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NATIONAL SCIENCE FOUNDATION AUTHORIZATION ACT FOR FISCAL YEARS 1979 AND 1980 AND THE WOMEN IN SCIENCE AND TECHNOLOGY EQUAL OPPORTUNITY ACT

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HEARING

BEFORE THE

SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH

OF THE

COMMITTEE ON HUMAN RESOURCES

UNITED STATES SENATE

NINETY-FIFTH CONGRESS

SECOND SESSION

ON

S. 2549

TO AUTHORIZE APPROPRIATIONS FOR THE ACTIVITIES OF THE NATIONAL SCIENCE FOUNDATION, AND FOR OTHER PURPOSES

S. 2550

TO PROMOTE THE FULL USE OF HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY THROUGH A COMPREHENSIVE PROGRAM TO MAXIMIZE THE POTENTIAL CONTRIBUTION AND ADVANCEMENT OF WOMEN IN SCIENTIFIC, PROFESSIONAL, AND TECHNICAL CAREERS

APRIL 10, 1978

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NATIONAL SCIENCE FOUNDATION AUTHORIZATION ACT FOR FISCAL YEARS 1979 AND 1980 AND THE WOMEN IN SCIENCE AND TECHNOLOGY EQUAL OPPORTUNITY ACT

MONDAY, APRIL 10, 1978

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

The subcommittee met at 10:45 a.m. in room 4232, Dirksen Senate Office Building, Senator Edward M. Kennedy (chairman of the subcommittee) presiding.

Present: Senators Kennedy and Javits.

Senator KENNEDY. We will come to order.

I will put my opening statement in the record. We outline in that opening statement the areas of principal interest to this committee. I will develop those themes during the course of our hearing this morning.

We are going to have a vote at 11 o'clock on the Farm Conference Report, but we will continue after that, obviously. We will have time to hear from our witnesses this morning.

OPENING STATEMENT OF SENATOR KENNEDY

Senator KENNEDY. The subject of our hearings this morning is the National Science Foundation Authorization Act and the Women in Science and Technology Equal Opportunity Act.

The witnesses we will hear will help us determine how well the Foundation is meeting its responsibility to support basic research and to fund applied research in areas where the potential exists to resolve significant national problems. In addition, the National Science Foundation has the primary responsibility within the Federal Government for strengthening science education. The Foundation must assure the Nation an adequate pool of scientific and technological human resources—with full participation of minorities and women. The Foundation must also work to improve science education to meet the needs of a broader range of students; to promote public understanding of issues involving science and technology; and to improve the general effectiveness and relevance of science education.

The budget proposal before the subcommittee totals $940.9 million. It is 8.8 percent above last year's program level and includes a 10-percent increase for the support of basic research. Taking into account the serious impact of inflation, the NSF budget will provide for real growth in basic research of 3.7 percent.

For the first time, the NSF's basic research program is actively encouraging joint proposals from academic and industrial researchers. This is an important recognition of the need to assure that the expertise of scientists in industry is applied to the basic research program of the Foundation. It is a new emphasis for the Foundation, and one which could contribute substantially to the advancement of science.

The Foundation is also proposing a 17 percent increase in basic research in behavioral and neural sciences. This is a particularly significant increase and the research the Foundation is supporting in this area may lead us to a new understanding of the influences which affect human behavior. An important part of that effort could lead us to the solution to a number of behavioral issues which are closely tied to preventive health care—another major concern of this subcommittee. I have in mind a program which would help us understand why so many children are developing poor eating habits, avoiding exercise, and why smoking has become so widespread among young boys and girls. A concerted basic and applied research effort, involving both NSF and NIH could lead us to the techniques we need to counter this trend—a trend which is having such a serious impact on the health of our population.

In the applied research area there has been a major reorganization in the NSF program during the past year. The new structure is designed to establish closer ties between basic and applied research. Its objective is to give the program the flexibility it needs to pursue identified areas of national concern as well as promising research proposals which may not fit into fixed categories. It is too early now to determine the impact of this reorganization on the strength of applied research. But we want to make sure that as it gets underway, the new program has access to the very best basic research proposals with outstanding potential for future application; we must make sure that the small business program continues to prosper; and we must assure that the Foundation's program to assist State and local government in applying science and technology is a full partner in the new effort.

In the area of science education there are a number of particularly important concerns which we want to examine today. As has happened all too often in the past, it appears that during the development of the NSF budget there was a substantial deviation from the Foundation the NSF budget there was a substantial deviation from the Foundation's original plan to fund the science education program at a level between $82 million and $88 million. The budget we have before us recommends just $77.6 million. I am concerned over the impact of this no-growth budget on the ambitious and necessary program envisioned by the Foundation's new assistant director for science education, Dr. Rutherford, when he testified before us during his confirmation hearing.

There is a growing recognition that we need to improve the basic math and science skills of junior and senior high school students. We need to put in place programs to stimulate women and minorities to pursue careers in science. We need to strengthen the base of science education in our 2- and 4-year colleges. I don't see how the NSF is going to fund these programs in the science education budget we have before us.

To begin to strengthen and adequately fund, the Foundation's programs for women in science I have introduced S. 2550, the "Women in Science Equal Opportunity Act". The act establishes a 10-year, $250 million program to improve the basic science and math skills of young women and to increase opportunities for the participation and advancement of women in science. We have no more women in the scientific wordforce now than we had in 1920. In some disciplines women are as few as one-tenth of 1 percent of the workforce. Women with the qualifications to go on to research careers experience an unemployment rate from three to five times higher than their male colleagues. Women who are employed in science earn an average of 17 percent less than their male counterparts.

My bill is designed to focus on the leverage of the NSF on the effort to achieve equal opportunity in science. It calls for the cooperation and assistance of other Federal agencies, the scientific community, industrial research firms, and educators. I look forward to the comments of our witnesses on this new legislation. I expect that they will be able to give us added information on how we can best approach these problems.

I will now insert in the record a statement by Senator Schweiker.

[The statement referred to follows:]

STATEMENT OF RICHARD S. SCHWEIKER, A U.S. SENATOR FROM THE STATE OF PENNSYLVANIA

Senator SCHWEIKER. Mr. Chairman, as the ranking Republican on this subcommittee, I have long been interested in the work of the National Science Foundation, and have in the past, greatly enjoyed receiving an update on activities at NSF.

