearing. Schools have responded by offering easier courses which require less homework which in turn tends to reinforce the idea that homework and school may not be all that important. I don't for a minute believe that the problems found in schools are only school-based problems. They are a reflection of the problems found in today's society. Education is, however, such an integral part of American society that we cannot afford to wait until the proper societal solutions are stumbled upon. I believe there is a solution in the near future, it is just that we--meaning the majority of the people in this country--have not recognized it as yet.

There is another race beyond the space race to be won. We are going to need more engineers, more scientists, more physicists and more chemists. We are going to have to have the same single-minded determination that this country had when it won the race to the moon. There is not going to be as much time to indulge in other problems. I believe we are going to need the National Science Foundation to duplicate its results of the 60's again.

This country must be made fully aware of and solve the problem of alternative energy sources. The NSF could lead the way in the solution by re-establishing institutes to retrain teachers in the areas of energy sources, pollution, and environment. All three areas are interwoven. Courses such as environmental chemistry, environmental pollution and consumer science are examples of what I am referring to. Considering that each teacher works with about 100 students per year, it is difficult to deny the impact that retraining 100,000 teachers would have on those 10,000,000 students per year.

Since the demise of the National Science Foundation Institutes, the opportunities for science teachers to improve their knowledge base has declined also. I sincerely request this sub-committee to call upon Congress to provide the funds to return the Institutes to their former importance so that a new generation of scientific advances can be made. This is needed for the good of the nation, our schools, our teachers, and our future citizens: our students.

I wish to thank the sub-committee for taking time to listen to me, and I hope you can help return the study of science to its former stature.

Senator KENNEDY. Dr. Wilson, maybe you would like to ask some questions, or Dr. Atkinson would respond to observations about the science education programs. Maybe we can start off with some exchange on that. Do you want to give some kind of response?

Dr. ATKINSON. I generally find myself in almost total agreement with almost all the points that were made. Dr. Hornig raised some interesting options that I had not quite considered before.

I might point out that in our postdoctoral fellowship program just this year, we did permit postdoctoral fellows to operate on a part-time basis. This is a step in that direction.

In the time we have I cannot address each of the concerns that each of you has raised, but the issue of quality and interest in science education in this country, I think, is absolutely critical.

Your comments on the television workshop series for young people are important. The summer institutes you mentioned have been tremendously effective in the past, and it is unfortunate that we have not been able to continue those activities.

Your comments about instrumentation in the 2- and 4-year colleges certainly are clearly on target. We do need to have students with firsthand experience—experience of actual experimentation—not just exposure to text books.

Dr. PARTRIDGE. I would just like to add my comment on the summer institutes. They were one of the best programs, I think, that NSF has undertaken in that field. They have been very effective in our area. We have seen students come through that had been inspired by teachers who participated in that program.

This ties into another aspect that I would like to have your comments on. In science in general there is a great need for continuing education.

I had a man in my office the other day who graduated about the same time I did in electrical engineering. He was just going back to an industry workshop to be retreaded the fourth time in 24 years. He came out qualified to design scientific equipment, using vacuum tubes, just about 1950—well, you know what has happened to the field since then. He has had to go back four different times.

The interesting part of it was he went back to school put on by industry, not by the universities. In so many scientific fields, in the practicing field, as well as teaching, these high school teachers and

college teachers have a very hard job keeping up with basic fundamentals in their particular field, to be able to pass them on to these high school students, and younger students, to inspire them, and show them what is happening.

Is there anything the foundation can do to help the universities meet that need to continue to update and retread all the people in the scientific fields?

Dr. ATKINSON. Obviously we have programs that are quite minimal. We have a program for college teachers that permits them to work in an industry for a year in scientific matters.

Senator KENNEDY. How many are involved in that?

Dr. ATKINSON. Very small numbers, about 120.

Senator SCHWEIKER. When did we discontinue the summer institute program?

Dr. RUTHERFORD. We still have them, Senator. They are currently very much on a reduced scale, but we are calling for an increase next year. At one time it was a very large expenditure of about \$25 million a year. That went down almost to zero. We have been trying to bring it back up again.

Senator SCHWEIKER. Do you have an index, Dr. Atkinson, of what Dan said? Could we see what is happening across the country in terms of high school students taking advanced physics or advanced chemistry, or biology courses? Do you keep any running tabs on something like that?

Dr. ATKINSON. The answer is yes, we do. The junior high school thrust was based on just that type of information—the fact that so many students were dropping out and the need to insure that more students stay in the science programs in the junior high school years.

Senator SCHWEIKER. If what he says is a national trend, we are really headed for trouble. I would like NSF to analyze whether this is a national trend. If it is, I think we have a serious problem on our hands.

Can you supply for the record the measurement you have of the trends of students today taking courses in science?

Dr. ATKINSON. We will.

[The following was received for the record:]

MEASUREMENT OF ENROLLMENTS IN COURSES IN SCIENCE

There are three significant pieces of relatively hard information regarding enrollments in science at the pre-college level. First, there is an analysis by Harnischfeger and Wiley stating that solid data collected by the National Center for Education Statistics for the short period 1970/71 to 1972/73 shows that mathematics enrollments had a total decline over this period amounting to about 7 percent. The pattern of enrollment is important because there was also reorganization in the courses taken. Remedial enrollments, always proportionately small, remained so absolutely, but in relative terms increased by 80 percent (1.4 to 2.6). General mathematics enrollments decreased by 15 percent. College preparatory enrollments did not change overall but, interestingly enough, there was also a redistribution: enrollments in beginning and intermediate algebra and plane geometry decreased while those in very advanced and specialty courses increased.

Harnischfeger and Wiley also found that there are large declines in science enrollments as well. Total general science courses taken in secondary school declined by 13 percent and, within the higher senior high school grades the decline amounted to 30 percent. College preparatory science has also declined: biology by 1 percent, chemistry by 10 percent, and physics by 30 percent. It appears that the magnitude of the decline is dependent on the mathematical preparation required.

The only increases, 61 percent, derived from specialty courses in biological science, e.g., ecology.

Second, an NSF sponsored study shows that about 50 percent of all students take no science beyond grade 10 while biology is the dominant 10th grade science subject. Third, we find that Project TALENT data show that students who drop out of a science/mathematics track at any level are unlikely to reenter such a track.

Senator KENNEDY. I am just interested in the dropping of the continuing education program as a line item in the budget. Does that bother you? We have heard the explanation over here. Does that make any difference to you, that those programs are being done in other areas? Would you rather have identification of that?

Dr. WILSON. We are very much concerned, Senator, about the dropping of the science faculty professional development program, that is scheduled in the 1980 budget proposal to be phased out.

We find this is one of the most important parts of continuing development of our own faculty at the graduate level, and we are very concerned about that.

Related to it is the slight decrease in the CAUSE program, comprehensive assistance for undergraduate science education. The request there is only a 2-percent drop for next year. We still feel this is a program that has very broad impact on our campuses in terms of upgrading of science education in general.

I should also emphasize that our feeling is that the priority assigned to women and minorities should not be submerged into other programs. We think it is important that those programs be in targeted areas. It is difficult once it is submerged into one other program.

Senator KENNEDY. I suppose the continuing educational program for women is particularly important. Dr. Partridge indicated what is happening in industry. I would think that there are instances where women may drop out for 2 or 3 years at the beginning of a family, and come back into a highly competitive situation.

Dr. WILSON. Very much the case. I might comment, from my own institution there are a large number of professionally well qualified women who are seeking jobs, even down to the skimpiest part-time position. These are people who are very well qualified, for whom more permanent positions have not been available across the spectrum of opportunities.

Senator KENNEDY. Dr. Hornig, do you want to say a word on this?

Dr. HORNIG. Yes. We feel very strongly there is a need for retraining programs, reentry programs. We also believe this is a general problem, and not simply a woman's problem, and does deserve that kind of attention.

Senator KENNEDY. I do not know if there are any other points that you would want to bring up with Dr. Atkinson, or any other reaction the Dr. Atkinson has, or any more specific recommendations you have to us in terms of authorizing legislation.

I think you reviewed in some detail the particular programs, and gave your concerns.

Dr. WILSON. We have appended to our particular remarks specific budget recommendations for a variety of science educational programs. We would like that to be in the record.

Senator KENNEDY. Very good.

[The appendices referred to follow:]

SUPPORT OF SCIENCE EDUCATION & BASIC RESEARCH^{1/}
NATIONAL SCIENCE FOUNDATION
FY 1967-1980 in FY '67 Dollars
(In Millions of Dollars)

	A.	B.	C.	D.	E.	F.	G.	H.
Fiscal Year	Fiscal Calendar Year CPI ^{2/} Average ^{3/}	CPI FY '67 Base=100	NSF Budget Expenditure for Science Education	Amount Needed to Equal FY 67 Expenditures for Science Ed.	Purchasing Power of NSF Sci. Ed. Support in '67 Dollars	NSF Budget Expenditure for Basic Research	Amount Needed to Equal FY 67 Expenditures for Basic Research	Purchasing Power of NSF Basic Research in '67 Dollars
'67	97.2-100.0	98.6	141.7	141.7	141.7	172.6	172.6	172.6
'68	100.0-104.2	102.1	147.6	145.9	143.3	170.6	177.8	165.6
'69	104.2-109.8	107.0	117.4	153.0	108.7	176.0	186.4	162.9
'70	109.8-116.3	113.0	107.0	161.5	93.8	161.0	196.7	161.2
'71	116.3-121.3	118.8	88.2	170.0	73.5	180.3	207.1	150.3
'72	121.3-125.3	123.3	74.0	177.1	59.2	248.6	215.8	198.9
'73	125.3-133.1	129.2	39.9	145.7	30.4	268.0	226.1	204.6
'74	131.1-147.7	140.4	58.1	201.2	40.9	338.1	245.1	197.9
'75	147.7-161.2	154.45	54.7	222.5	34.8	520.9	271.0	215.4
'76	161.2-170.5	165.86	44.3	238.1	26.4	128.1	290.0	310.1
TQ ^{4/}			2.4	59.5	1.4	649.0	72.5	76.3
			46.7	297.6	27.8	649.0	362.5	386.3
'77	170.5-181.5	176.0	56.3	253.6	31.4	472.9	309.0	264.2
'78	181.5-195.3	188.4	59.1	270.6	30.9	601.9	339.7	315.1
'79	195.3-210.3	202.85/ ^{5/}	63.82/ ^{6/}	291.9	31.0	647.42/ ^{7/}	355.6	314.3
'80	210.3-224.4	217.256/ ^{8/}	67.98/ ^{8/}	311.7	30.9	712.58/ ^{8/}	379.7	323.9

APPENDIX A

^{1/} Science Education does not include Graduate Student Support or Traineeships, Technological Innovation in Education and Public Understanding of Science, Basic Research Includes only Mathematical & Physical Sciences & Engineering; Astronomical, Atmospheric, Earth & Ocean Sciences, and Biological, Behavioral, and Social Sciences. (This is done to provide compatible figures.)

^{2/} CPI=Consumer Price Index (Bureau of Labor Statistics, U.S. Dept. of Labor)

^{3/} Calculated by averaging two adjacent calendar years.

^{4/} TQ=Transition Quarter, period from July 1 through September 30, 1977, created by changing Federal Fiscal Year to an October 1 through September 30 basis.

^{5/} Projection based on CPI-keyed 7.7% inflation for CY '79 (Council of Economic Advisers, OMB)

^{6/} Projection based on CPI-keyed 6.8% inflation for CY '80 (CEA, OMB)

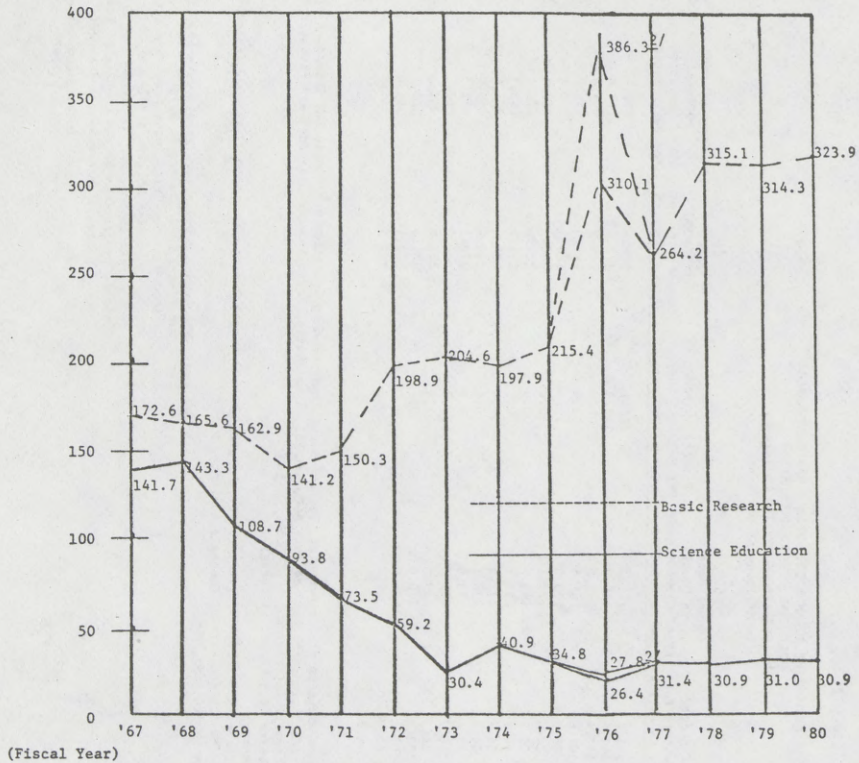
^{7/} Current plan.

^{8/} NSF fiscal 1980 budget request

Sources: NSF Annual Reports for fiscal years 1967 through 1977
NSF Fiscal 1980 "Budget in Brief"
Revised Consumer Price Index for Urban Wage Earners and Clerical Workers (1967-100), Bureau of Labor Statistics, U.S. Department of Labor
Economic projections of the Council of Economic Advisers, Office of Management and Budget
Independent Colleges Office
January, 1979

APPENDIX B
NATIONAL SCIENCE FOUNDATION
Support of Science Education and Basic Research^{1/}, FY 1967-1980
in FY '67 Dollars

(Millions of Dollars)



^{1/} Science Education does not include Graduate Student Support or Traineeships, Technological Innovation in Education and Public Understanding of Science. Basic Research includes only Mathematical & Physical Sciences & Engineering; Astronomical, Atmospheric, Earth & Ocean Sciences; and Biological, Behavioral and Social Sciences.

^{2/} Figure includes obligations for transition quarter (July 1 through September 30, 1977) created by changing the Federal Fiscal year to an October 1 through September 30 basis.

Sources: NSF Annual Reports for fiscal years 1967-1977
NSF Fiscal 1980 "Budget in Brief"
Revised Consumer Price Index for Urban Wage Earners and Clerical Workers
(1967=100), Bureau of Labor Statistics, U.S. Department of Labor
Economic projections of the Council of Economic Advisers, Office of Management and Budget

Appendix C

SUMMARY OF BUDGET REQUESTS FOR
SELECTED NATIONAL SCIENCE FOUNDATION EDUCATION PROGRAMS
(In Millions of Dollars)

Program Name	NSF FY 1980 Request	Our Request	Increase Over NSF Request	Previous Program High (Year)
<u>Comprehensive Assistance to Under-graduate Science Education (CAUSE)</u> Encourages broad scope improvement in quality and effectiveness of undergraduate science education. Maximum \$250,000 award for up to three years in response to detailed plans for a coordinated set of activities for science departments, groups of departments or Institution's total science education effort.	13.5	15.0	+1.5	13.8 ('79)
<u>Instructional Scientific Equipment Program (ISEP)</u> Encourages improvement in undergraduate science education by matching support for purchase of new scientific equipment for educational purposes.	3.5	9.0	+5.5	8.9 ('64)
<u>Local Course Improvement (LOCI)</u> Funds concentrated, short-term, small-scale efforts by individuals or small groups of faculty to upgrade undergraduate science instruction by redesigning courses in the sciences and social sciences.	3.0	5.0	+2.0	3.0 ('79)
<u>Science Faculty Professional Development (SFPD)</u> Supports three- to twelve-month research and study projects at institutions of higher education or industrial labs to improve the competence of faculty involved primarily in undergraduate science teaching.	0	5.0	+5.0	predecessors: a. 4.0 ('71) b. 1.3 ('73)
<u>Student-Originated Studies (SOS)</u> Supports ten- to twelve-week projects for small teams of college students in an experience in self-designed, self-directed scientific research.	0.9	2.0	+1.1	2.0 ('72)
<u>Student Science Training (SSTP)</u> Provides talented high school students with special advanced courses and/or research participation experience beyond that available in high school for students with high potential from high schools with deficient science training or students with high ability from nationally-recognized, excellent high schools.	2.3	3.4	+1.1	2.4 ('64)
<u>Pre-College Teacher Development in Science</u> (Teacher Training Programs) Funds academic year or summer programs of continuing education for elementary and secondary school teachers in mathematics, natural or social sciences to upgrade the quality of science teaching.	9.0	15.0	+6.0	24.3 ('65)
<u>Undergraduate Research Participation (URP)</u> Provides talented undergraduate students with firsthand experience in scientific research activities through direct collaboration with science faculty.	2.0	5.0	+3.0	6.8 ('66)

Independent Colleges Office
February, 1979

NATIONAL SCIENCE BOARD MEMBERS, 1950 - 1979

This study shows the composition of the National Science Board by current affiliation or, for past members, last institutional affiliation while serving on the National Science Board.

A comparison of institutional affiliations shows that representation from institutions primarily concerned with undergraduate education is presently 4 per cent of the total membership. Ph.D. granting institutions are presently represented by 71 per cent of the membership and non-degree granting organizations currently by 25 per cent of the membership.

Over the 29-year history of the National Science Board, undergraduate institutions have had only 6 per cent representation and often no representation at all. Ph.D. granting institutions have an overall 66 per cent representation and non-degree granting organizations 28 per cent.

National Science Board Members, Past and Present

	<u>Number</u>	<u>Percentage</u>
B.A. and M.A. Degree-Granting Institutions (C)*	7	6
Ph.D. Degree-Granting Institutions (U)	77	66
Non-Degree Granting Organizations (ND)	<u>32</u>	<u>28</u>
Total	116	100

National Science Board Members, Present

	<u>Number</u>	<u>Percentage</u>
B.A. and M.A. Degree-Granting Institutions (C)	1	4
Ph.D. Degree-Granting Institutions (U)	18	72
Non-Degree Granting Organizations (ND)	<u>6</u>	<u>24</u>
Total	25	100

*These institutions are Carleton, Defiance, Spring Hill, Texas Southern, West Virginia State, Mount Holyoke, and California State at Fullerton.

NATIONAL SCIENCE BOARD MEMBERS, 1950-1979

This National Science Board roster lists every member since the inception of the Board in 1950, together with the last affiliation of each while on the NSB.

Present members' names are underlined.

	<u>Name</u>	<u>Affiliation</u>
U	1. Aberle, Dr. <u>Sophie D.</u>	University of New Mexico
U	2. Adams, Dr. <u>Roger*</u>	University of Illinois
ND	3. <u>Atkinson, Dr. Richard C., ex officio</u>	National Science Foundation
ND	4. <u>Baker, Dr. W.O.</u>	Bell Telephone Laboratories
ND	5. <u>Barnard, Dr. Chester*</u>	Rockefeller Foundation
U	6. <u>Barnes, Dr. Robert P.</u>	Howard University
U	7. <u>Bing, Dr. R.H.</u>	University of Texas at Austin
U	8. <u>Bisplinghoff, Dr. Raymond L.</u>	University of Missouri at Rolla
ND	9. <u>Branscomb, Dr. Lewis M.⁺</u>	IBM
U	10. <u>Bronk, Dr. Detley W.</u>	Rockefeller University
U	11. <u>Brooks, Dr. Harvey</u>	Harvard University
U	12. <u>Bunting, Dr. Mary I.</u>	Radcliffe College
U	13. <u>Campbell, Dr. W. Glenn</u>	Stanford University
U	14. <u>Carter, Dr. H.E.</u>	University of Arizona
ND	15. <u>Charpie, Dr. Robert A.</u>	Cabot Corporation
U	16. <u>Clement, Dr. Rufus E.*</u>	Atlanta University
U	17. <u>Cobb, Dr. Jewel P.</u>	Rutgers-The State University of New Jersey, Brunswick
U	18. <u>Conant, Dr. James B.*</u>	Harvard University
ND	19. <u>Cooke, Dr. Lloyd M.</u>	Economic Development Corp. of N.Y., Inc.
U	20. <u>Cori, Dr. Gerty T.*</u>	Washington University
U	21. <u>Cota-Robles, Dr. Eugene H.⁺</u>	University of California, Santa Cruz
C	22. <u>Davis, Dr. John W.</u>	West Virginia State
U	23. <u>Dicke, Dr. Robert H.</u>	Princeton University
ND	24. <u>Doan, Mr. Herbert D.</u>	Doan Associates
ND	25. <u>Dollard, Mr. Charles*</u>	Carnegie Corporation

National Science Board Members
Page Two

	<u>Name</u>	<u>Affiliation</u>
U	26. DuBridge, Dr. Lee A.	California Institute of Technology
U	27. Elvehjem, Dr. Conrad A.*	University of Wisconsin
U	28. Eyring, Dr. Henry	University of Utah
U	29. Fowler, Dr. William A.	California Institute of Technology
U	30. Fred, Dr. Edwin B.	University of Wisconsin
U	31. <u>Friedl, Dr. Ernestine</u> ⁺	Duke University
U	32. Gates, Dr. David M.	University of Michigan
U	33. Glennan, Dr. T. Keith	Case University
U	34. Goldsmith, Dr. Julian R.	University of Chicago
C	35. Gould, Dr. Laurence M.	Carleton College
U	36. Gross, Dr. Paul M.	Duke University
U	37. <u>Hackerman, Dr. Norman</u> (Chairman)	Rice University
U	38. Hagerty, Dr. William W.	Drexel Institute of Technology
ND	39. Hahn, Dr. T. Marshall, Jr.	Georgia-Pacific Corporation
ND	40. Handler, Dr. Phillip	National Academy of Sciences
U	41. Hardin, Dr. Clifford M.	University of Nebraska
ND	42. Haworth, Dr. Leland J.	National Science Foundation
C	43. Harrison, Dr. Anna J.	Mount Holyoke College
U	44. Hesburgh, The Very Reverend Theodore M., C.S.C.	University of Notre Dame
U	45. Heffner, Dr. Hubert*	Stanford University
U	46. <u>Hogness, Dr. John R.</u>	University of Washington, Seattle
U	47. Houston, Dr. William W.*	Rice University
ND	48. <u>Hubbard, Dr. W.N.</u>	The Upjohn Company
U	49. <u>Hueg, Dr. William F., Jr.</u>	University of Minnesota, St. Paul
U	50. Humphrey, Dr. George D.*	University of Wyoming
U	51. Hyman, Dr. O.W.*	University of Tennessee

National Science Board Members
Page Three

Appendix D - 4

	<u>Name</u>	<u>Affiliation</u>
ND	52. Heyns, Dr. Roger W.	American Council on Education
ND	53. Jones, Dr. Charles F.	Humble Oil and Refining Company
U	54. Jones, Dr. Thomas F., Jr.	University of South Carolina
U	55. <u>Kasha, Dr. Michael⁺</u>	Florida State University
U	56. <u>Koshland, Dr. Marian E.</u>	University of California at Berkeley
U	57. Loeb, Dr. Robert F.*	Columbia University
U	58. <u>MacLane, Dr. Saunders</u>	University of Chicago
U	59. Macelwane, The Reverend James B., S.J.*	St. Louis University
U	60. March, Dr. James G.	Stanford University
U	61. <u>Massey, Dr. Walter E.⁺</u>	Brown University
U	62. McBride, Dr. Katherine E.*	Bryn Mawr College
U	63. McCann, Dr. Kevin	Defiance College
ND	64. McElroy, Dr. W.D.*	National Science Foundation
ND	65. McLaughlin, Dr. Donald H.	Homestake Mining Company
U	66. McShane, Dr. Edward J.	University of Virginia
U	67. Meckling, Mr. William H.	University of Rochester
ND	68. Merck, Mr. George*	Merck and Company, Inc.
U	69. Middlebush, Dr. Frederick*	University of Missouri
U	70. Moreland, Mr. Edward L.*	Massachusetts Institute of Technology
U	71. Morison, Dr. Robert S.	Cornell University
ND	72. Morse, Dr. Marston*	Institute for Advanced Study
U	73. Morris, Dr. Joseph C.*	Tulane University
U	74. <u>Murray, Dr. Grover E.</u>	Texas Technological University
C	75. Nabrit, Dr. Samuel M.	Texas Southern University
U	76. Nierenberg, Dr. William A.	University of California, San Diego (Scripps Institution)
U	77. O'Brien, Dean Morrough P.	University of California at Berkeley
ND	78. O'Neal, Dr. Russell D.	KMS Fusion, Inc.
U	79. <u>Pettit, Dr. Joseph M.⁺</u>	Georgia Institute of Technology

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	<u>Name</u>	<u>Affiliation</u>
ND	80. Picker, Mr. Harvey	Picker Corporation
ND	81. Piore, Dr. E.R.	IBM Corporation
U	82. Potter, Dr. Andrey A.	Purdue University
U	83. Press, Dr. Frank	Massachusetts Institute of Technology
U	84. <u>Ragone, Dr. David V.</u> ⁺	University of Michigan
U	85. Rees, Dr. Mina S.	City University of New York
U	86. Reyniers, Prof. James A.*	University of Notre Dame
U	87. Reynolds, Dr. Joseph M.	Louisiana State University
ND	88. <u>Rice, Dr. Donald B., Jr.</u>	Rand Corporation
U	89. <u>Rich, Dr. Alexander</u>	Massachusetts Institute of Technology
U	90. Rubey, Dr. William W.*	University of California at Los Angeles
U	91. Russell, Dr. Jane A.*	Emory University
U	92. <u>Salt peter, Dr. Edwin E.</u> ⁺	Cornell University
U	93. Seaborg, Dr. Glenn T.	University of California at Berkeley
U	94. Sears, Dr. Paul B.	Yale University
C	95. <u>Shields, Dr. L. Donald</u> ⁺	California State University at Fullerton
U	96. <u>Slichter, Charles P.</u>	University of Illinois, Urbana-Champaign
U	97. Smith, Dr. Frederick E.	Harvard University
ND	98. Snyder, Mr. John I., Jr.*	U.S. Industries, Inc.
ND	99. Spilhaus, Dr. Athelstan F.	Smithsonian Institution
U	100. Stakman, Dr. E.C.	University of Minnesota
ND	101. Stevenson, Dr. Earl P.	Arthur D. Little, Inc.
ND	102. Stever, Dr. H. Guyford	National Science Foundation
U	103. Stratton, Julius A.	Massachusetts Institute of Technology
ND	104. Sullivan, Mr. Richard H.	Carnegie Corporation
U	105. Tatum, Dr. Edward L.	Rockefeller University
U	106. Thieme, Dr. F.P.	University of Colorado
ND	107. Tyler, Dr. Ralph W.	Center for Advanced Study in the <u>Behavioral Sciences</u>

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	<u>Name</u>	<u>Affiliation</u>
ND	108. Volwiler, Dr. Ernest H.	Abbott Laboratories
U	109. Walker, Dr. Eric A.	Pennsylvania State University
ND	110. Waterman, Dr. Allan T.*	National Science Foundation
ND	111. Weaver, Dr. Warren*	Alfred P. Sloan Foundation
U	112. Whitaker, Dr. Douglas M.*	Rockefeller University
U	113. Willey, Dr. Malcolm M.*	University of Minnesota
ND	114. Wilson, Dr. Charles*	General Electric Company
C	115. Yancey, The Reverend Patrick H., S.J.*	Spring Hill College
U	116. <u>Zumberge, Dr. James H.</u>	Southern Methodist University

*Deceased

+Nominated but not confirmed

Dr. WILSON. One other area in which we have some concern, and this really reflects, or follows up on the point made a moment ago, that is the composition of the National Science Board.

We feel very strongly it would be appropriate to have more representation from people who are primarily undergraduate teachers in science, and also I would echo Mr. Storaska's recommendation of high school teachers in science. We feel this would be very important input into the National Science Board.

Senator KENNEDY. We want to thank all of you. I think we have a big budget, Dr. Atkinson, and we are going to need a lot of people trying to deal with this.

Senator SCHWEIKER. One of the few groups that does have a big budget these days.

Senator KENNEDY. To the extent it does respond to a number of these points that have been raised during the course of this panel today, I think it strengthens the whole process, and strengthens the case.

Senator SCHWEIKER. I would like to ask to put in a statement by Senator Hatch into the record.

Senator KENNEDY. It will be printed in the appropriate place in the record.

[The prepared statement of Senator Hatch and opening statement of Senator Schweiker follow:]

PREPARED STATEMENT OF HON. ORRIN G. HATCH, A U.S. SENATOR FROM THE
STATE OF UTAH

Mr. HATCH. Mr. Chairman, I want it clearly understood that I am in full support of the basic purpose of the National Science Foundation. It is my understanding that it is the function of this organization to strengthen the fundamental science

capability of the United States, by producing the vital information necessary for technological innovation and development in the future.

I believe that the Foundation should maintain the strongest programs possible in both the basic and applied research fields by making awards on the basis of excellence through real merit selection under the peer review system.

Mr. MURRAY. May I say, from the standpoint of a member of the National Science Board, that I have not heard any suggestions here to which I do not fully subscribe.

I would point out that the Director has established an Advisory Council, which includes among its members Constance P. Tate, Coordinator of Science for the Baltimore City Public School System.

Senator KENNEDY. We do not have any on the Board.