I am pleased to see that S. 2549 would encourage the growth of NSF's science education programs and the research programs. I strongly believe that our Nation's scientific and educational communities will greatly benefit from the joint effort and approach of the National Science Foundation. Research cannot be strong without good solid science education programs in our schools, and indeed the whole country benefits from an active scientific community. I know that last year Senator Kennedy and I indicated our continuing support for the programs of the National Science Foundation because it is within the scientific community that we will hopefully find solutions to many of the problems we face as a Nation today, such as our energy problems.

I look forward to reviewing the testimony to be presented today, and want to thank the distinguished panel of witnesses for their contributions.

Senator KENNEDY. With us on behalf of the administration this morning is: Richard Atkinson, director of the National Science Board; Norman Hackerman, chairman of the National Science Board; George Pimentel, N.S.F.'s deputy director; Alexander Rich, from from MIT, a member of the National Science Board.

Our public witnesses are: Irving Shain, chancellor of the University of Wisconsin; Robert Randolph, president of Westfield State College; Lucy Sells, a sociologist from the University of Maryland; Edward Helminski, director of the energy and natural resources program of the National Governors Association.

We hope that this roundtable format will make it possible to encourage a good exchange of views between the members of the subcommittee, the officials of the NSF and the public witnesses. I would encourage all the participants to present their testimony as concisely as possible, with the assurance that the full texts of their statements will appear in the hearing record. We want to leave enough time so that the witnesses will be able to raise and respond to the questions which will come up during the proceedings this morning.

[The text of S. 2549 and S. 2550 follows:]

95TH CONGRESS
2D SESSION

S. 2549

IN THE SENATE OF THE UNITED STATES

FEBRUARY 21 (legislative day, FEBRUARY 6), 1978

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

A BILL

To authorize appropriations for the activities of the National Science Foundation, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Authorization Act for Fiscal Years 1979 and 1980".

SEC. 2. (a) There is hereby authorized to be appropriated to the National Science Foundation $934,000,000 for the fiscal year 1979 and such sums as may be necessary for the fiscal year 1980.

(b) Funds authorized for the fiscal year 1979 shall be available for the following categories:

(1) Mathematical and Physical Sciences and Engineering, $268,300,000.

(2) Astronomical, Atmospheric, Earth and Ocean Sciences, $227,300,000.

(3) United States Antarctic Program, $50,700,000.

(4) Biological, Behavioral, and Social Sciences, $158,000,000.

(5) Science Education Programs, $77,600,000.

(6) Applied Science and Research Applications, $67,000,000.

(7) Scientific, Technological, and International Affairs, $24,300,000.

(8) Program Development and Management, $54,800,000.

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

SEC. 4. From appropriations made under this Act, not more than $5,000 each for fiscal year 1979 and fiscal year 1980 may be used for official consultation, representation, or other extraordinary expenses upon the determination of the Director of the National Science Foundation, and his determination shall be final and conclusive upon the accounting officers of the Government.

SEC. 5. In addition to the sums authorized by section 2, not more than $6,000,000 for fiscal year 1979 and not

more than such sums as may be necessary for fiscal year 1980 are authorized to be appropriated for expenses of the National Science Foundation incurred outside the United States and to be paid for in foreign currencies that the Treasury Department determines to be excess to the normal requirements of the United States.

SEC. 6. Funds may be transferred among the categories listed in section 2 (b), but neither the total funds transferred from any category nor the total funds transferred to any category may exceed 10 percent of the amounts authorized for that category in section 2, unless—

(A) thirty legislative days have passed after the Director of the National Science Foundation or his designee has transmitted to the Speaker of the House of Representatives, to the President of the Senate, to the Committee on Science and Technology of the House of Representatives, and to the Committee on Human Resources of the Senate a written report containing a full and complete explanation of the transfer and the reason for it, or

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

95TH CONGRESS
2D SESSION

S. 2550

IN THE SENATE OF THE UNITED STATES

FEBRUARY 21 (legislative day, FEBRUARY 6), 1978

Mr. KENNEDY (for himself, Mr. HATHAWAY, Mr. JAVITS, Mr. PELL, and Mr. WILLIAMS) introduced the following bill; which was read twice and referred to the Committee on Human Resources

A BILL

To promote the full use of human resources in science and technology through a comprehensive program to maximize the potential contribution and advancement of women in scientific, professional, and technical careers.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Women in Science and Technology Equal Opportunity Act".

TITLE I—STATEMENT OF FINDINGS, PURPOSE, AND POLICY

STATEMENT OF FINDINGS

SEC. 101. The Congress finds that—

(1) it is in the national interest to promote the

full use of human resources in science and technology and to insure the full development and use of the talents of men and women with scientific and technical skills;

(2) the Nation's preeminent postion in science and technology depends upon the development of the full potential of the talents of men and women with scientific and technological skills and the full employment of such men and women produces job opportunities in technical and support occupations and exerts a strong multiplier effect on the gross national product;

(3) the full use of the Nation's scientific and technical human resources is required to meet the strong demand for such skills over the long term; and

(4) skills in science and mathematics contribute substantially to entry and achievement in a wide range of professional and technical fields;

(5) although men and women have equal potential for excellence and advancement in scientific and technical fields—

(A) the number and proportion of women earning degrees in science and engineering has remained virtually unchanged over the last fifty years,

(B) less than 10 per centum of scientists and engineers engaged in basic or applied research are women,

(C) the unemployment rates of women scientists and engineers are three times higher than for men in every field of science, and are five times higher among young doctorates, and

(D) women scientists and engineers earn less than men in every field, at every degree level, at every level of experience and in every employment setting.

DECLARATION OF PURPOSE

SEC. 102. The Congress declares that it is therefore the purpose of this Act to encourage the full participation of women in scientific, professional, and technical fields through new and existing programs and procedures which—

(1) improve science education, with particular emphasis on mathematics;

(2) promote literacy in science and mathematics and prepare women for scientific, professional, and technical careers;

(3) increase opportunities for the employment and advancement of women in science and technology;

(4) encourage the participation of minority and handicapped women in scientific and technical careers; and

(5) educate and inform the public concerning the

importance of the participation of women in science and technology.

STATEMENT OF POLICY

SEC. 103. The Congress declares it is the policy of the United States to assure equal opportunity for women in education, training, and employment in scientific and technical fields and thereby promote the full use of the nation's human resources in science and technology.