Dr. MURRAY. That is true. However, Dr. Walter E. Massey, presently a nominee to the National Science Board, participates directly in science education at the precollege level, through involvement as a project director for academic year institutes for high school teachers in science. Among the current members of the board, Dr. Lloyd M. Cooke has served actively on the High School Advisory Committee of the Economic Development Council of New York City—EDC—since its inception in 1970. He has also led the team of the Union Carbide Corp. which has participated in the important work of the Red Sky Street Academy for 9 years.

Senator KENNEDY. We would like to see them on the Board.

Dr. WILSON. I believe over the history of the Board there has never been a high school teacher, and the percentage of people primarily in liberal arts and undergraduate institutions is only 4 percent in the history of the Board. We feel that is disproportionately underrepresented.

Senator KENNEDY. At this point we will include in the record the additional questions and responses which was subsequently supplied for the printed hearing.

[The supplementary questions and responses referred to follow:]

SUPPLEMENTARY QUESTIONS AND RESPONSES

QUESTIONS SUBMITTED BY SENATOR EDWARD M. KENNEDY

BUDGET PROJECTIONS

I understand that in February the National Science Board was briefed on five year budget projections for the Foundation on a Directorate-by-Directorate basis. Can you provide the Committee with those figures and projections.

NATIONAL SCIENCE BOARD

The Foundation's proposed program and budget reflects the results of the Board's forums on younger researchers and the use of alternative performers of research. What happened with regard to the recommendations of the Forum on women and minorities in science. Did the participants recommend the reductions in targeted programs which are included in the FY 1980 budget?

Did the Foundation's recommendations for new Board members include any non-scientists or pre-college science educators? If not, how can such action be encouraged?

I understand that new financial disclosure laws are presenting some problems for Board nominees. Can you describe the nature of the difficulty?

INDUSTRY-UNIVERSITY COOPERATIVE RESEARCH AND SMALL BUSINESS

How has the new cooperative research program been received by the academic sector? By the industrial sector?

How is the applied research small business set aside working. How has it been affected by the reorganization of the applied research directorate?

BASIC RESEARCH

What was the impact on the strength of science and technology of the decline in support for basic research which took place in the early 1970's?

With the increase in basic research support you are proposing, what will the average rate of growth in federally supported basic research have been over the last seven or eight years?

The Board's report "Basic Research in the Mission Agencies" appears to have been very timely. Did it have an impact on the Administration's decision to place such a high priority on basic research in this year's federal agency budgets?

Are we losing important research opportunities due to lack of funds? To what extent are other sources of support available for worthy proposals which the N.S.F. cannot fund?

NUTRITION

To what extent is the Foundation's applied research program in nutrition coordinated with the expanding H.E.W. program in Health Education and Health Promotion?

SOCIAL SCIENCE

You point out in your detailed budget presentations that the N.S.F. is the only federal agency providing support for basic research in the social sciences. Does this make this particular area especially important in terms of the overall budget?

INSTRUMENTATION

To what extent is the Foundation receiving joint proposals from industries and universities to establish regional instrumentation centers?

To what extent, if any, are regional instrumentation centers competing with privately funded activities?

Last year, we urged the Foundation to set aside fifteen percent of total funds for research instrumentation for a small research instrumentation grants program. Did you meet that goal? If not, how far short did you fall? What problems did you encounter?

WOMEN, MINORITIES AND THE HANDICAPPED

All N.S.F. programs must provide equal opportunity for women. With the present serious under-representation of women in science, documented extensively through your own data collection and analysis, is it possible that an effort of just under \$1 million, only one-tenth of one percent of the N.S.F.'s budget, is going to be enough to deal with a situation which is last year's hearing the Foundation described as "a significant national problem?"

Is it true that the cut-back in the Women in Science Program is going to result in a reduction of 14% in the number of projects you are going to be able to support? What efforts are going to be cut-back in order to accomplish this reduction?

I have heard Directly from Dr. Thomas Cole, Director of the Resource Center at the University of Atlanta. He is extremely pleased with the way the program is going. How are plans coming for a second Resource Center, perhaps in the Southwest?

ETHICS

Can you tell us a little about where you are in your negotiations with N.I.H. officials to get them to participate in your Ethics program.

ADMINISTRATIVE ISSUES

You have started a very interesting pilot project to reduce the paperwork burden in universities. It looks as though a decrease in paperwork may actually result in an increase in accountability. Have you talked about this experiment with other agencies which support research? What has been their reaction?

What has been the impact of the salary limitation included in last year's appropriation legislation for the National Science Foundation?"

Several years ago the Foundation was able to hold its administrative expenses at below 5% of the total budget. Now those expenses are close to 6%. Is there a particular reason for this?

DEPARTMENT OF EDUCATION

In your prepared testimony you described a carefully coordinated program in Science Education, a program which contributes importantly to the ability of the Foundation to achieve a reasonable degree of geographic distribution in its total program. If many of these programs are transferred to a new Department of Education, how will this affect States which are just beginning to qualify for basic research support. Isn't it true that 15 states would lose almost all of their N.S.F. funding.

WHITE HOUSE SCIENCE OFFICE

Are you continuing to provide support to the Office of Science and Technology Policy? Can you tell us a little about the kind of work you are doing for the Office.

INTERNATIONAL

Please comment on the potential impact of the kinds of restrictions on scientific exchanges proposed on the Senate floor last year. Have you had an opportunity to discuss these concerns with Dr. Press. What are his concerns, if any?

QUESTIONS SUBMITTED BY SENATOR CLAIBORNE PELL

1. The Administration's authorization proposal includes provisions for construction funds for an oceanographic coastal research vessel. I support this proposal, but looking toward the future, I believe research vessel construction proposals should be advanced in the context of a comprehensive, long-range program based on projected research needs.
Is the current proposal for ship construction based on a long-range comprehensive plan?
If so, please submit a summary of the plan.
If not, please provide information on the status of a long-range research vessel construction plan.
2. There is continued concern over the adequacy of NSF funds allocated for research vessel equipment. Please provide for the record a summary of the total ship equipment requests received by NSF for the last fiscal year, the amount funded, and the amount budgeted for Fiscal '80. In addition, would you please comment on the adequacy of the equipment budget in the context of other budget priorities?
3. In regard to research vessel operating funds, does the amount budgeted take into account the recent and continuing increases in costs of fuel for the vessels?

4. In regard to the International Decade of Ocean Exploration, would you please provide a summary of NSF's plans for continuation of IDOE projects and work after the conclusion of the Decade?

Are these plans in general accordance with the National Research Council recommendations?

Do the plans include continuation of IDOE work as an identifiable program as recommended by the National Research Council?

5. Would you please provide a summary of participation by small business in NSF programs?

Have Rhode Island small business firms participated?

If so, please provide a listing of such firms and their participation?

SUBMITTED BY SENATOR RICHARD SCHWEIKER

PROPOSED QUESTIONS FOR
NATIONAL SCIENCE FOUNDATION WITNESSES

1. I HAVE FOLLOWED WITH INTEREST THE NATIONAL SCIENCE FOUNDATION'S (NSF) IMPLEMENTATION OF ITS REGIONAL INSTRUMENTATION FACILITIES PROGRAM. I WAS EXTREMELY IMPRESSED WITH THE INCREASED AWARENESS NSF HAS SHOWN IN ITS PROGRAM SOLICITATION FOR ROUND 2 TO THE NEED TO FOCUS THIS PROGRAM ON BASIC RESEARCH. I AM ALSO AWARE THAT NSF IS UNDERTAKING A BROAD REVIEW OF ALL ITS PROGRAMS TO DETERMINE TO WHAT EXTENT NSF FUNDED EQUIPMENT IS BEING USED TO ADVANCE FUNDAMENTAL KNOWLEDGE AND WHAT POLICIES CAN BE FORMULATED TO LIMIT UNFAIR COMPETITION BY NSF GRANT RECIPIENTS WITH THE PRIVATE SECTOR. WOULD YOU COMMENT ON THESE DEVELOPMENTS, SPECIFIC ISSUES NSF IS ADDRESSING AND WHAT FURTHER PROGRESS YOU ANTICIPATE.
2. ALONG THE SAME LINES, I HAVE OBSERVED A LACK OF A WELL DEFINED GOVERNMENT-WIDE POLICY FOR ASSURING THAT UNIVERSITIES DO NOT DUPLICATE SERVICES AVAILABLE FROM THE PRIVATE SECTOR. CAN NSF PROVIDE GOVERNMENT-WIDE LEADERSHIP TO ASSURE THAT UNIVERSITIES PURSUE EDUCATIONAL AND FUNDAMENTAL RESEARCH GOALS AND AVOID ROUTINE COMMERCIAL ACTIVITIES?
3. RECENTLY NSF HAS ISSUED A REQUEST FOR INNOVATION PROPOSALS FROM SMALL BUSINESSES. BY LIMITING THESE PROPOSALS TO NO MORE THAN 20 PAGES, NSF HAS MADE IT MORE REALISTIC FOR ADDITIONAL SMALL BUSINESSES TO SUBMIT PROPOSALS. I AM AWARE OF A NUMBER OF SMALL R&D LABORATORIES IN PENNSYLVANIA WHICH HAVE BEEN ENCOURAGED TO SUBMIT PROPOSALS. WHAT PLANS DOES NSF HAVE TO STRENGTHEN THIS PROGRAM

FURTHER AND MAKE IT POSSIBLE TO SUPPORT EVEN GREATER ACTIVITY?

- pe.
4. ATKINSON⁶-PRIVATE NON-MILITARY R&D SPENDING HAS DROPPED SHARPLY AS A SHARE OF NATIONAL ECONOMIC ACTIVITY OVER THE LAST DECADE. APPARENTLY, MANY FIRMS NOW QUESTION THE IN-HOUSE WISDOM OF COMMITTING SHAREHOLDERS' FUNDS TO SPECULATIVE R&D PROGRAMS. AS AN EXPERT ON NATIONAL R&D TRENDS, HOW WOULD YOU REVERSE THIS UNFORTUNATE TREND. ONE SUGGESTION HAS BEEN TO STRENGTHEN PATENTS LAWS AND CHANGE FEDERAL REGULATORY PROCEDURES WHICH AFFECT MARKETING NEW PRODUCTS TODAY. PRESENT LAWS IN THESE AREAS, IT SEEMS TO ME, INCREASE THE RISK THAT IN-HOUSE R&D SPENDING WILL PROVE UNPROFITABLE, OR IF PROFITS ARE MADE, THEY WILL BE MODEST IN NATURE. COULD YOU COMMENT ON THIS.
 5. IN ADDITION TO POSSIBLE CHANGES IN PATENT AND REGULATORY PROCEDURES, WHAT OTHER STEPS CAN BE TAKEN TO RAISE THE LEVEL OF PRIVATE COMMITMENTS TO NON-MILITARY R&D PROGRAMS BACK TO THE LEVEL EXPERIENCED IN THE 1960's ?
 6. IF PRIVATE NON-MILITARY R&D SPENDING REGAINED AND MAINTAINED ITS 1960's MARKET SHARE IN THE NATIONAL ECONOMY, HOW MUCH WOULD WORKER PRODUCTIVITY RISE OVER THE NEXT TWO DECADES? HOW MUCH WOULD GNP/ CAPITAL RISE BY 1998?
 7. I WOULD LIKE TO HEAR ANY COMMENTS IN GENERAL YOU WANT TO MAKE ABOUT PRODUCTIVITY LEVELS. YOU RAISE IT IN YOUR TESTIMONY ON PAGE 3.

8. DR. ATKINSON, I NOTICE YOU HAVE A DECREASE OF \$500,000 IN THE MINORITIES, WOMEN AND THE PHYSICALLY HANDICAPPED SCIENCE EDUCATION PROGRAM. WHY HAS THIS PROGRAM BEEN DECREASED WHEN THE NEED IS SO GREAT? YOUR BUDGET JUSTIFICATION SAYS YOU WANT TO SEE THESE GROUPS REPRESENTED IN THE OTHER NSF SCIENCE EDUCATION PROGRAMS. HOW WILL YOU DO THIS, AND IS THERE SUBSTANTIAL INVOLVEMENT NOW IN ALL NSF PROGRAMS OF THESE GROUPS?
9. ALONG THESE SAME LINES, I HAVE A NUMBER OF PENNSYLVANIA CONSTITUENTS WHO ARE INTERESTED IN PROVIDING TRAINING TO INDIVIDUALS WHO ARE MEMBERS OF GROUPS TRADITIONALLY EXCLUDED FROM SCIENCE PROFESSIONS. THEY START WORKING WITH A STUDENT WHEN HE OR SHE IS IN HIGH SCHOOL AND CONTINUE UNTIL THE YOUNG PERSON HAS FINISHED COLLEGE. STUDENTS IN THIS PROGRAM DO VERY WELL IN SCHOOL AND ON THEIR GRADUATE BOARDS, AND SO ARE EXTREMELY COMPETITIVE WITH STUDENTS FROM MORE ADVANTAGED BACKGROUNDS FOR GRADUATE, MEDICAL OR LAW SCHOOLS. COULD THIS ORGANIZATION RECEIVE HELP FROM NSF AND IF SO WHICH PROGRAMS WOULD HELP THEM?
10. DURING THE DEBATE IN THE CONGRESS IN THE LAST SESSION ON LEGISLATION TO RAISE THE MANDATORY RETIREMENT ^{AGE} LIMIT, THE PROBLEM OF LIMITED ^{positions} SPACES ON COLLEGE AND UNIVERSITY FACULTIES WAS BROUGHT UP. DO YOU FEEL THAT THIS NEW LAW WILL SERIOUSLY LIMIT THE NUMBER OF YOUNG SCIENTISTS WHO WILL BE ABLE TO TEACH? IF SO, DO YOU HAVE ANY SUGGESTIONS TO HELP ALLEVIATE THIS PROBLEM?
11. DR. WILSON, I SEE ON PAGES 4 AND 5 OF YOUR TESTIMONY YOU ARE VERY CONCERNED ABOUT THE DECLINE OF THE PERCENTAGE SHARE OF NSF BUDGET OF THE SCIENCE EDUCATION PROGRAMS. ARE YOU SUGGESTING THAT WE LEGISLATE A RATIO OF 33 PERCENT OF NSF EXPENDITURES FOR RESEARCH SHOULD BE IN SCIENCE EDUCATION PROGRAMS?

QUESTIONS SUBMITTED BY SENATOR EDWARD M. KENNEDY

BUDGET PROJECTIONS

Question: I understand that in February the National Science Board was briefed on five year budget projections for the Foundation on a Directorate-by-Directorate basis. Can you provide the Committee with those figures and projections.

Answer: The five year estimates developed as part of the Foundation's continuing long range planning effort should be viewed as working targets only. They do not represent agreed upon levels and they have not been reviewed by the Office of Management and Budget. They are used strictly for internal planning purposes only. At any moment in time the NSF planning process is in a state of evolution. The following estimates are a snapshot of NSF planning estimates in February 1979.