TITLE II—EDUCATION

ELEMENTARY AND SECONDARY EDUCATION PROGRAMS

SEC. 201. (a) The National Science Foundation is authorized and directed to support activities designed to strengthen elementary and secondary school programs in science and mathematics in accordance with the provisions of this section. Such activities shall demonstrate potential to interest and involve female students and assist them in acquiring knowledge, skills, and information.

(b) Programs assisted under this section shall emphasize activities focused on female students in grades seven through twelve and shall include, but not limited to—

(1) the development of methods, instructional materials, and technologies to improve the quality and relevance of education in science and mathematics and awareness of career opportunities requiring scientific and technical skills;

(2) the training and retraining (including inservice training) of teachers, counselors, and other appropriate educational personnel to improve the quality and relevance of education in science and mathematics and to increase awareness of career opportunities requiring scientific and technical skills;

(3) the use of innovative methods, systems, materials, or other arrangements to encourage students to continue in and complete courses in science and mathematics and to consider careers in scientific and technical fields;

(4) student science training programs, research participation projects, and internships; and

(5) workshops for students and their parents and guardians to increase awareness and understanding of the importance of basic skills in science and mathematics and of career opportunities requiring scientific and technical skills.

(c) No grant may be made and no contract may be entered into under the provisions of this section unless an application is submitted to the Director of the National Science Foundation at such time, in such manner, and containing or accompanied by such information as the Director may require.

HIGHER EDUCATION PROGRAMS

SEC. 202. (a) The National Science Foundation is authorized and directed to support programs which demonstrate potential (1) to increase the participation of women in courses of study leading to degrees in scientific and technical fields, (2) to encourage women to consider and prepare for careers in science and technology, and (3) to provide traineeship and fellowship opportunities for women in science and technology, in accordance with the provisions of this section.

(b) Programs assisted under this section shall include, but not be limited to—

(1) the development of technologies, methods, and instructional materials to strengthen basic skills in science and mathematics, to improve the quality and relevance of scientific and technical courses, and to increase student awareness of career opportunities requiring scientific and technical skills, particularly at the undergraduate level;

(2) the training and retraining (including inservice training) of faculty, counselors, and other appropriate personnel to improve the quality, relevance, and presentation of scientific and technical curricula, and to increase student awareness of career opportunities requiring scientific and technical skills, particularly at the undergraduate level;

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(3) the award of traineeships and graduate and postgraduate fellowships;

(4) projects to encourage promising students enrolled at institutions of higher education to continue in and complete courses of study leading to degrees in scientific and technical fields.

(c) No grant may be made and no contract may be entered into under the provisions of this section unless an application is submitted to the Director of the National Science Foundation at such time, in such manner, and containing or accompanied by such information as the Director may require.

(d) Recipients of traineeships and fellowships under clause (3) of subsection (b) of this section shall be paid such stipends (including such allowances for subsistence, health insurance, relocation expenses, and other expenses for such recipients and their dependents) as the Director of the National Science Foundation may prescribe by regulation.

CONTINUING EDUCATION PROGRAM

SEC. 203. (a) The National Science Foundation shall initiate a program of continuing education in science and engineering, with particular emphasis on the participation and needs of women, in order to enable persons who (1)

have been in the work force for at least three years at the time of selection under the program authorized by this Act, or (2) hold degrees in scientific and technical fields, or (3) have had their careers in science and technology interrupted for at least three years, to pursue courses of study designed to—

(A) enable such persons to render more valuable contributions to the Nation through the acquisition of new knowledge, techniques, and skills in other fields; or

(B) provide such persons with new knowledge, techniques, and skills in their special fields.

(b) The program developed under this section shall include but not be limited to—

(1) the development of special curricula and education techniques in cooperation with industry and academic institutions for continuing education in science and engineering; and

(2) the award of fellowships to enable persons eligible under subsection (a) to pursue courses of study which provide continuing education in science and technology.

(c) The Director of the National Science Foundation is authorized to make grants to, and to enter into contracts with institutions of higher education and other academic institutions, nonprofit institutes and organizations, and pri-

vate business firms, for the purpose of developing courses and curricula designed for continuing education in science and technology under this section.

(d) (1) The Director of the National Science Foundation shall allocate fellowships under this subsection in such a manner, insofar as practicable, as will—

(A) attract highly qualified applicants; and

(B) encourage the participation of women in careers in science and technology.

(2) The Director of the National Science Foundation shall pay to individuals awarded fellowships under this section such stipends (including such allowances for subsistence, health insurance, relocation expenses, and other expenses for such persons and their dependents) as the Director may prescribe.

(3) Fellowships shall be awarded under this section upon application made at such times and containing such information as the Director of the National Science Foundation shall by regulation require.

EVALUATION

SEC. 204. The Director of the National Science Foundation shall require that programs supported under this title include provisions for the development and use of standardized evaluation tools and mechanisms in order to determine

the long term impact on individuals of participation in programs authorized under this title.

TECHNICAL ASSISTANCE

SEC. 205. In carrying out the activities required by this title the Director of the National Science Foundation is authorized to make available technical assistance relating to the design and conduct of activities under this title.

TITLE III—PUBLIC UNDERSTANDING

PART A—INFORMATION PROGRAMS

CLEARINGHOUSE ON WOMEN IN SCIENCE

SEC. 301. (a) The National Science Foundation is authorized and directed to establish and operate a Clearinghouse on Women in Science. The Clearinghouse shall collect, analyze, and disseminate to the public information concerning activities in the public and private sector which encourage the full participation of women in science and technology. Such information shall include, but not be limited to—

(1) federally supported programs designed to encourage the advancement of women in science;

(2) job openings for women in scientific and technological positions in public agencies, business concerns, private nonprofit organizations, and educational institutions;

(3) programs to assure equal opportunity for women in science and technology;

(4) programs to improve science education and promote literacy in science and mathematics;

(5) internships, traineeships, scholarships, fellowships, doctoral and postdoctoral positions;

(6) opportunities for minority and handicapped women in scientific and technical careers;

(7) data on the status and number of women in scientific and technological positions, including, but not limited to, material gathered under titles II, III, and IV of this Act;

(8) research being conducted to increase the potential contribution of women in science and technology and to facilitate the participation and advancement of women in scientific and technological careers, and the results of such research, including, but not limited to, material gathered under sections 302 and 303 of this Act; and

(9) programs to educate and inform the public concerning the importance of the participation of women in science and technology.