National Science Foundation
Tentative FY 1981-1985 Planning Estimates from Directorates
As Presented to the National Science Board
In February 1979

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985	
	Constant Level	Adequate Level	Constant Level	Adequate Level	Constant Level	Adequate Level	Constant Level	Adequate Level	Constant Level	Adequate Level
MPE	\$ 302.7	\$ 505.1	\$ 323.7	\$ 555.4	\$ 346.3	\$ 603.3	\$ 370.6	\$ 661.9	\$ 394.7	\$ 720.1
AAEOS	246.1	355.1	263.3	407.2	281.7	445.6	301.4	474.0	322.5	508.8
BBS	185.6	255.1	198.6	305.1	212.5	364.1	227.4	422.8	243.3	486.1
Total	\$ 734.4	\$ 1,115.3	\$ 785.6	\$ 1,267.9	\$ 840.5	\$ 1,413.0	\$ 899.4	\$ 1,558.7	\$ 1,060.5	\$ 1,715.0
ASRA	66.7	89.3	71.4	101.7	76.4	112.0	81.8	119.0	87.5	119.5
SE	90.9	106.7	97.3	120.9	104.1	134.7	111.4	145.3	119.2	157.3
STIA	29.0	33.1	31.0	---	33.2	---	35.5	---	38.0	---

*Being Revised

Definition of Terms:

Constant Level--The amount included in the FY 1980 budget for this purpose plus an allowance for inflation for FY 1981; then for FY 1982, the FY 1981 amount plus 7% for inflation and so on for each of the out years;

Adequate Level--This level provides for real growth and covers research opportunities and needs identified by the various directorates of NSF.

NATIONAL SCIENCE BOARD

Question: The Foundation's proposed program and budget reflects the results of the Board's forums on younger researchers and the use of alternative performers of research. What happened with regard to the recommendations of the Forum on women and minorities in science. Did the participants recommend the reductions in targeted programs which are included in the FY 1980 budget:

Answer : The Forums did not recommend a reduction in targeted programs. Although there is a reduction in the targeted budget line item Minorities, Women and the Physically Handicapped, in both targeted and non-targeted programs, we anticipate an increase of at least 15% and FY 1979 in funds which can be ascribed to the participation of these groups and the improvement of their education in science.

Each of the National Science Board Regional Forums received suggestions related to science education activities for minorities and women. The first Forum, held in Atlanta, included suggestions for special minority student programs at the undergraduate and graduate levels and encouraged the use of both traditional and non-traditional educational tools and settings for this activity. We believe that a number of existing Foundation programs are responsive to these suggestions including the Minority Institutions Science Improvement program, the Minority Institutions Graduate Traineeship program, the Minority Graduate Fellowships program, the Resource Centers for Science and Engineering program, and the special emphasis on the participation of minorities in the Undergraduate Research Participation program.

The second Forum, held in Seattle, submitted suggestions regarding research and training funds for women minorities and the physically handicapped. In addition to the programs cited above, the following program existing activities are responsive to these suggestions: the Research Initiation in Minority Institutions program, the Science Career Facilitation Projects for Women, the Visiting Women Scientists program, the Science Career Workshops for Women, the various workshops, studies, conferences and training projects directed toward the integration of the physically handicapped into the mainstream of science and the Student Science Training for high ability high school students and Undergraduate Research Participation programs where a particular effort is made to recruit these groups as participants. In addition, the restructuring of the Foundation's Postdoctoral Fellowship program to provide part-time fellowship support

is expected to be particularly attractive to women with family obligations, minorities and individuals from the lower socio-economic groups with pressing ancillary job requirements which preclude their full-time pursuit of scientific research and advanced study as they seek to establish themselves in the scientific research community.

The third Forum, held in Dallas, made numerous suggestions. Some of these, and the Foundation's program activities which are responsive are: Programs that reduce the fear that some students have of science and mathematics—the "Early Adolescence Thrust" described on page H-2 and 3 and subsequent pages in the FY 1980 Budget Document; career counseling for junior and senior high school girls and use of role models—visiting Women Scientists program; summer internships for minorities and women—Undergraduate Research Participation program; studies and development of guidelines—all three components of the Minorities, Women and the Physically Handicapped program have over the past 3 to 5 years engaged in studies of barriers to the participation of these groups and the manner in which they can be overcome.

NATIONAL SCIENCE BOARD

Question Did the Foundation's recommendations for new Board Members include any non-scientific or pre-college science educators? If not, how can such action be encouraged?

Answer In response to the solicitation for recommendations for nominations to the National Science Board, over 400 names were submitted for the vacancies which occurred on the Board in May 1978. Sources submitting recommendations included the Congress; the general public; the scientific and educational communities; and NSF advisory bodies and staff. These recommendations included representatives of the major fields of science, law, public affairs, and science education. From among these, the National Science Board and the Director of the National Science Foundation made its own joint recommendations and these, together with all names received from all sources, were submitted to the White House on September 30, 1977. The joint recommendations of the Board and the Director did include a non-scientist. Although these recommendations did not include a precollege science educator, they did contain the name of Dr. Walter E. Massey, Dean of the College and Professor of Physics, Brown University. Dr. Massey is presently a nominee to the National Science Board.

Dr. Massey participates directly in science education at the precollege level, through involvement as a project director for academic year institutes for urban high school teachers in science, and has published widely in this area.

Dr. Massey received the Outstanding Educator of America award in 1974 and a Distinguished Service Citation from the American Association of Physics Teachers.

Among the current Members of the Board, Dr. Lloyd M. Cooke is Vice Chairman of the Economic Development Council of New York City (EDC). He is on loan from the Union Carbide Corporation for two years and is serving as a senior consultant to the External Relations Group of EDC. Dr. Cooke leads EDC efforts in cooperation with the school system, the teachers' union, and others in the private sector to help increase the communication and computational skills of those who graduate from public high school.

Dr. Cooke has served actively on the High School Advisory Committee of the EDC since its inception in 1970. He has led the Union Carbide team which

has participated in the important work of the Bed-Sty Street Academy for nine years. During the 1976-77 school term the Academy enabled 235 previously disruptive and truant students to achieve a high level of self-control and self-confidence in a unique environmental readiness and learning readiness program. These students were then returned to Boys & Girls High School where they proceeded to function "normally."

In addition to the direct involvement of Dr. Massey and Dr. Cooke in precollege science education, most Members and nominees of the National Science Board have indirectly participated in activities at this level through programs at their institutions which include high school students and teachers of science at the high school level or below.

In addition, the Director and senior staff receive advice from the National Science Foundation Advisory Council, a body established to provide advice and counsel on matters of Foundation-wide concern. It operates at the agency level in order to provide a perspective from outside the Foundation on issues that transcend matters of concern to an individual discipline or program area, and that relate to the Foundation's interaction with the scientific community, with the Congress, and with the public. It includes the following individuals who are non-scientists or precollege science educators:

Emilio Q. Daddario, Attorney
 Saville R. Davis, Special Correspondent for The Christian Science Monitor
 Carleton E. McMullin, City Manager, Little Rock, Arkansas
 Harold R. Sims, Vice President, Corporate Affairs, Johnson & Johnson
 Constance P. Tate, Coordinator of Science, Baltimore City Public School System

The various directorates of the National Science Foundation also have advisory committees. Those advising in particular the Directorate for Science Education and the Directorate for Applied Science and Research Applications also include representation from the nonscience and precollege science education communities.

Thus, the National Science Foundation has available to it, from a variety of sources, input and advice from not only the scientific community but also from the nonscience and science education portions of society.

NATIONAL SCIENCE BOARD

Question I understand that new financial disclosure laws are presenting some problems for Board nominees. Can you describe the nature of the difficulty?

Answer Two recent nominees to the Board, understanding that the Ethics in Government Act of 1978 would require public disclosure of the private finances of them and their families as a precondition to appointment, asked that their names be withdrawn from the nomination process. The Office of Government Ethics subsequently issued an opinion (copy attached) to the effect that public disclosure is not required of appointees who serve in their positions for less than sixty days a year, though nonpublic filing of the same financial disclosure forms would be administratively required of Presidential nominees in this category.

One of the two persons who had asked that their names be withdrawn is satisfied with this resolution of the matter, so long as the Legislative Branch, and specifically your Committee, agrees with this official interpretation of the Ethics Act, and will similarly respect the confidentiality of his private finances. The other person considered that some of the detail requested in the Ethics Act forms is not necessary to reveal any conflict of interests he might have in connection with his membership on the Board and that any possible conflict could be determined from information which he is willing to provide and has already provided to the White House.

In general, these two nominees and other nominees and current Members of the Board have been less concerned with their personal situations than with the principle they have seen that is involved. The financial disclosure requirements, particularly as applied to persons who are private citizens and are considered as Government employees only because of sporadic service on a Board or other advisory group, have seemed to them unduly intrusive and invasive of personal privacy.

United States Government
MEMORANDUM

Office of
Personnel Management

Subject: Financial Disclosure By Persons Who Are Expected to Perform Duties For a Period of 60 Days or Less - Ethics in Government Act of 1978 Date: FEB 16 1979
In Reply Refer To:
From: Director, Office of Government Ethics Your Reference:
To: Heads of Departments, Independent Agencies and Government Corporations

The question has arisen whether Section 201 of the Ethics in Government Act of 1978, P.L. 95-521, requires reports by persons assuming, nominated to, or terminating employment in, a position designated in Section 201(f) of the Act, even though the terms of such person's employment or appointment is expected to involve or actually involves service of 60 days or less. The question is generated by the fact that the primary reporting provision, Section 201(d), which requires an annual report on or before May 15 of each year, specifically excludes such persons, while other provisions do not expressly do so.

It is clear from the legislative history of the Act that arrival and departure reports were designed to be in aid of, and were viewed as directly connected with, the May 15 annual report. See S. Rep. No. 95-170, 95th Congress, 1st Sess. p.111 (1977). If no annual report is required, no report ancillary to it should be required. Although other considerations may be applicable in the case of Presidential appointees, and the legislative history does not separately address such cases, it is clear that Congress did not intend individuals serving part-time to make the unrestricted public disclosure of financial interests that the government requires in the case of full-time employees. On the other hand, the basic need remains for such reporting as will satisfy agency ethics counsellors and Congressional committees considering nominations that there is no apparent conflict-of-interest.

In reaching this conclusion, we have sought the opinions of those closely involved in the drafting of the Act, and they are in concurrence.

Accordingly, pursuant to Section 201(g) of the Act, I hereby authorize an across-the-board extension of 90 days with

respect to the filing of public financial disclosure reports by 1) persons joining the government in a position described in 201(f) but who are expected to serve 60 calendar days or less; 2) persons leaving a position described in 201(f) who served less than 60 calendar days; and 3) nominees of the President to a position, appointment to which requires the advice and consent of the Senate, who are expected to serve for 60 calendar days or less in any calendar year. If any of the above described persons joining the government should actually work 61 days in this calendar year, this extension shall no longer apply and the reports required by Section 201(b) would be due immediately. However, as a condition of and in connection with this extension, the following rules shall apply to persons joining the government whose duties are expected to involve less than 61 days of service during this calendar year:

1. Each special government employee whose appointment does not require the advice and consent of the Senate shall comply with the requirements for reporting established by the agency for which he will serve, and each executive agency shall require at least such reporting as is prescribed by Form 278A, issued by this Office.

2. Each nominee of the President to a position, appointment to which requires the advice and consent of the Senate, shall fill out reporting Form 278A and deliver it to the designated agency ethics official in the agency in which he will, if appointed, serve. Delivery shall be made within 10 days of the transmittal of his nomination by the President. Such officer shall also transmit a copy to the Counsel to the President.

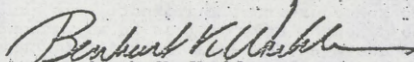
3. Neither the Form 278A or any similar reports filed, nor any copies, shall be made public, but shall be reviewed by the designated agency ethics official and other recipients for purpose of determining the existence of, and protecting against, potential conflicts-of-interest.

4. A nominee shall also make available to any Committee of the Senate or Congress considering his nomination, such information as the Committee, in its discretion, shall desire for this purpose.

If the reporting requirements for these individuals are not legislatively clarified within the aforesaid 90 days,

the Office of Government Ethics will do so by proposing the adoption of an interpretive regulation.

Any questions concerning this procedure may be addressed to this Office.



Bernhardt K. Wruble

Industry-University Cooperative Research

Question: How has the new cooperative research program been received by the academic sector? By the industrial sector?

Answer: Interest in the Industry-University Cooperative program has increased dramatically in both the academic and industrial sectors. Last year when the program was first announced, 16 proposals were received and eight awards made. In the first six months of FY 1979, the program has received 27 proposals and has made 19 awards.

Interest is highest in academic areas and industries concerned with engineering, materials, chemistry and computer science. We expect interest to continue to grow as the program becomes more widely known. We intend to analyze the program in several months as a basis for determining a funding level for the FY 1981 budget request.

INDUSTRY-UNIVERSITY COOPERATIVE RESEARCH AND SMALL BUSINESS

Question: How is the applied research small business set-aside working? How has it been affected by the reorganization of the applied research directorate?

Answer: The set-aside of ASRA funds for awards to small business firms has been quite successful. In recent fiscal years ASRA support to small business firms has exceeded the amount specified by the set-aside. For example, in Fiscal Year 1977, ASRA support to small business firms was 11.2% of total obligations compared to a 10% requirement; in Fiscal Year 1978 ASRA support to small business was 13.4% of total obligations compared to a 12.5% requirement.

The set-aside has resulted in considerable interest in NSF from small business firms, particularly in ASRA's Small Business Innovation Research program. The Innovation program was designed from the point of view of the needs of small science and technology firms and meets most of the criticisms small business has expressed relative to Federal R&D support. It has been extremely well received by the small business community and received the first award for Federal Program Excellence of COSIBA, the Council of Small and Independent Business Associations.

The reorganization of the Applied Research Directorate affected the set-aside in the sense that it reduced the base of the Directorate's activities which normally provide support to small business. Before the reorganization, all of the Directorate's programs were receptive to small business proposals. Since then, two new programs have been initiated which do not normally provide support to small business; i.e., the Integrated Basic Research (IBR) subactivity and the Experimental Program to Stimulate Competitive Research. IBR provides increased funding for selected basic research projects recommended by the Foundation's basic research directorates. Consequently, the pattern of support parallels that of the basic research directorates which is mostly to universities and colleges. The objectives of the Experimental Program to Stimulate Competitive Research also will be implemented primarily through grants to universities and colleges.

Total funding for these two programs is estimated at \$6.0 million in FY 1979 and \$7.7 million in FY 1980. In FY 1980, if ASRA is required to set aside 12.5% of its funds for small business, the total dollar requirement will be \$7.8 million. However the actual base from which small business proposals can be supported will only be \$54.7 million (\$62.4 million ASRA request less the \$7.7 million). This means that the actual percent requirement of support to small business firms in FY 1980 will be 14.3% of the applicable ASRA base.

BASIC RESEARCH

Question: What was the impact on the strength of science and technology of the decline in support for basic research which took place in the early 1970's?