(b) There is authorized to be appropriated the sum of $3,000,000 for fiscal year 1980 and for each of the nine succeeding fiscal years to carry out the functions of the

Clearinghouse specified in this section and in section 413 of this Act.

RESEARCH PROGRAM

SEC. 302. (a) The National Science Foundation is authorized and directed to conduct, directly or by way of grant or contract, a comprehensive research program designed to increase understandjng of (1) the potential contribution of women in science and technology and (2) means to facilitate the participation and advancement of women in scientific and technical careers.

(b) The program shall include studies leading to understanding and amelioration of problems confronting young women in the study of science and mathematics, and the impact of science and mathematics skills on the entry and advancement of women in technical and nonscientific fields,

DISSEMINATION

SEC. 303. Data collected and research conducted under sections 302 and 404 shall be made available to the public through appropriate dissemination mechanisms including the Clearinghouse on Women in Science established under section 301 of this Act.

MEDIA PROJECTS

SEC. 304. The National Science Foundation is authorized and directed to support projects designed to improve the scope, relevance, and quality of information available to

the public concerning the importance of the participation of women in careers in science and technology through the use of radio, television, journals, newspapers, magazines, and other media. In carrying out the provisions of this section, the Director of the National Science Foundation shall develop criteria which assign highest priority to proposals which emphasize innovative approaches, demonstrate potential for increasing public awareness of the contribution of women in scientific and technical fields, and which stress the importance of equal opportunity for women in careers in science and technology.

BOOKS AND INSTRUCTIONAL MATERIALS

SEC. 305. (a) The National Science Foundation shall identify books and instructional material which encourage girls and young women to study mathematics and science and to pursue careers in scientific and technical fields, and which stress the importance of equal opportunity for women in science and technology. In identifying books and instructional materials under this section, the Foundation shall assign highest priority to books and materials which—

(1) portray women in scientific and technical careers;

(2) encourage girls and young women to consider careers in science and technology;

(3) emphasize the need for mathematical and technical skills in a wide range of professions;

(4) present scientific and technical material in a manner responsive to the needs of girls and young women; and

(5) emphasize the equal ability and status of men and women in science and technology.

(b) Information concerning books and materials identified under subsection (a) shall be made available to the public through appropriate existing dissemination mechanisms, including the Clearinghouse on Women in Science established under section 301 of this Act.

(c) The National Science Foundation is authorized and directed to support the development of books and instructional materials which present science and mathematics in a manner consistent with the criteria established under subsection (a). Books and instructional materials developed under this subsection shall be considered for identification under subsection (a).

COMMUNITY OUTREACH

SEC. 306. (a) The National Science Foundation is authorized and directed to support community outreach activities with the potential to attract substantial numbers of young women and girls and designed to—

(1) emphasize the importance of equal opportunity in scientific and technical fields;

(2) stimulate the interest of girls and young women in science and mathematics; and

(3) encourage girls and young women to continue in and complete courses of study in science and mathematics.

(b) In carrying out the provisions of this section the National Science Foundation shall make grants to nonprofit organizations which sponsor community activities, including afterschool, weekend and summer programs, to enable such organizations to include programs related to mathematics and science in new or existing activities.

MUSEUM PROGRAMS

SEC. 307. The National Science Foundation is authorized and directed to make grants and enter into contracts with museums and science centers for the support of projects which demonstrate potential to interest and involve women. Such projects shall be designed to encourage the study and development of skills in mathematics and science, to emphasize opportunities for careers in scientific and technical fields, and to stress the importance of equal opportunity for women in science and technology.

PART B—AWARDS

ESTABLISHMENT OF EQUAL OPPORTUNITY IN SCIENCE AWARDS COMMITTEE

SEC. 311. (a) There is established the President's Committee for Equal Opportunity in Science Awards (hereinafter referred to in this part as the "Committee"), which shall be composed of thirteen members. The Committee shall make recommendations to the President and the Director of the National Science Foundation concerning the names of persons to receive the awards authorized in sections 312, 313, and 314 of this Act. In making such recommendations the Committee shall consider recommendations from the National Science Board and the Clearinghouse on Women in Science established under part A of this title.

(b) Each member of the Committee shall be appointed by the President and the membership shall represent a cross section of the physical, life and social sciences. At least two members of the Committee shall be nonscientists. At least seven members of the Committee shall be women, and at least three members shall be members of minority groups. In appointing members to the Committee, the President shall consider recommendations submitted by the Clearinghouse on Women in Science established under part A of this title.

(c) Members of the Committee shall be appointed to

serve for a three-year term, except that the terms of office of members first appointed shall expire, as designated by the President at the time of appointment, five at the end of one year, four at the end of two years, and four at the end of three years. Any member appointed to fill a vacancy occurring prior to the expiration of the term for which the member's predecessor was appointed shall be appointed for the remainder of such term. Members may be reappointed to serve one additional term of three years.

(d) Seven members of the Committee shall constitute a quorum, and any vacancy in the Committee shall not affect its power to function.

(e) The President shall designate one of the members of the Committee to serve as Chairperson.

(f) (1) Members of the Committee who are otherwise employed by the Federal Government shall serve without compensation but shall be reimbursed for travel, subsistence, and other necessary expenses incurred by them in carrying out the duties of the Committee.

(2) Members of the Committee not otherwise employed by the Federal Government shall receive compensation at a rate equal to the daily rate prescribed for GS–18 of the General Schedule under section 5332 of title 5, United States Code, including traveltime, for each day they are engaged in

the performance of their duties as members of the Committee, and shall be entitled to reimbursement for travel, subsistence, and other necessary expenses incurred by them in carrying out the duties for the Committee.

(g) The National Science Foundation is authorized to provide such additional assistance as may be necessary and appropriate to carry out the purposes of this section.

(h) The Committee, with the approval of the President, is authorized to establish such additional procedures and criteria as necessary to implement the provisions of this part.

DISTINGUISHED ACHIEVEMENT IN THE ADVANCEMENT OF WOMEN IN SCIENCE AWARD

SEC. 312. The President, upon the recommendations of the Committee, shall make twenty cash awards, of $25,000 each, to be known as the Distinguished Achievement in the Advancement of Women in Science Award (hereinafter in this section referred to as the "award"). The awards shall be made once each calendar year to the individuals, academic institutions, State or local public agencies, private nonprofit organizations or business concerns which have made an outstanding contribution in the past calendar year to the participation and advancement of women in science and technology. Each recipient of the award shall receive a suitable citation describing the achievements for which the award is presented.