Answer: - Between 1970 and 1975 national basic research spending increased by nearly 30 percent in current dollars but decreased by some 7 percent in constant dollars. (see table) Over this period the Federal Government, which supports about 70 percent of the national basic research effort, deemphasized its defense and space programs, resulting in a constant dollar 10 percent reduction in Federal basic research support. In addition, during this period industry continued to emphasize its applied research and development programs at the expense of basic research. The growth in real funding of basic research which began in 1976 has helped to offset some of the problems which had begun to emerge.^{1/}

- ° The reduction in effective level of basic research support through 1975 caused some high quality research to be curtailed, but apparently did not damage the overall excellence of the U.S. scientific effort: According to the views expressed in 1976 by members of the NSF technical staff, scientific efforts in this country remained generally strong, although in many areas there was additional high quality research that could have been conducted if additional funds had been available.
- ° As a result of a declining level of effective support, the NSF technical staff reported that average research grants were smaller and that some scientists claimed that big (costly), innovative projects were discouraged or at least not encouraged by the science agencies.

¹Source: National Science Foundation, Science Resources Studies Highlights, "National R&D Spending Expected to Exceed \$57 Billion Dollars in 1980" (NSF 79-309) (In Press)

National Basic Research Spending

Year	millions of current dollars	millions of 1972 constant dollars
1969	\$3,425	\$3,949
1970	3,513	3,845
1971	3,577	3,725
1972	3,748	3,748
1973	3,877	3,665
1974	4,144	3,571
1975	4,527	3,561
1976	4,881	3,649
1977	5,444	3,844
1978	6,040	3,971
1979	6,650	4,057

Source: Division of Science Resources Studies, National Science Foundation

- In addition to the declining level of support, funding patterns changed with respect to particular scientific disciplines. For example, between 1967 and 1975:
 - The effective level of federal support for both basic and applied research declined in the physical sciences. In terms of major science disciplines, the effective level of support for basic and applied research fell in astronomy, chemistry and physics. In the engineering sciences there were slight declines in both basic and applied research centered largely in astronautical, chemical and mechanical engineering as well as applied electrical engineering. Life sciences and environmental sciences generally showed level or increasing levels of effective support with a shift in emphasis from basic to applied research.
 - A cause of increasing concern in many disciplines was and continues to be inadequate instrumentation and facilities.

BASIC RESEARCH

Question: With the increase in basic research support you are proposing, what will the average rate of growth in federally supported basic research have been over the last seven or eight years?

Answer: Federal obligations for basic research, when computed on the basis of FY 1980 budget proposals, will have averaged a 10 percent annual rate of growth since 1972. After adjusting for inflation using the GNP implicit price deflator, the annual growth rate is 2.5 percent.

BASIC RESEARCH

Question The Board's report Basic Research in the Mission Agencies appears to have been very timely. Did it have an impact on the Administration's decision to place such a high priority on basic research in this year's federal agency budgets?

Answer The emphasis on basic research in the President's Budget for fiscal year 1980 reflects a continuation of the Administration's commitment in this area. Although the tenth report of the National Science Board, Basic Research in the Mission Agencies, may have reinforced this policy of the Administration, it should be noted that the Board has always been concerned about the health of basic research. It expressed this concern publicly most recently in its resolution of October 18, 1974 which stated:

Whereas, the national welfare requires and it has been a long standing matter of national policy that mission agencies pursue strong programs of basic research appropriate for their missions;

The National Science Board encourages mission agencies of the Federal Government to maintain strong basic research programs in areas that have the potential of contributing to their mission objectives over the long term.

The complete text of this resolution is attached.

The eighth report of the Board, Science at the Bicentennial--A Report from the Research Community, detailed the conditions affecting research or likely to affect it in the near future.

This continuing concern on the part of the Board, which is the only Federal body which has as its broad charter responsibility for the overall health of fundamental science in the United States, stems from the issuance of Executive Order 10521 in 1954, as amended by Executive Order 10807 in 1959. A copy of that order is attached.

**RESOLUTION ADOPTED BY THE NATIONAL SCIENCE BOARD
AT ITS 167TH MEETING ON OCTOBER 18, 1974**

Whereas, Section 3(d) of the National Science Foundation Act of 1950 as amended states 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."; and

Whereas, Section 3(a)(5) of the Act authorizes and directs the National Science Foundation 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; and

Whereas, the national welfare requires and it has been a long standing matter of national policy that mission agencies pursue strong programs of basic research appropriate for their missions; and

Whereas, in recent years some Federal agencies have significantly reduced their efforts in basic research relevant to their missions; and

Whereas, shifts in other agencies' support of basic research affect the National Science Foundation's capability to fulfill one of its roles to ensure the adequacy of the Nation's research effort;

Therefore, be it **RESOLVED**, That:

The National Science Board encourages mission agencies of the Federal Government to maintain strong basic research programs in areas that have the potential of contributing to their mission objectives over the long term;

The National Science Foundation shall develop information on the interrelationships of NSF basic research programs with the basic research activities of other Federal agencies for use in evaluating the status and needs of the various sciences, in correlating the basic research programs undertaken and supported by the Foundation with related programs undertaken by other agencies of the Federal Government, and in recommending to applicable agencies, to the Administration, and to the National Science Board those areas that require strengthening;

To assist the National Science Foundation in coordinating and correlating its basic research programs with those of other agencies, the National Science Board shall develop and promulgate a general policy statement pertaining to Foundation assumption of management and/or support responsibilities for major program activities or projects for which support has been terminated or significantly reduced by other Federal agencies due to considerations of mission relevancy or budgetary priorities;

The Director of the National Science Foundation is urged to hold a series of discussions with the secretaries and/or other appropriate senior officials of selected mission agencies of the Federal Government for the purposes of discussing the need for mission agencies to maintain strong basic research programs appropriate to their missions and the benefits that are likely to accrue from such programs over the long term. These discussions should also focus on the nature and scope of current and planned mission agency basic research efforts and on the areas of research that are likely to be of significance to mission agency programs. These discussions should be carried out with a view to strengthening the overall Federal basic research posture and to identifying areas of need in the various science fields;

The Director of the National Science Foundation is urged to take an active role in promoting basic research within the Executive Branch, including assisting other Federal agencies as appropriate in initiating basic research programs where none now exists and where the potential for long term benefits to the agencies' missions from such programs is greatest; and through discussions with the mission agencies and the Office of Management and Budget ascertain the status of Federal

EXECUTIVE ORDER 10521, DATED MARCH 17, 1954
AS AMENDED BY
EXECUTIVE ORDER 10807, DATED MARCH 13, 1959

ADMINISTRATION OF SCIENTIFIC RESEARCH
BY AGENCIES OF THE FEDERAL GOVERNMENT

WHEREAS the security and welfare of the United States depend increasingly upon the advancement of knowledge in the sciences; and

WHEREAS useful applications of science to defense, humanitarian, and other purposes in the Nation require a strong foundation in basic scientific knowledge and trained scientific manpower; and

WHEREAS the administration of Federal scientific research programs affecting institutions of learning must be consistent with the preservation of the strength, vitality, and independence of higher education in the United States; and

WHEREAS, in order to conserve fiscal and manpower resources, it is necessary that Federal scientific research programs be administered with all practicable efficiency and economy; and

WHEREAS the National Science Foundation has been established by law for the purpose, among others, of developing and encouraging the pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences:

NOW, THEREFORE, by virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

Section 1. The National Science Foundation (hereinafter referred to as the 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.

Section 2. 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 foreseeable 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 existing sources of information and research facilities within the Federal Government.

Section 3. The Foundation, in concert with each Federal agency concerned, shall review the basic scientific research programs and activities of the Federal Government in order, among other purposes, to formulate methods for strengthening the administration of such programs and activities by the responsible agencies, and to study areas of basic research where gaps or undesirable overlapping of support may exist, and shall recommend to the heads of agencies concerning the support given to basic research.

Section 4. As now or hereafter authorized or permitted by law, the Foundation shall be increasingly responsible for providing support by the Federal Government for general-purpose basic research through contracts and grants. The conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable, especially in response to current national needs, and shall continue.

Section 5. The Foundation, in consultation with educational institutions, the heads of Federal agencies, and the Commissioner of Education of the Department of Health, Education, and Welfare, shall study the effects upon educational institutions of Federal policies and administration of contracts and grants for scientific research and development, and shall recommend policies and procedures which will promote the attainment of general national research objectives and realization of the research needs of Federal agencies while safeguarding the strength and independence of the Nation's institutions of learning.

Section 6. The head of each Federal agency engaged in scientific research shall make certain that effective executive, organizational, and fiscal practices exist to ensure (a) that the Foundation is consulted on policies concerning the support of basic research, (b) that approved scientific

research programs conducted by the agency are reviewed continuously in order to preserve priorities in research efforts and to adjust programs to meet changing conditions without imposing unnecessary added burdens on budgetary and other resources, (c) that applied research and development shall be undertaken with sufficient consideration of the underlying basic research and such other factors as relative urgency, project costs, and availability of manpower and facilities, and (d) that, subject to considerations of security and applicable law, adequate dissemination shall be made within the Federal Government of reports on the nature and progress of research projects as an aid to the efficiency and economy of the overall Federal scientific research program.

Section 7. Federal agencies supporting or engaging in scientific research shall, with the assistance of the Foundation, cooperate in an effort to improve the methods of classification and reporting of scientific research projects and activities, subject to the requirements of security of information.

Section 8. To facilitate the efficient use of scientific research equipment and facilities held by Federal agencies:

(a) the head of each such agency engaged in scientific research shall, to the extent practicable, encourage and facilitate the sharing with other Federal agencies of major equipment and facilities; and

(b) a Federal agency shall procure new major equipment or facilities for scientific research purposes only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories or facilities of its own or of other agencies.

Section 9. The heads of the respective Federal agencies shall make such reports concerning activities within the purview of this order as may be required by the President.

Section 10. The National Science Foundation shall provide leadership in the effective coordination of the scientific information activities of the Federal Government with a view to improving the availability and dissemination of scientific information. Federal agencies shall cooperate with and assist the National Science Foundation in the performance of this function, to the extent permitted by law.

BASIC RESEARCH

Question: Are we losing important research opportunities due to lack of funds? To what extent are other sources of support available for worthy proposals which the N.S.F. cannot fund?

Answer: About 45 percent of the research proposals submitted to NSF are funded. The success ratio varies considerably by field of science. In some areas there is a greater degree of prescreening than in others. Consequently, success ratios have to be interpreted with some degree of caution. Nevertheless, it is estimated that about 20 percent of the proposals which are judged meritorious and deserving of support do not receive support due to a lack of available funds.

The budget as presented for FY 1980 provides strong support for research in all fields of science and engineering. While it will not provide support for all the meritorious projects that are likely to be received, it does provide for an adequate level of funding to insure continued U.S. scientific strength and to meet research opportunities and needs as identified by the National Science Board, the NSF staff, and various advisory panels and committees which assist NSF in this determination.

NUTRITION

Question: To what extent is the Foundation's applied research program in nutrition coordinated with the expanding HEW program in Health Education and Health Promotion?

Answer: In the course of internal deliberations at NSF during the preparation of ASRA's applied research program on human nutrition, several suitable topics were proposed and discussed. These were evaluated by an ad hoc interagency panel consisting of representatives from NIH, USDA-AR, USDA-Competitive Grants Office and FDA. Their comments were helpful to us in the final decision which resulted in the selection of the current program topic.

Representatives from these agencies will be invited to assist us in the review of the proposals received in response to NSF's program announcement. The closing date for the FY 79 program is April 30, 1979. We expect the program to be officially coordinated with HEW and USDA nutrition programs via the recently established Joint Subcommittee on Human Nutrition Research of the Federal Coordinating Council of Science, Engineering, and Technology. It has been organized under the direction of the Office of Science and Technology Policy and will act as the principal mechanism for coordinating the various Nutrition Research Programs supported by HEW, USDA and other agencies of the Federal government. Results from the NSF's effort will be transmitted expeditiously to members of the committee, who can incorporate relevant findings into their own program.

SOCIAL SCIENCE

Question: You point out in your detailed budget presentations that the N.S.F. is the only federal agency providing support for basic research in the social sciences. Does this make this particular area especially important in terms of the overall budget?

Answer: The Foundation's level of support for the social sciences is not a dominant portion of the overall budget totals, but it is essential for progress in the most important and needed aspects—advancing the scientific techniques and methods with which social scientists can study the many important social problems. In recognition of this fact, the National Science Board has recommended special emphasis on support of basic research in these fields. A number of external and internal reviews have strengthened the conclusion that more resources need to be given to them.

Although NSF is not the Only Federal agency providing support for basic research in the social sciences, its role is unique in that it is the only Federal agency that provides support designed primarily to facilitate long-range progress in the social sciences. The concern in other Federal agencies is for the support of research that will be utilized in the responsibility for strengthening scientific research potential in the social sciences is reflected in the support of fundamental theoretical work, methodological development, and data resource improvement. Such research often requires long periods of support followed by further research on applications before the knowledge can be utilized fully in the design and implementation of public policy. As indicated in the budget statement, basic work supported by NSF in the past now serves as the foundation for more applied work in other Federal agencies.

NSF plays a special role in the funding in the social sciences. In political science, for example, more than 90 percent of the Federal total for basic research is provided by NSF. Federal support is, however, much less concentrated in NSF for economics and sociology; approximately 30 percent of the Federal total in economics and approximately 20 percent of the Federal total in sociology is provided by NSF. (NSF contributes a higher proportion, approximately 40 percent, of the Federal funding for research performed in universities and colleges.) In both economics and sociology, basic research is a broad designation. For selected important specialties, the NSF programs are virtually the sole source of Federal research support. Although the topics—employment, inflation, mobility—have many aspects, work in basic theory, mathematical economics, econometrics, and quantitative methodology is not supported by other sources.

INSTRUMENTATION

Question: To what extent is the Foundation receiving joint proposals from industries and universities to establish regional instrumentation centers?

Answer: The Regional Instrumentation Centers Program was initiated in FY 1978 with the establishment of six centers. All were located at universities. In the initial year of the program no joint industry-university proposals were received. Numerous proposals, however, included substantial developmental work on the part of industry to satisfy the spirit and intent of the regional centers although the proposals are not joint proposals per se. The deadline for the current year of operation was March 15, 1979, and essentially all the proposals are in process in the Central Processing Section of the Foundation; thus, we do not as yet have any new information on joint industry-university proposals. Such information will, of course, be developed during the next few weeks as we are able to carefully scrutinize each proposal.

Question: To what extent, if any, are regional instrumentation centers competing with privately funded activities?

Answer: The Foundation has taken special care through interaction with interested private laboratories to avoid competition with any privately funded activity. The Program Solicitation for FY 1979 was sent to private-industrial laboratories for comment, and the Foundation will continually monitor the progress of each facility to insure that competition with privately funded activities will be minimized. In this regard a Foundation Task Force on Competition with Commercial Organizations has been studying this issue for several months and an interim report is in preparation.

INSTRUMENTATION

Question: Last year, we urged the Foundation to set aside fifteen percent of total funds for research instrumentation for a small research instrumentation grants program. Did you meet that goal? If not how far short did you fall? What problems did you encounter?

Answer: The language in the report accompanying the Senate Authorization Bill for FY 1979 provides that NSF should set aside 15 percent of the total funds for research instrumentation for a small research instrumentation grants program. The 15 percent set aside provided that NSF would use that amount of funds, 15 percent of the total, for instrumentation costing \$25,000 or less. NSF met this goal in FY 1978 and will meet it again in FY 1979. Historically, more than 15 percent of NSF instrumentation funding has been provided for instrumentation and equipment costing \$25,000 or less. No problem has arisen in connection with the 15 percent set aside for instruments costing \$25,000 or less.

WOMEN, MINORITIES, AND THE HANDICAPPED

Questions: All NSF programs must provide equal opportunity for women. With the present serious under-representation of women in science, documented extensively through your own data collection and analysis, it is possible that an effort of just under \$1 million, only one-tenth of one percent of the NSF's budget, is going to be enough to deal with a situation which in last year's hearing the Foundation described as "a significant national problem?"

Is it true that the cut-back in the Women in Science Program is going to result in a reduction of 14% in the number of projects you are going to be cut back in order to accomplish this reduction?

Answer: This reduction should not be considered a signal that the Foundation has reduced its commitment to this special group. The strategy for the Science Education Directorate is to continue special studies and experimental activities designed to improve the science literacy of women and increase opportunities for these individuals to prepare themselves for science-related careers, but at the same time place a particular emphasis on increasing the effectiveness of the Directorate's regular programs in addressing these problems.

Estimates are being made throughout all program areas of the Science Education Directorate which provide support for the participation of women in education in the sciences, in specially targeted programs such as the Minority, Women and the Physically Handicapped program as well as our programs which are not specially targeted. The results show that in the current year, FY 1979, approximately 17 percent, or about \$13 million of all science education funds will be devoted to supporting the participation of women in activities to improve their science literacy and increase opportunities for study and research in science-related careers. For FY 1980, the proportion of the total science education budget devoted to this purpose will increase to approximately 19 percent or about \$16 million. Thus, rather than a decrease in effort, there will be an overall increase in effort over FY 1979.

All literature distributed by the Foundation relating to the FY 1980 program must be reviewed to assure that NSF's concern and commitment to this effort is adequately and properly addressed. This will include a special notice highlighting the special thrusts which NSF will pursue in FY 1980 and in the future. It will also involve the review of criteria for proposals and state the manner in which these criteria will be taken into consideration in the evaluation of proposals and the making of awards.

WOMEN, MINORITIES, AND THE HANDICAPPED

Question: I have heard directly from Dr. Thomas Cole, Director of the Resource Center at the University of Atlanta. He is extremely pleased with the way the program is going. How are plans coming for a second Resource Center, perhaps in the Southwest?

Answer: As suggested in Senate Report No. 95-851, the Resource Center for Science and Engineering to be established by an award in FY 1979 will be selected from the most outstanding proposals which had to be denied in the competition for the Center award in FY 1978. Staff-work on the proposal for the second Center is nearing completion. The location of the second Center will be announced shortly.

ETHICS

Question:

Can you tell us a little about where you are in your negotiations with NIH officials to get them to participate in your Ethics program?

Answer:

NSF staff has been engaged in informal discussions with NIH officials for more than two years, in an effort to encourage the development at NIH of a program of activities dealing with ethical and value issues in the context of biomedical research and practice. Throughout these discussions, we have been informed that NIH agrees to the importance of this task and has been trying to solve the administrative and budgetary problems that it presents.

In an effort to move these discussions forward, on November 9, 1978, Dr. Rutherford (NSF Assistant Director for Science Education) wrote to Dr. Thomas E. Malone, Deputy Director, National Institutes of Health, with a specific proposal. Dr. Rutherford suggested that the successful cooperation of NSF and the National Endowment for the Humanities for joint review and joint funding of appropriate projects serve as a model for NSF/NIH relationships in this field. In such an arrangement, NSF would be the lead agency for the receipt and review of proposals and for administration of grants, with NIH appointing members of the peer review panel and contributing partial support for those awards that it regarded as appropriate to its mission. As in the case of the NEH, this would leave both agencies free to support additional activities that did not appear to be suitable for joint funding. These arrangements would provide a single point of focus for all three agencies that have a substantial interest in work along these lines.

As of this date, we are informally advised that NIH still has the matter under consideration.

ADMINISTRATIVE ISSUES

QUESTION: You have started a very interesting pilot project to reduce the paperwork burden in universities. It looks as though a decrease in paperwork may actually result in an increase in accountability. Have you talked about this experiment with other agencies which support research? What has been their reaction?

ANSWER: We have discussed the Master Grants Pilot Project with OMB and GAO as well as with several other agencies. Officials with whom we have discussed the program have reacted favorably, and we will continue to keep them informed of progress. If the Master Grants Program proves as successful as we hope it will, several of the agencies with whom we have held informal discussions may explore the possibilities of incorporating the Master Grants concept into their own award-making processes. We will keep you informed of our progress.

ADMINISTRATIVE ISSUES

Question: What has been the impact of the salary limitation included in last year's appropriation legislation for the National Science Foundation?

Answer: The salary limitation included in P.L. 92-392, Title II, states that "... none of the funds provided by this Act shall be used to pay an investigator, through a grant, at more than the maximum rate paid for GS-18, unless expressly approved by the Director of the National Science Foundation."

Implementation of this provision was done through Important Notice No. 74, September 28, 1978. As interpreted by NSF, the provision (1) does not limit the salary an institution can pay an investigator out of its own funds; (2) does limit the rate at which an investigator can be paid from NSF grant funds; (3) specifies that this rate can be no more than \$3,958.33 per month, both for the summer and academic year months, in accordance with provisions in Title 5, Sec. 5332(b) of the U.S. Code (the GS-18 annual rate of \$47,500 divided by 12 months); (4) applies to any individual, not just principal investigators, receiving reimbursement as a direct cost under an NSF grant; (5) indicates exemption at the NSF Director's discretion will be used very infrequently, if at all; waivers to be granted where conflict with Federal legislation or procedures arises, or in other unusual circumstances; (6) provides each individual case will be examined on its own merits and, if an exemption is granted, will be reported to Congress.

The salary limitation provision has provoked substantial protest from institutions receiving NSF grants. Initially, particular concern was expressed regarding its impact on institutions located in exceptionally high cost of living areas. Specific requests for exceptions to the provisions were received by NSF from institutions in Alaska and Hawaii. After careful consideration of this request and review of the cost-of-living adjustment allowed by the Federal Government in 5 U.S.C. Section 5941 for these two states, (up to 25 percent more than the rate of basic pay), it was decided to raise the ceiling 25 percent above the GS-18 salary limitation for institutions in these two states, although salaries will be paid up to the new limitation only if in accordance with grantee salary policy. A letter from Dr. Atkinson to NSF's

Appropriations Subcommittees on January 16, 1979, informed them of the plan to follow this procedure.

In addition to the inequities relating to cost-of-living differences, institutions have voiced concern that the salary rate limitation is inequitable in the following respects:

- Discriminates between NSF and other agencies and in the long run may inhibit involvement of the ablest faculty in NSF-sponsored research;
- Discriminates between Federal and academic scientists, despite the intent of equalizing compensation; differences in social security and pension contributions reduce the pre-tax income of academic researchers substantially below that of Federal scientists receiving the same salary, without a corresponding increase in equity;
- Fails to take account of different employment practices among educational institutions and even within an institution, thereby discriminating between faculty scientists on nine-month contracts and research staff on twelve-month contracts. Academic faculty, who are apt to be on a nine-month contract, are limited to an effective annual rate of reimbursement of \$43,540, rather than \$47,500, while full-time researchers are apt to be on a twelve-month contract and eligible for compensation at the full \$47,500 annual rate; this is true even if the summer research time is two months in both cases. It results from the fact that the salaries are tied to the GS-18 rate and there are stringent specifications for computing these salary payments contained in the U.S. Code.
- Leaves it up to institutions to compensate for these inequities, increasing what some of them refer to as their "involuntary cost sharing", as well as increased paperwork burdens. Some universities have asserted that this is one more step making it more difficult for universities to attract and retain the ablest faculty.

NSF is continuing in fiscal 1979 to follow this situation and to obtain data on the number of individuals affected by the provision. We have recommended that such restrictions be stricken from the FY 1980 appropriation.

ADMINISTRATIVE ISSUES

Question: Several years ago the Foundation was able to hold its administrative expenses at below 5% of the total budget. Now those expenses are close to 6%. Is there a particular reason for this?

Answer: During the period FY 1976-1980, administrative costs budgeted under the Program Development and Management Activity has averaged 6.0 per cent of NSF's total budget. Major factors contributing to this increase were:

- o Personnel Compensation and Benefits, which comprise approximately 70% of all administrative costs, rose by \$10 million, due principally to the Federal-wide pay increase which averaged 22% during this period.
- o Travel costs of staff and consultants increased by approximately one-third with the average cost of a travel day rising from an estimated \$110 to \$140. Part of this increase resulted from approval of higher per diem rates.
- o Consultant Compensation costs have more than doubled due to extensive use of outside experts in the program oversight activities and more intensive proposal review.
- o Rental costs of leased space occupied by the Foundation increased by \$425,000 (14%), as assessed by the General Services Administration, with only minor adjustments in the total space leased.
- o Telephone, telegraph and postage combined has increased by \$986,000 (72%) due in part to postage rate increases and higher assessments by GSA for the Foundation's pro-rata share of telephone services.
- o Other contractual services, which includes services provided by private contractors as well as other Federal agencies increased by approximately 100%. While one-half of the increase can be attributed to new services which were not being provided in FY 1976 such as software development for the office automation projects, the remaining 50% balance of the increase represents the inflationary effect on the price the Foundation must pay for these necessary services. Contributing to these higher costs is the requirement that Federal agencies recover from their customers the actual cost of the services performed. This means that the performing agency passes on to the Foundation its increased pay costs and other increases in operating expenses.
- o Supplies and material costs have increased by 20% due almost entirely to the inflationary effect on prices the Foundation must pay on the commercial market and through the GSA supply service.

DEPARTMENT OF EDUCATION

Question: In your prepared testimony you described a carefully coordinated program in Science Education, a program which contributes importantly to the ability of the Foundation to achieve a reasonable degree of geographic distribution in its total program. If many of these programs are transferred to a new Department of Education, how will this affect States which are just beginning to qualify for basic research support? Isn't it true that 15 states would lose almost all of their NSF funding?

Answer: It is true that the programs of the Directorate for Science Education do contribute to the ability of the Foundation to achieve a reasonable degree of geographic distribution in its total program. The extent to which the transfer of programs to a new Department of Education would affect this distribution would depend upon both the number and type of programs which would be involved in such a transfer.

A review of a listing of FY 1978 Program Grants and Contracts by state of recipient indicates that it is not true that "15 states would lose almost all of their NSF funding." Only in four cases do science education funds represent more than half the total of NSF funds awarded to that state. Those states and the percent of total NSF funds awarded by the Directorate for Science Education are: Arkansas--53%, Mississippi--60%, North Dakota--60%, and South Dakota--53%.

WHITE HOUSE SCIENCE OFFICE

Question: Are you continuing to provide support to the Office of Science and Technology Policy? Can you tell us a little about the kind of work you are doing for the Office?

Answer: The Foundation has provided OSTP with three general kinds of support: administrative, personnel, and policy analysis and research. The NSF originally provided administrative support to OSTP, e.g., payroll and travel services, now handled through the White House Central Administrative Unit. The Foundation has also handled the administrative arrangements for OSTP's use of personnel under the Intergovernmental Personnel Act (P.L. 91-648), notably in the area of intergovernmental science and technology. In addition, NSF personnel are providing analytical services to some of the interagency working groups functioning under the aegis of OSTP.

Most of the policy analysis and research services provided by NSF to the OSTP are provided by the NSF Directorate for Scientific, Technological, and International Affairs (STIA). In addition to supplying backup studies and long-term policy studies in support of OSTP activities, NSF was assigned specific functions from P.L. 94-282 in Reorganization Plan No. 1 of 1977, viz:

All functions vested in the Director of the Office of Science and Technology Policy and in the Office of Science and Technology Policy pursuant to sections 205 (a)(2), 206, and 209 of the National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282; 90 Stat. 459), are hereby transferred to the . . . Director of the National Science Foundation.

Specific examples of NSF support for OSTP responsibilities include:

- At the request of OSTP, STIA participated in three Domestic Policy Review and several interagency studies in FY 1978:

- Domestic Policy Reviews

- Solar Energy (Division of Policy Research and Analysis and staff from Applied Science and Research Applications Directorate)

- Nonfuel Minerals (Division of Policy Research and Analysis and Division of Science Resources Studies, and staff from Applied Science and Research Applications Directorate, Atmospheric, Earth, and Ocean Sciences Directorate, and Mathematical and Physical Sciences, and Engineering Directorate)
- Industrial Innovation (Division of Policy Research and Analysis, Division of International Programs, Office of the Director)
- Interagency Studies
 - Interagency Study of S&T Information Policy (Division of International Programs, Division of Information Science and Technology)
 - Innovation and R&D in the U.S. Steel Industry (Division of Policy Research and Analysis)
- National Security Council Studies
 - In FY 1978, NSF was assigned responsibility to produce Annual S&T reports and Five-Year Outlook.
 - Policy coordination by Science Adviser and Director of NSF
 - Operational coordination by General Counsel of OSTP and STIA/PRA (Division of Policy Research and Analysis); oversight by Assistant Director/STIA
 - Preparation of Annual S&T report issue papers and statistical analyses by Division of Policy Research and Analysis and Division of Science Resources Studies
 - Support of OSTP in international areas:
 - Negotiations with Peoples Republic of China on exchange of students and scholars.
 - Staffing for U.S./U.S.S.R. Joint Commission on S&T, co-chaired by Dr. Press.
 - Analytical Studies and Analysis of Country Papers for the U.N. Conference on Science, Technology and Development.
 - Assistance to Interagency Planning Committee for the Institute for Technological Cooperation.
 - Expansion of U.S./Japan S&T Cooperation.
 - Preparation of S&T materials for discussion of S&T issues for President's visit to Mexico.
 - Support of OSTP in Federal S&T budgetary matters
 - Provision and analysis of data concerning R&D funding and S&E personnel in response to specific questions or S&T policy issues raised by OSTP (Division of Science Resources Studies)

INTERNATIONAL

Question: Please comment on the potential impact of the kinds of restrictions on scientific exchanges proposed on the Senate floor last year. Have you had an opportunity to discuss these concerns with Dr. Press. What are his concerns, if any?

Answer: Restrictions on scientific exchanges between the United States and the Soviet Union such as those proposed on the Senate floor last year would have produced three major negative results.