MATHEMATICS AND SCIENCE INCENTIVE AWARD

SEC. 313. The Director of the National Science Foundation (hereinafter referred to in this part as the "Director") shall, upon the recommendations of the Committee, make not more than twenty cash awards of $10,000 each, to be known as the Mathematics and Science Incentive Awards, to schools which include one or more of grades seven through twelve and which have demonstrated a commitment to encouraging the enrollment of girls and young women in mathematics and science courses, in accordance with the provisions of this section. Awards shall be made to such schools which have demonstrated a substantial increase in the number of women enrolled in mathematics and science courses during the year immediately preceding the granting of the award. Such schools which enroll substantially more than the national average of women in advanced mathematics and science courses shall also be eligible for awards. The Mathematics and Science Incentive Awards shall be presented once each year.

(b) The cash awarded under subsection (a) shall be used by the recipients to establish or further programs which encourage the participation of women in mathematical and scientific careers.

(c) Each recipient of the award shall also receive a suitable plaque to commemorate the achievements on which

the award is based. The size and design of the plaques shall be determined by the Committee with the approval of the Director.

(d) The Director is authorized to establish such rules and regulations as are necessary to carry out his functions under this section.

VISITING WOMEN SCIENTISTS PROGRAM

SEC. 314. (a) There is established the visting women scientists program. The purpose of the program is to select women scientists who shall visit secondary schools and institutions of higher education in order to—

(1) encourage girls and women to consider careers in science and engineering and to prepare themselves appropriately for such careers;

(2) provide information to students, teachers, and counselors; and

(3) conduct lectures, seminars, informal discussions, and presentations concerning various aspects of scientific and technical careers for women.

(b) Each year, the Director, upon the recommendation of the Committee, shall name not less than thirty women from the government, industrial, private nonprofit, and academic sectors to be visiting women scientists. Each woman selected shall demonstrate the potential to fulfill the purposes of the program as described in subsection (a). At least one-half of the visiting women scientists named in a par-

ticular calendar year shall be women who have degrees in science and engineering which were conferred during the five-year period immediately preceding the date of their selection.

(c) (1) Visiting women scientists who are otherwise employed by the Federal Government shall serve without compensation but shall be reimbursed for travel, subsistence, and other necessary expenses incurred by them in carrying out their duties under subsection (a).

(2) Visiting women scientists not otherwise employed by the Federal Government shall receive compensation at a rate of $100 a day, including traveltime, for each day they are engaged in the performance of their duties under subsection (a) and shall be entitled to reimbursement for travel, subsistence, and other necessary expenses incurred by them in carrying out their duties under subsection (a).

TITLE IV—EQUAL EMPLOYMENT OPPORTUNITY

PART A—AGENCY RESPONSIBILITY AND REPORTING REQUIREMENTS

AGENCY RESPONSIBILITY

SEC. 401. (a) The head of each Federal agency, national laboratory, and federally funded research and development center which supports or conducts research and development in science and technology shall take appropriate action to—

(1) prevent discrimination against women in science and technology;

(2) increase opportunities for the employment and advancement of women in science; and

(3) encourage the participation of minority and physically handicapped women in scientific and technical careers.

(b) In carrying out the provisions of this section, the head of each such agency, laboratory, and center shall take action including, but not limited to, activities designed to increase the number of qualified women—

(1) in permanent scientific and technical positions at each appropriate GS level or other similar category;

(2) realizing opportunities for promotion;

(3) serving on peer review and advisory panels; and

(4) serving as principal investigators for research projects, grants, and contracts.

REPORTING REQUIRED

SEC. 402. (a) The head of each Federal agency which provides Federal financial assistance for research and development in science and technology which equals or exceeds $30,000,000 in any fiscal year and the head of each national laboratory and federally funded research and development center, shall report to the Congress annually, to the

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maximum extent possible through existing appropriate reports, concerning the employment status of women in scientific and technical positions, both at the agency, laboratory, or center and in agency, laboratory, or center supported research and development projects. The reports required shall include, but not be limited to, a compilation evaluation, and comparison, by sex and as a per centum of the total of—

(1) the number of persons in (A) permanent and (B) temporary scientific and technical positions, by GS level or other similar category;

(2) the average salary of persons employed in such scientific and technical positions;

(3) the number and type of promotional opportunities realized by persons in such scientific and technological positions;

(4) the number of persons serving on (A) peer review and (B) advisory panels dealing with scientific research and development activities; and

(5) the number of persons serving as principal investigators in agency, laboratory or center supported or conducted scientific research and development projects.

(b) The head of each Federal agency, laboratory, and center required to report under subsection (a) shall transmit

the data, compiled and evaluated, to the Director of the Office of Science and Technology Policy for use in the reports required under section 209 of the National Science and Technology Policy and Priorities Act of 1976.

(c) The head of each Federal agency, laboratory, and center is authorized to establish such rules and regulations as are necessary to implement the provisions of this Act.

DEFINITIONS

SEC. 403. (a) For purposes of sections 401 and 402—

(1) "Federal financial assistance" means any grants, loans, or contracts other than a contract of insurance or guaranty;

(2) "national laboratory" means Government directed research and development laboratories, as well as research and development laboratories funded at least in part by the Federal Government, except as provided in clause (3) of this subsection;

(3) "federally funded research and development center" means organizations which perform research and development exclusively or substantially financed by the Federal Government and which are administered by industrial firms, universities, and colleges, or other nonprofit institutions.

(b) The Director of the Office of Science and Technology Policy, in consultation with the Director of the Na-

tional Science Foundation, the Chairman of the Civil Service Commission and the Director of the Office of Management and Budget, shall establish the criteria for defining "scientific and technological positions" for the purpose of this part.

DATA COLLECTION PROGRAM

SEC. 404. (a) The Director of the National Science Foundation is authorized and directed to make an accurate accounting of the participation and status of women in all disciplines and job categories of scientific and technological fields in the public sector, private enterprise and academic institutions. The Director shall make and publicize such an assessment through the use of existing data collection, analysis, publication and dissemination programs and shall develop new programs, if necessary, in order to assure that a complete assessment of the participation of women in scientific and technological careers is made and publicized.

(b) The gathering and reporting of data pursuant to subsection (a) shall include an accounting and comparison, by sex, of the participation of women and men in scientific and technological positions in public agencies, business concerns, private nonprofit organizations, and educational institutions. The Director shall collect, compile, and analyze data concerning—

(1) the number of persons in (A) permanent and

(B) temporary scientific and technological positions by appropriate job category;

(2) the average salary of persons in such scientific and technological positions;

(3) the number and type of promotional opportunities realized by persons in such scientific and technological positions; and

(4) the number of persons serving as principal investigators in federally conducted or federally supported research and development.

(c) All data collected, compiled, and analyzed pursuant to the provisions of this section shall be made available to the public through new and existing dissemination mechanisms, including the Clearinghouse on Women in Science established under section 301 of this Act.

(d) Once each year, the Director of the National Science Foundation shall make a report on the data collected, compiled, and analyzed pursuant to this section. Such report shall be transmitted to the Director of the Office of Science and Technology Policy, the Attorney General, the Chairman of the Equal Employment Opportunity Commission, the Director of the Office of Civil Rights of the Office of Education of the Department of Health, Education, and Welfare and the Director of the Office of Contract Compliance of the Department of Labor.

(c) The Director of the Office of Science and Technology Policy shall include the data received pursuant to subsection (d) in the annual report submitted to Congress under section 209 of the National Science and Technology Policy and Priorities Act of 1976.

PART B—OPPORTUNITY PROGRAMS

FEDERAL GOVERNMENT TRAINING FOR THE ENCOURAGEMENT OF WOMEN IN SCIENCE

SEC. 411. The Civil Service Commission is authorized and directed to include in its training program for officials of appropriate Federal agencies, information and instructions relating to—

(1) the recruitment, retention, and promotion of qualified women scientists, engineers, and technicians;

(2) Federal programs designed to assist in assuring equal opportunity for women in science and technology;

(3) Federal laws requiring equal employment opportunity for women; and

(4) enforcement and compliance mechanisms available to assure full participation of women in scientific and technological fields.

CIVIL SERVICE REGISTERS

SEC. 412. The Chairman of the Civil Service Commission is authorized and directed to include in existing registers women qualified for and seeking scientific and tech-

nological positions. The Chairman shall take whatever action is necessary to assure that such registers are circulated to each Federal agency, national laboratory, and federally funded research and development center conducting research and development activities.

EMPLOYMENT REGISTER

SEC. 413. (a) The Clearinghouse on Women in Science established under section 301 of this Act shall establish an employment register. Such register shall include—

(1) a listing of qualified women seeking scientific and technological positions; and

(2) a listing of positions available in public agencies, business concerns, private nonprofit organizations and educational institutions.

(b) The Clearinghouse shall notify State and local scientific organizations, private nonprofit organizations, educational institutions, and business concerns that the register has been established and is available for use in filling scientific and technological positions and as a means of notifying the public of job opportunities in scientific and technological fields.

DEMONSTRATION PROJECTS

SEC. 414. (a) The National Science Foundation is authorized and directed to make grants to public agencies,

business concerns, private organizations, and individuals for activities to encourage employment and advancement of women in science and technology through—

(1) flexible work schedules and job sharing arrangements;

(2) eligibility for fringe benefits and the establishment of tenure for part-time employees;

(3) the removal of antinepotism employment conditions; and

(4) other similar arrangements, including day care which show promise of encouraging such employment and advancement.

(b) No grant may be made under this section unless an application is submitted to the Director of the National Science Foundation at such time and in such manner and containing or accompanied by such information as the Director determines to be reasonable and appropriate.

TITLE V—GENERAL PROVISIONS

AUTHORITY

SEC. 501. (a) Except as otherwise provided in this Act the Foundation shall, in carrying out its functions under this Act, have the same powers and authority the Foundation has under the National Science Foundation Act of 1950 to carry out its functions under that Act.

(b) Except as otherwise provided in this Act, the

Director of the National Science Foundation shall, in carrying out the functions of the Director under this Act, have the same powers and authority the Director of the Foundation has under the National Science Foundation Act of 1950 to carry out the functions of the Director under that Act.

DEFINITIONS

SEC. 502. (a) For the purposes of this Act the term—

(1) "Federal agency" means any such agency as defined in section 551 (1) of title 5, United States Code; and

(2) "State" means each of the several States and the District of Columbia; and

(3) "Foundation" means the National Science Foundation.

AUTHORIZATION OF APPROPRIATIONS

SEC. 503. There are authorized to be appropriated for the fiscal year 1980 and for each of the succeeding nine fiscal years, such sums, but not to exceed $25,000,000 in any fiscal year, as may be necessary to carry out the provisions of this Act.

Senator KENNEDY. We will start with Dr. Atkinson and then we will hear from the balance of the panel.

Then we will hear from our other witnesses as well.

STATEMENT OF DR. RICHARD C. ATKINSON, DIRECTOR, NATIONAL SCIENCE FOUNDATION, ACCOMPANIED BY DR. JAMES KRUMHANSL, ASSISTANT DIRECTOR OF MATHEMATICAL AND PHYSICAL SCIENCES AND ENGINEERING; DR. F. JAMES RUTHERFORD, ASSISTANT DIRECTOR FOR SCIENCE EDUCATION; DR. ELOISE E. CLARK, ASSISTANT DIRECTOR FOR BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES; DR. JACK T. SANDERSON, ASSISTANT DIRECTOR FOR APPLIED SCIENCE AND RESEARCH APPLICATIONS; DR. JOHN B. SLAUGHTER, ASSISTANT DIRECTOR FOR ASTRONOMICAL ATMOSPHERIC, EARTH, AND OCEAN SCIENCES; AND DR. HARVEY AVERCH, ASSISTANT DIRECTOR FOR SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS; AND DR. NORMAN HACKERMAN, CHAIRMAN, NATIONAL SCIENCE BOARD, ACCOMPANIED BY DR. GEORGE C. PIMENTEL, DEPUTY DIRECTOR, NATIONAL SCIENCE FOUNDATION; AND DR. ALEXANDER RICH, MEMBER, NATIONAL SCIENCE BOARD, A PANEL

Dr. ATKINSON. Senator Kennedy, I will follow your cue and also put my statement in the record. Your opening statement covers most of the points I would like to emphasize.

I would like to introduce the various Assistant Directors. You have met them before.