(1) An important channel of U.S. access to Soviet science and technology and to information on Soviet mechanisms for making science policy would have been closed. While there are a variety of ways for U.S. scientists to get together with scientists of most countries, between the United States and the Soviet Union formal exchange programs are the principal means of communication. Through these formal exchanges, U.S. scientists have derived real scientific benefits and have gained information on current Soviet research across a broad range of disciplines and scientific fields. Over the last several years, the U.S. side has been working to further improve the technical quality of the exchanges to U.S. science. Additionally, the exchanges provide opportunities to increase U.S. understanding of the structure, personnel, and operations of Soviet science and of the Soviet civilian sector in general.

(2) Opportunities for promotion of better understanding between the United States and the U.S.S.R. and for reduction of overall tensions between the countries would have been lost. Significant political and cultural benefits result from formal science exchanges between the United States and the Soviet Union. These exchanges provide an open window between the two countries and build bonds of friendship with a key element of Soviet society. Contacts between scientists of the two countries on narrow scientific issues contribute to the overall confidence and respect required to deal effectively with broader questions of concern between the countries.

(3) Loss of contact by Soviet dissident scientists with U.S. scientists would have worsened the Soviets' fate. It is largely due to contacts already established between Soviet and U.S. scientists through formal exchanges that Soviet scientists are known in the United States and that information on repressive actions against them reaches the United States. The formal science agreements provide valuable opportunities to convey our concerns on human rights to Soviet officials at all levels. Through continuing contacts with Soviet counterparts, U.S. scientists are able to provide encouragement to them and to speak out for them in the international scientific community. There is evidence that an awareness of the concern of the international community may be a contributing factor to Soviet restraint. Soviet dissidents have themselves stressed that their security is greater because of their links to the West.

Dr. Press agrees with and supports the above three points.

QUESTIONS SUBMITTED BY SENATOR CLAIBORNE PELL

OCEANOGRAPHIC COASTAL RESEARCH VESSEL

Question:

The Administration's authorization proposal includes provisions for construction funds for an oceanographic coastal research vessel. I support this proposal, but looking toward the future, I believe research vessel construction proposals should be advanced in the context of a comprehensive, long-range program based on projected research needs.

Is the current proposal for ship construction based on a long-range comprehensive plan?

If so, please submit a summary of the plan.

If not, please provide information on the status of a long-range research vessel construction plan.

Answer:

The UNOLS (University National Oceanographic Laboratory) report "On the Orderly Replacement of the Academic Research Fleet" referred to last year, prior to its formal adoption, is now an official report of that organization and serves as one major source of guidance to the Foundation in its annual updating of long-range plans. It calls for the construction of six ships in the 130-140 ft. size coastal as well as several smaller and larger ships over the coming decade. The funds requested for FY 1980 will support the construction of a second coastal ship of the size highlighted in this and earlier UNOLS recommendations, namely 130-140 ft. In response to the project solicitation for construction and operation of the FY 1979 funded coastal ship, the Ocean Sciences Division has received nine proposals from academic laboratories and consortia representing most of the oceanographic research community.

Based on this competition, NSF has reserved the option to make an award for the second ship, as well, should funds be available in our FY 1980 appropriation as requested. For the future, we continue to reassess construction plans based on related considerations such as changes in research demands, operating costs and sources of support, material condition of ships and community input.

RESEARCH VESSEL EQUIPMENT

Question:

There is continued concern over the adequacy of NSF funds allocated for research vessel equipment. Please provide for the record a summary of the total ship equipment requests received by NSF for the last fiscal year, the amount funded, and the amount budgeted for Fiscal '80. In addition, would you please comment on the adequacy of the equipment budget in the context of other budget priorities?

Answer:

The following figures for research vessel equipment requests and awards are for the Office for Oceanographic Facilities and Support (OFS) only. Project related oceanographic instruments used aboard ships are provided as a part of research grant support, but most shared-use equipment directly associated with UNOLS ships is provided via OFS.

	<u>Amt. Requested</u>	<u>Amt. Awarded/ Budgeted</u>
FY 78	\$ 3,093,157	\$ 1,291,700
FY 79	3,733,000	1,200,000
FY 80	Proposals due 1 July 1979	1,850,000

The substantially increased budget request for equipment in FY 1980 reflects Foundation commitment to meet the increasing costs of equipment and the growing demand for the entire range of items essential to the effective staging and deployment of oceanographic research at sea. We are presently working with the oceanographic community, through UNOLS, to develop standards for upgrading fleet ships and their gear and instrumentation. A UNOLS sponsored workshop was held recently at Texas A&M University to begin this assessment and planning activity, the end result of which will be estimates for achieving comparability of outfitting among classes of ships. We will factor such estimates into our long range planning.

RESEARCH VESSEL OPERATING FUNDS

Question : In regard to research vessel operating funds, does the amount budgeted take into account the recent and continuing increases in costs of fuel for the vessels?

Answer: No, the amount budgeted does not take into account recent and probable continuing increases in fuel costs. Estimates for FY 1980 ship operations support and related budget figures were prepared and submitted before the recent escalation began to occur. We are not yet able to assess the impact on current year operating costs but are following the issue closely and will work with the ship operator institutions to determine on a case by case basis the extent of the problem, reasonable measures for reducing fuel consumption, and ways to offset unavoidable increases in overall operating costs.

CONTINUATION OF IDOE

QUESTION: What are NSF's plans for continuation of IDOE projects and work after the conclusion of the Decade?

Are these plans in general accordance with the National Research Council recommendations?

Do the plans include continuation of IDOE work as an identifiable program as recommended by the National Research Council?

ANSWER: NSF will retain the capability to support large scale, long-term, coordinated ocean-research projects after IDOE ends in FY 1980 as recommended by the National Research Council. Large scale ocean science research projects are now essential to the continued development of Ocean Sciences. Such projects have also contributed to more informed use of the global environment. The importance of large scale ocean research, and of NSF's retaining the capability to support such research, was recognized by the National Advisory Committee on Oceans and Atmospheres in its 1975 review of IDOE and in its 1979 letter to NSF Director Atkinson; by the National Research Council in its 1978 report "The Continuing Quest; Large Scale Ocean Science for the Future;" and by the National Science Board in their 1979 acceptance of a plan for retaining NSF capability for support of large scale ocean science research after termination of IDOE. The plan for this retained capability was developed over 2 years and with the advice of over 400 U.S. Ocean Scientists. NSF plans are in general accord with the NAOA and NRC recommendations.

Following the NRC recommendations, NSF plans to retain a separate Research Support Section within the Ocean Sciences Division (OCE) to review and support proposals for large scale research projects, of the sort that have characterized IDOE. The new section will also continue to supervise existing IDOE projects until they are completed. New projects will be initiated under a procedure that retains the strengths of existing IDOE procedures and integrates large-scale project initiation with the activities of the Oceanography Section and the smaller projects it supports.

Because of the relatively large size (c. \$1 million) and long duration (3 to 10 yrs.) of IDOE-like projects, new projects will be evaluated in two stages. Both stages will be evaluated by the NSF peer review system and scientific staff. Preliminary proposals that are scientifically meritorious and appropriate for further development will be encouraged for formal development. Formal proposals will then be submitted to the new section and reviewed under the same rules (and generally with the same review panels)

used for review of all ocean sciences research proposals. Once approved and funded, each project will be overseen by teams of senior NSF Program Managers tailored to match the particular research project.

Budgets for supporting large scale ocean research projects are expected to remain approximately equal to those for the small-scale research programs. The exact balance will depend on the number and quality of meritorious proposals for research projects of various sizes.

SMALL BUSINESS

Question: Would you please provide a summary of participation by small business in NSF programs?

Have Rhode Island small business firms participated? If so, please provide a listing of such firms and their participation.

Answer: The attached table summarizes data on participation by small companies in NSF awards.

At present there are only three Rhode Island firms on our mailing list for small science and technology companies. These are:

LeBlanc Research Corporation
5454 Post Rd.
E. Greenwich, RI 02818

Enertec
Box 2480
Providence, RI 02906

Jamieson Labs.
P21 G. Washington Highway
Esmond, RI 02917

We would like to have on our list the names of more small firms in Rhode Island that are highly capable in scientific research and high technology. The National Science Foundation has been making increasing use of the Commerce Business Daily and of the newsletters of small business associations in an effort to advise small companies of specific opportunities for NSF support. We will continue to do this but will welcome other opportunities to increase the number of Rhode Island firms on our list. In fiscal year 1977 and fiscal 1978 no small science and technology companies in Rhode Island received NSF awards.

There will be an NSF-supported conference in Boston for small science and technology companies in New England in the Fall of 1979. This will be given considerable advance publicity and is being planned with advice from the Small Business Association of New England. It has been our experience that the level of interest and awareness of opportunities at NSF and at other science-supporting federal agencies increases markedly among the small companies of a region following such a conference.

SMALL BUSINESS
GRANT AND CONTRACT AWARDS^{1/}
FY 1977 and FY 1978

	No. of Awards		Amount		Total Obligations		% to Small Business	
	FY 77	FY 78	FY 77	FY 78	FY 77	FY 78	of Tot. Obligs	
							FY 77	FY 78
			(dollars in millions)					
Mathematical & Physical Sciences & Engineering	5	3	.259	.179	224.4	248.5	.11	.07
Astronomical, Atmospheric Earth & Ocean Sciences ^{2/}	2	7	.189	.307	188.2	211.6	.1	.15
Biological, Behavioral, & Social Sciences	1	1	.083	.050	126.6	141.8	.07	.04
Scientific, Technological & International Affairs	16	30	1.754	2.560	19.4 ^{3/}	23.8	9.0	10.8
Applied Science & Research Applications	95	77	7.594	7.388	63.7 ^{3/}	55.1	11.9	13.4
Science Education ^{4/}	5	8	.556	.716	59.0	59.7	.94	1.2
TOTAL^{5/}	124	126	10.435	11.200	681.3^{2/}	740.5	1.5	1.5

^{1/} Program funds--excludes PD&M and purchase orders

^{2/} Excludes Antarctic Research Program

^{3/} These figures shown without \$1.3 million transfer from RA to STIA in FY 77

^{4/} Excludes Fellowships & Traineeships

^{5/} Total obligations excluding Special Foreign Currency, PD&M, Fellowships and Traineeships, and purchase orders.

QUESTIONS SUBMITTED BY SENATOR RICHARD SCHWEIKER

REGIONAL INSTRUMENTATION

Question: I have followed with interest the National Science Foundation's (NSF) implementation of its Regional Instrumentation Facilities Program. I was extremely impressed with the increased awareness NSF has shown in its program solicitation for Round 2 to the need to focus this program on basic research. I am also aware that NSF is undertaking a broad review of all its programs to determine to what extent NSF funded equipment is being used to advance fundamental knowledge and what policies can be formulated to limit unfair competition by NSF grant recipients with the private sector. Would you comment on these developments, specific issues NSF is addressing and what further progress you anticipate.

Answer: In FY 1978, six institutions were selected to receive support under the Foundation's Regional Instrumentation Facilities program. Facilities for nuclear magnetic resonance spectroscopy were established at Colorado State University and the University of South Carolina. Mass spectrometry facilities were established at Johns Hopkins University and the University of Nebraska. The University of Pennsylvania is the site of a new laser facility, and the University of Arizona is establishing a facility for carbon-14 dating and trace analyses by accelerator techniques. Support for the facilities will include funds for the purchase of major instruments as well as set-up and operating costs.

The exact number of additional facilities to be supported in FY 1979 and FY 1980 will depend on such factors as the quality of proposals received, geographical distribution, and the nature of the institutional commitment and support. However, it is estimated that the total NSF program for these facilities will permit the establishment of four to six new facilities in FY 1979, in addition to providing for sustaining operation of those facilities initiated in FY 1978. The FY 1980 budget request will permit the establishment of three to five additional facilities, plus operational support for those already in existence.

The matter of competition with the private sector is addressed in the answers to the next question.

UNIVERSITIES AND THE PRIVATE SECTOR

Questions: Along the same lines, I have observed a lack of a well defined government-wide policy for assuring that universities do not duplicate services available from the private sector. Can NSF provide government-wide leadership to assure that universities pursue educational and fundamental research goals and avoid routine commercial activities?

Universities usually make a serious effort to avoid commercial activities since such activities could jeopardize the tax status of the institution. The tax laws themselves probably provide the most effective government-wide assurance that commercial ventures by academic institutions will be avoided. The Foundation is keenly aware of the need to avoid the support of programs that would place the universities in an unfair competitive position with private firms. The wide activities of both academic institutions and private firms go far beyond the roles and missions of NSF. Consequently, the Foundation believes that federal-wide leadership in this area should probably be a matter of concern for the President's Science Adviser and his staff. The Foundation would cooperate in any such undertaking.

Answer : For example, in determining whether Regional Instrumentation Facilities are needed in a particular location, the Foundation examines not only the needs of various institutions in the region, but also takes into consideration what is available in the way of private facilities. The resources and capabilities of the regional facilities should complement, rather than compete with, the resources and capabilities of academic, industrial, and other organizations in a region.

The Foundation intends that the facilities provide services not otherwise available for basic research to a broad spectrum of scientists in the geographic region covered by the facility. If there are facilities that meet these purposes already openly available in the region, NSF will not support proposals to duplicate them. The facilities should have the capability to accommodate projects which must be carried at the facility. The service provided should not compete with generally available commercial facilities or resources.

SMALL BUSINESS

Question: Recently NSF has issued a request for innovation proposals from small businesses. By limiting these proposals to no more than 20 pages, NSF has made it more realistic for additional small businesses to submit proposals. I am aware of a number of small R&D laboratories in Pennsylvania which have been encouraged to submit proposals. What plans does NSF have to strengthen this program further and make it possible to support even greater activity?

Answer: The Small Business Innovation Program provides an incentive for small science and technology-based firms to perform research on important scientific and technical problems and encourages the use of Federal research to stimulate technological innovation in the private sector. The program is divided into three phases. Phase I provides support of up to \$25,000 for a six month period to conduct feasibility-related experiments or theoretical research on the proposed innovative idea. Phase II supports the principal research project and is awarded for those Phase I projects which are judged to be the most promising. Phase III is the development phase, which is conducted by the small business firm and is privately funded. There are incentives for the small business firm to obtain private venture capital contingent upon certain technical objectives being met in Phase II. Proposals with a commitment for the Phase III private venture capital receive extra consideration in the Phase II evaluation. This will increase the application of research results and also increase the return on the investment of Federal dollars in this program.

The first Small Business Innovation Solicitation was issued in March of 1977 and resulted in 329 proposals received and 42 Phase I awards totalling \$1,028,000. It is expected that 21 firms will receive Phase II awards averaging \$200,000 for one to two years of support for a total of \$4.3 million. Ten of the 21 potential Phase II awardees have had varying degrees of a venture capital commitment from third parties.

A second solicitation was issued in February 1979, and Phase I proposals are due to NSF by April 2, 1979. Currently, ASRA plans to issue a similar program solicitation each fiscal year. The support to new small business firms under these solicitations coupled with on-going support each year to Phase II awardees and the incentive to obtain private venture capital strengthens the scope of this program significantly.