Dr. James Krumhansl, on leave from Cornell University. Dr. Krumhansl is Assistant Director for Mathematical and Physical Sciences and Engineering.

Dr. F. James Rutherford, on leave from New York University, Assistant Director for Science Education.

Dr. Eloise E. Clark, whom you have known for some time, Assistant Director for Biological, Behavioral and Social Sciences.

Dr. Jack T. Sanderson, whom you know from your State. He is Assistant Director for Applied Science and Research Applications.

Dr. John B. Slaughter, professor and head of the Applied Physics Laboratory, University of Washington. He is Assistant Director for Astronomical, Atmospheric, Earth, and Ocean Sciences.

Dr. Harvey Averch, Assistant Director for Scientific, Technological and International Affairs.

Senator Kennedy, that is all I will have to say at this time.

Senator KENNEDY. That is all.

Let us hear from Dr. Hackerman.

Dr. HACKERMAN. Senator Kennedy, I would like to leave this short statement for the record if you don't mind. It states the Board's position on and its involvement with this budget. Also it restates our commitment to strong support in basic science and our commitment to excellence in science education.

I would like to take this opportunity to introduce—I think that is not the proper word—Alexander Rich, Professor of Biophysics of MIT, to this hearing. Alex is a member of the National Science Board.

Also George C. Pimentel, Deputy Director of the Natonal Science Foundation, a chemist of note on leave from the University of California, Berkeley.

[The biographical sketches of Dr. Atkinson, Dr. Hackerman, Dr. Rich, and Dr. Pimentel, and the prepared statement of Dr. Atkinson and Dr. Hackerman follow:]

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

DR. 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 at 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 with experimental and theoretical analyses 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. The system is highly adaptive and depends on a mathematical representation of the student's learning process that is optimized using control theory methods. 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 American Academy of Arts and Sciences, the National Academy of Education, and the Society of Experimental Psychologists. 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.

Dr. Atkinson joined the Stanford University faculty in 1956 after military service in the U.S. Army. Except for three years at UCLA and one at the University of Michigan, he has been at Stanford ever since. He served as chairman of the Psychology Department from 1968 to 1973, and as a Dean in the School of Humanities and Sciences from 1973 to 1975. 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.

NATIONAL SCIENCE BOARD
WASHINGTON D.C. 20550

Dr. Norman Hackerman
Chairman
National Science Board

Dr. Norman Hackerman, president of Rice University, Houston, Texas, was appointed to the National Science Board by President Johnson in 1968 and was reappointed by President Ford in 1974. He was elected as Chairman by the Board in 1974 and reelected in 1976.

A chemist whose special research interest is in surface chemistry, electrochemistry, and corrosion, Dr. Hackerman was born in Baltimore, Maryland, March 2, 1912. He received an A.B. degree from The Johns Hopkins University in 1932 and a Ph.D. in 1935.

Early in his career, Dr. Hackerman was an assistant professor at Loyola College, Baltimore, a research chemist with the Colloid Corporation, and a chemist with the U.S. Coast Guard. Dr. Hackerman became an assistant professor at the Virginia Polytechnic Institute at Blacksburg, and later a research chemist with the Kellex Corporation in the Manhattan District Project.

In 1945, Dr. Hackerman began a long and distinguished career at The University of Texas, beginning as an assistant professor of chemistry and holding positions successively as an associate professor, professor, department chairman, director of the corrosion research laboratory, dean for research and sponsored programs, vice president and provost, vice chancellor for academic affairs, and president (1967-1970). In 1970 he became professor of chemistry and president of Rice University.

Dr. Hackerman's professional society memberships include the National Academy of Sciences, American Philosophical Society, Texas Philosophical Society, American Association for the Advancement of Science, American Chemical Society, Electrochemical Society, Faraday Society, National Association of Corrosion Engineers, the New York Academy of Sciences and Sigma Xi. He is editor of the Journal of the Electrochemical Society and has served as a member of the editorial board of Catalysis Reviews and the American Chemical Society Monograph Series. He has also served in an editorial advisory capacity with Electrochemical Technology and Corrosion Science.

He is president of the Independent Colleges and Universities of Texas and was a director of the Gordon Research Conferences. He was Palladium Medalist of the Electrochemical Society, 1965; was Joseph J. Mattiello Memorial Lecturer, Federation of Societies of Paint Technology, 1964; and recipient of the Whitney award, National Association of Corrosion Engineers, 1956. He is an honorary member of the Electrochemical Society and the American Institute of Chemists.

ALEXANDER RICH

BIOPHYSICAL CHEMIST

Born Hartford, Connecticut, November 15, 1924; married 1952; children--4.

A.B., Harvard, 1947; M.D.,Harvard, 1949.

Resident fellow chemistry, California Institute of Technology, 1949-54; chief of section, physical chemistry, National Institutes of Health, 1954-58; associate professor of biophysics, Massachusetts Institute of Technology, 1958-61, professor, 1961--; visiting scientist, Cavendish Lab, Cambridge, England, 1955; member, postdoctoral fellowship board, National Institutes of Health, 1956-58; career award committee, 1964-67; Guggenheim fellowship,1963; member, visiting committee, biology department, Yale University,1963; United States National Committee for the International Organization of Pure and Applied Biophysical and Exobiological Committee, Space Science Board, National Academy of Sciences, 1964-66; member, visiting committee, biology department, Weizmann Institute of Science, 1965-66; mem. corp., Marine Biological Laboratory, Woods Hole, 1965--; member, Lunar and Planetary Missions Board, NASA, 1968-71, Life Science Committee, 1971--; Biology Advisory Committee, Oak Ridge National Laboratory, 1972--; United States Navy, 1943-46.

Member, National Academy of Sciences; American Chemical Society; Biophysical Society; American Crystallogical Association; fellow, American Academy of Arts and Sciences; American Society of Biological Chemistry. Molecular structure of biological systems; x-ray crystallography; protein chemistry; nucleic acid chemistry; polymer molecular structure; information transfer in biological systems; mechanism of protein synthesis.

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Excerpt from AMERICAN MEN AND WOMEN IN SCIENCE, 12th Edition, Vol. 3.

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

GEORGE CLAUDE PIMENTEL

Deputy Director

Dr. George Claude Pimentel, Deputy Director of the National Science Foundation (NSF) was confirmed by the Senate to that post on September 28, 1977. He was sworn in by Dr. Frank Press, the President's Science Advisor, on October 7, 1977.