In addition to support provided under the Small Business Innovation Program, ASRA awards grants and contracts to small business firms who submit unsolicited proposals. In Fiscal Year 1979 it is estimated that about \$7.8 million (12.5% of the ASRA budget) will support research and related activities performed by small business firms. Approximately \$4.8 million of this amount will result from unsolicited proposals.

ASRA has also supported three small business conferences in various regions of the United States and eight more are planned for the period FY 1979 to FY 1982 (two each fiscal year). These conferences are designed to acquaint small business firms with Federal R&D programs for which they may be eligible to receive support. Information is provided on NSF programs and policies as well as those of other Federal agencies. In addition, there is ample opportunity for small business personnel to meet with ASRA program managers and other Federal agency personnel to discuss their ideas and projects. We believe that these conferences will also serve to further stimulate small business interest in participating in Federal R&D.

R&D SPENDING

Question: Private non-military R&D spending has dropped sharply as a share of national economic activity over the last decade. Apparently, many firms now question the in-house wisdom of committing shareholders' funds to speculative R&D programs. As an expert on national R&D trends, how would you reverse this unfortunate trend? b) One suggestion has been to strengthen patents laws and change Federal regulatory procedures which affect marketing new products today. Present laws in these areas, it seems to me, increase the risk that in-house R&D spending will prove unprofitable, or if profits are made, they will be modest in nature. Could you comment on this.

Answer: Over the past decade, company funded R&D has remained a stable proportion of the Gross National Product. As may be seen from the table below, company funded R&D has hovered around 1.0 percent of GNP. Looking at the manufacturing sector where the bulk of the company funded R&D takes place reveals a rising trend. From 1967 through 1977, company funded R&D in manufacturing has increased from 3.55 to 4.17 percent of manufacturing GNP.

The situation, however, is different with regard to basic research which represents the more speculative aspects of industry supported R&D. Over the past decade company funded basic research as a percent of the Gross National Product dropped by one-third as seen from the table below. Also, basic research as a percent of manufacturing GNP decreased from 1967 to 1977 by about 15 percent.

Ratio of Company Funded R&D and Basic Research to GNP for the Economy
and the Manufacturing Sector

Year	Company Funded		Mfg. Sector Company Funded	
	R&D as % of GNP	BR as % of GNP	R&D as % of Mfg. GNP	BR as % of Mfg. GNP
1960	0.88	.059	3.04	0.20
1961	0.89	.060	3.20	0.21
1962	0.89	.061	3.14	0.21
1963	0.90	.063	3.17	0.21
1964	0.91	.060	3.19	0.20
1965	0.94	.059	3.22	0.20
1966	0.96	.060	3.28	0.19
1967	1.01	.054	3.55	0.17
1968	1.02	.053	3.60	0.18
1969	1.05	.049	3.79	0.17
1970	1.05	.045	4.02	0.17
1971	1.00	.043	3.97	0.17
1972	0.98	.040	3.89	0.15
1973	1.00	.038	3.97	0.15
1974	1.04	.038	4.29	0.15
1975	1.02	.037	4.32	0.15
1976	1.02	.037	4.20	0.15
1977	1.03	.037	4.17	0.15

SOURCES: National Science Foundation, Science Resources Studies
Division; Department of Commerce

As to the effects of existing patent laws and regulating procedures on the risks and returns from industrial innovation, the Division of Policy Research and Analysis within NSF has recently completed reviews of available research. These papers assessed the major research findings relevant to questions about the effects of existing patenting conditions, environmental, health and safety regulations and economic regulations (of firms in energy, transportation and communication sectors) on industrial innovation. According to these assessments, the existing legislation and government procedures can, under some circumstances, increase risks or reduce the profitability of commercial R&D. In addition, selected modifications in legislation or practices are generally recognized as desirable for industrial innovation. Copies of the NSF papers are being furnished to the Subcommittee.

A major problem now facing the Nation is to find the combination of changes in legislation and practices which permit both a high rate of industrial innovation and satisfy societal demands for improved environmental and safety conditions and regulation of public utilities in energy, transportation and communications.

Formal recommendations on these topics, resulting from the Domestic Policy Review on Industrial Innovation, will be forwarded to the President this spring (c.f. response to Question No. 5). Following White House review and decisions by the President, the results of this work should be forthcoming.

R&D SPENDING

Question: In addition to possible changes in patent and regulatory procedures, what other steps can be taken to raise the level of private commitments to non-military R&D programs back to the level experience in the 1960's?

Answer: A large number of suggested changes in current legislation and government practices have been examined in the industrial innovation domestic policy review. Suggestions cover changes in tax rates and practices, Federal financial assistance to venture technology firms, modifications in anti-trust laws and standards, improvements in Federal science and technology information programs and to changes in patent and regulatory procedures. Under this domestic policy review, various government task forces and the staff of the Assistant Secretary of Commerce for Science and Technology are now sifting through these suggestions. In their analyses, these groups are supposed to take into account both the likely effectiveness and costs of the various options.

R&D SPENDING

Question: If private non-military R&D spending regained and maintained its 1960's market share in the national economy, how much would worker productivity rise over the next two decades? How much would GNP/capita rise by 1998?

Answer : Available research has focussed largely on estimating the association between increases in output and R&D spending. The existing estimates represent largely the experiences of individual industries within the timeframe of the 1960's. Though the findings show predominantly high returns, the actual magnitudes range widely.

Even with estimates of the share of company funded R&D to Gross National Product, it is not possible to estimate the quantitative effect of this R&D on GNP per capita. Productivity growth depends on more than the proportion of resources firms devote to R&D. Productivity growth from R&D expenditures depends on how effectively R&D projects are selected and implemented, and on the diffusion of new technology. Other factors such as changing quality of the labor force or the rate at which new plant or equipment are installed also play a major role in determining the rate of productivity growth. In addition, existing productivity measures fail to capture an important share of the increase in output from R&D incorporated in quality improvements.

PRODUCTIVITY

Questions: I would like to hear any comments in general you want to make about productivity levels. You raise it in your testimony on page 3.

Answer : Productivity growth hinges on a number of factors in addition to R&D and technological innovation. One of the difficulties of policymaking is that the causes as well as the appropriate remedies for the slow U.S. productivity growth are imperfectly understood. The NSF has encouraged research which seeks to improve the measurement of productivity growth and the understanding of the determinants of the rates of output growth among nations. Examples of research funded by NSF include the work of John Kendrick (George Washington University), Edward Denison (Brookings Institution), Dale Jorgensen (Howard), and Laurits Christensen (Wisconsin).

Legitimate concerns with productivity growth should not detract from the priorities given to other societal objectives. Current strong societal demands for lowering the pollution and safety risks from technology stem from the inadequate attention given to these factors in the earlier post-World War II era. An important portion of the government R&D effort must be directed to improving the effectiveness and efficiency with which society can meet these non-economic objectives. At NSF there are a number of basic and applied research programs directed to improving the scientific base required to achieve these goals.

MINORITIES, WOMEN, AND THE HANDICAPPED

Question: I notice you have a decrease of \$500,000 in the Minorities, Women and the Physically Handicapped Science Education Program. Why has this program been decreased when the need is so great? Your budget justification says you want to see these groups represented in the other NSF Science Education programs. How will you do this, and is there substantial involvement now in all NSF programs of these groups?

Answer : The strategy for the Science Education Directorate is to continue special studies and experimental activities designed to improve the science literacy of these groups and increase opportunities for these individuals to prepare themselves for science-related careers while at the same time placing a particular emphasis on increasing the effectiveness of the Directorate's regular programs in addressing these problems..

Estimates have been made of impact of these priority thrusts throughout all programs of the Science Education Directorate, in targeted as well as non-targeted programs. The results show that in the current year, FY 1979, approximately 17 percent or about \$13 million of all science education funds will be devoted to supporting the participation of women in science education programs to improve science literacy and increase opportunities for study and research in science-related careers. For FY 1980, the proportion of the total science education budget devoted to this purpose will increase to approximately 19 percent or about \$16 million. This is an increase of about 18 percent over FY 1979.

We have already begun to make adjustments in FY 1979. For example, in the design of the Undergraduate Research Participation and the Student Science Training programs, eligibility remains open to all as in the past, but we have highlighted in the guidelines for submission of proposals our interest in having these programs used to address these special concerns. In the Science Education Directorate I have made arrangements to require that all brochures relating to the FY 1980 program must be reviewed to assure that NSF's concern and commitment to these groups is adequately and properly addressed in program descriptions. This will include a special notice highlighting the special thrusts to be pursued in FY 1980 and in the future. It will also involve the review of criteria for proposals and the manner in which these criteria will be taken into consideration in the evaluation of proposals and the making of awards.

In addition, NSF is instituting two new program management requirements which will enable us to track our progress over time in achieving these objectives. The first of these is a requirement for the establishment of a Science Education directorate capability to capture information about special purposes of awards. This is outlined in SE Circular No. 43, Availability of Information on Special Directorate Thrusts, attached. The circular requires reporting on specific directorate objectives in the areas of minorities, women, and early adolescence across all science education programs. As a corollary to this grantees will be asked to provide post-award information on the number of minorities and women participants which have been supported under grants awarded by the Directorate for Science Education.

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550



December 21, 1978

AD/SE CIRCULAR NO. 43

ADMINISTRATION AND MANAGEMENT

SUBJECT: Availability of Information on Special Directorate Thrusts

1. Purpose. To establish a Directorate capability to capture, by program, information about special purposes of awards.
2. Cancellation. None.
3. Background. There is a need to obtain information on awards which will describe the total Directorate effort in serving specific objectives which cut across program lines. At this time the specific Directorate objective of concern is science literacy and career access for these target groups:

Minorities,
Women, and
Early Adolescents.

Certain programs, e.g., Minority Institutions Science Improvement, are specifically and totally designed to serve one of these objectives; they may also, however, address additional special objectives. Other programs, e.g., Local Course Improvement, may support only an occasional project which can be said to support in part an activity aimed at one or more of these target groups. It is the purpose of this effort to establish a system which will allow data to be systematically collected on special Directorate efforts.

4. Implementation. Beginning in Fiscal Year 1979 each program must provide information on all awards which address the above three objectives in whole or in part. Where feasible, Alternative A, below, will be used. Where not feasible, e.g., Graduate Fellowships, Alternative B, below, will be used.

Alternative A: The Special Program Data Elements field, Item 7, Form 779, will be used to record the proportion of the award judged to represent an effort to serve the special objectives as follows:

Form 779
Data
Element

Special Objective

7.K

Minorities

7.L

Women

7.M

Early Adolescence

The percent of effort, 0-100, will be entered in these positions. The percent figures will be justified right. This shall be entered for each award.

Division and Office Directors will be responsible for assuring that each action is coded for these purposes.

The Directorate DIS Representative will be responsible for creating and maintaining a capability to regularly provide the AD/SE with reports, by program area, which display for each of the three special objectives:

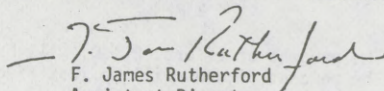
- (1) the number of award actions;
- (2) the total dollars awarded; and
- (3) the total award dollars serving the objective.

Alternative B: Certain program areas may find that the use of Alternative A is not feasible. In each such case the program must provide for the approval of the cognizant Division or Office Director a memorandum stating why it is not feasible to utilize Alternative A and outlining a plan which will provide the information as specified above. Following approval of the memorandum by the Office/Division Director, a copy of that plan will be forwarded to the DAD/SE for information.

5. Definitions. Funds recorded in this manner are to represent the costs of projects or components of projects which specifically address science literacy or career access problems of the target group. No attempt should be made to extract potential or longer impact of projects on these groups. Simple demographic data, for example, regarding the percentage of minorities and women among the population ultimately impacted by a project should not be used.
6. Reports. Reporting will be at the request of the AD/SE but not more frequently than on a quarterly basis. In addition, each Division/

Office Director will be responsible for submitting to the AD/SE at the close of each fiscal year a summary report which displays the required information on each program and for each Division/Office a grand summary for that unit.

7. Effective Date. This circular is effective as of date of issuance.


F. James Rutherford
Assistant Director
for Science Education

Distribution:

Science Education - F

WOMEN, MINORITIES, AND THE HANDICAPPED

Question : I have a number of Pennsylvania constituents who are interested in providing training to individuals who are members of groups traditionally excluded from science professions. They start working with a student when he is in high school and continue until the young person has finished college. Students in this program do very well in school and on their graduate boards, and so are extremely competitive with students from more advantaged backgrounds for graduate, medical or law schools. Could this organization receive help from NSF and if so, which programs would help them?

Answer : The Foundation's Student Science Training Program for high ability secondary school students may be the type of activity in which your constituents would be interested.

Student Science Training (SST) is one of three programs comprising the National Science Foundation's Student-Oriented Programs. It shares with the other programs the basic goal of providing talented students with learning opportunities above and beyond those normally available in most formal science education programs in the Nation's schools and colleges.

A secondary goal of SST is that of recognizing the capacity of students to be motivated by a measure of independence in their studies and thus to accept greater responsibility for planning and carrying out their own learning activities.

Two-year and four-year colleges and universities and nonprofit organizations with appropriate scientific and educational expertise may serve as sponsors for SST projects. The program is more thoroughly described in the NSF publication Student Science Training Program: A Guide for Preparation of Proposals and Project Operation (Brochure No. SE 79-20) and is available from the Foundation at no cost.

YOUNG SCIENTISTS

Question: During the debate in the Congress in the last session on legislation to raise the mandatory retirement age, the problem of limited positions on college and university faculties was brought up. Do you feel that this new law will seriously limit the number of young scientists who will be able to teach? If so, do you have any suggestions to help alleviate this problem?

Answer : The opportunities for young scientists now and in the future continues to be an important concern of the Foundation. As part of that concern, the Director has announced the appointment of an NSF Staff Group to compile and analyze current supply and demand of young scientists and to examine the projections of future supply-utilization data. Additionally, the National Academy of Sciences (NAS) will take a study of such projections. The question of the impact of a change in the mandatory retirement age upon such projections is a timely one, since retirement age is one of a number of factors being carefully analyzed.

The potential severity of the influence of retirement age upon the opportunities for young scientists, however, was characterized recently in an address by Dr. William G. Bowen, President of Princeton University. Dr. Bowen stated:

"... If certain factors are held constant (student-teacher ratios, fractions of age-groups being educated, etc.), and if all faculty members who do not retire before age 65 were to continue teaching until 70, aggregative statistical projections indicate that on a net basis there would be literally no new faculty openings across the country for six consecutive years—from 1983 through 1988 . . ."

On the other hand, recent evidence reported by the American Association of University Professors (based upon TIAA-CREF data) suggests that there is a growing tendency for pre-65 retirement by academicians in the U.S.

Although the NSF studies are currently under way and no conclusive findings are available yet, it is clear that retirement age and the number of academicians that retire each year must affect the opportunities for young scientists. The exact nature and extent of this effect will hopefully be available for consideration by the various policy-making groups within the next six months so that various alternative actions may be evaluated.

Senator KENNEDY. The subcommittee stands in recess.
[Whereupon, at 12 noon the subcommittee adjourned, subject to the call of the Chair.]