Dr. Pimentel is widely known not only for his scientific contributions but also for his excellence in teaching while on the faculty of the University of California at Berkeley where he had been a full professor since 1959 before coming to the NSF.

Dr. Pimentel's research in the fields of infrared spectroscopy, chemical lasers, molecular structure, free radicals, and hydrogen bonding have drawn wide acclaim. Dr. Pimentel's research has involved the application of spectroscopic methods to study unusual chemical bonding. A major contribution was the invention and exploration of the method of matrix isolation for the examination of the properties of highly unstable molecules. This involves stabilization of such molecules in a matrix of frozen rare gas, such as argon, at a very low temperature so that their properties and reactivity can be more fully determined by infrared, ultraviolet, or microwave techniques. Application of this matrix isolation method led to the discovery of a variety of unusual and highly reactive molecules that could not otherwise have been detected.

His development of fast techniques for infrared spectroscopy are especially useful in the compositional analysis of planetary atmospheres. An instrument he developed was used in the 1969 Mariner interplanetary vehicle to get information on the composition of the atmosphere of Mars. It also is being used to identify chemicals present in smog.

During studies of photochemical reactions, Dr. Pimentel and his students discovered the first chemical laser. This required the development of methods of producing chemical species in an excited state by chemical reactions and then inducing stimulated light emission by these excited molecules. This process has been used in a wide variety of systems, both for the study of the excitation states of chemical molecules and for the production of intense, sharply defined light.

An enthusiastic teacher, Dr. Pimentel had lectured in freshman chemistry at Berkeley during his last six years there before coming to his Washington position. He is coauthor of seven books, four of which are textbooks, and three of which concern areas of his research. He has

long been concerned with the quality of teaching in secondary schools and was editor of the CHEM Study project which was devoted to the development of a new high school chemistry textbook. The text, titled Chemistry--An Experimental Science, was published in 1963 and is now used in high schools in every state. More than 950,000 copies have been sold, with all royalties going to the U.S. Treasury and the text has been translated into 13 languages, including Russian. Dr. Pimentel also has collaborated in the production of several chemistry educational films, including one which concerns the impact of science on the quality of life.

In 1968, Dr. Pimentel received the Campus Teaching Award at the University of California, granted to five professors each year on the basis of student nominations and evaluations. His name is listed in the 1970 edition of Outstanding Educators of America. He received the American Chemistry Society California Section Award in 1957 and that society's Precision Scientific Award in 1959. He was elected a member of the National Academy of Sciences in 1966 and two years later he was elected a Fellow of the American Academy of Arts and Sciences.

In 1971 he received the Manufacturing Chemists Association College Chemistry Teacher Award; in 1972 he earned the Dickenson College Priestly Memorial Award; and in 1974 he won the Spectroscopy Society of Pittsburgh Award. He has earned many other honors and awards for his scientific contributions. He was awarded a Guggenheim Fellowship in 1955.

Dr. Pimentel was selected to participate in the 1973-74 U.S.-Japan Eminent Scientist Exchange Program and was an Alexander von Humboldt Senior Scientists Awardee in 1974.

Born May 2, 1922, in Rolinda, California, Dr. Pimentel received a bachelor of arts degree from the University of California at Los Angeles (UCLA) in 1943. After a year on the Manhattan Project at the Berkeley campus and more than two years in the Navy, he returned to Berkeley and completed his graduate work. After earning a Doctor of Philosophy degree in 1949, Dr. Pimentel was appointed a member of the faculty at Berkeley and 10 years later he had attained the rank of professor.

From 1966 to 1968 he served as Chairman of the Chemistry Department. He was a member of the Lunar and Planetary Missions Board, an advisory unit to the National Aeronautics and Space Administration (NASA), from 1967 to 1970.

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STATEMENT OF DR. RICHARD C. ATKINSON

DIRECTOR OF THE NATIONAL SCIENCE FOUNDATION

BEFORE THE

SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH

COMMITTEE ON HUMAN RESOURCES

U.S. SENATE

APRIL 10, 1978

Mr. Chairman and Members of the Committee:

I am pleased to present the National Science Foundation's authorization request for FY 1979. The total program is $940.9 million, consisting of $934.0 million in New Obligational Authority (NOA) and $6.9 million in proposed FY 1978 deferrals. The $934 million consists of funds for three appropriations: $850.4 million for Research and Related Activities, $77.6 million for Science Education Activities, and $6.0 million for the Special Foreign Currency Appropriation. The FY 1978 deferral of $6.9 million is in Applied Science and Research Applications and brings the total for Research and Related Activities to $857.3 million.

The total program is 8.8 percent above the FY 1978 Current Plan. This increase is needed to maintain the scientific strength of the Nation through the support of fundamental research activities, to encourage the application of basic scientific and engineering knowledge to the solution of significant problems, and to strengthen science education. The request includes $755 million for support of basic research, an increase of 9.7 percent above the FY 1978 figure.

Research Investment and Economic Progress

As you know, President Carter's first budget to the Congress provides real growth for basic research. The Administration is emphasizing basic research in both NSF and other government agencies with major research activities. The long-term benefit of basic research that the President emphasized in his budget message is its importance to the continued vitality of our economy. I would like to refer to some economic research on this matter and then summarize the major points of the Foundation's FY 1979 1979 budget request.

Studies funded by the NSF and others have provided evidence that R&D is a very significant contributor to economic growth. For example, a recent study by Data Resources, Inc. indicates that over the past three decades high-technology industries,

— have grown almost three times as fast,
— increased their productivity twice as fast,
— expanded their employment nine times as fast,
— and, at the same time, have raised their prices only one-sixth as much as the low technology industries.

High technology industries have achieved these results through a vigorous R&D effort, with primary emphasis on the development and applied end of the R&D spectrum. In the long run, however, successful, applied research and development depends on the detailed knowledge and understanding of the physical world, that is provided by basic research. Because many of the benefits of basic research go to society as a whole and not to an individual firm, it is both appropriate and necessary for the Federal Government to

provide more support for basic research.

Thus the record provides a strong case for maintaining and enhancing the strength of our basic research effort. If we do not do this, then over the long run this Nation is going to run short of new ideas, new knowledge, new technologies, and, in turn economic and social progress.

Much of the research supported by the Foundation has implications with respect to long-term economic advance as well as other forms of human betterment.

Mathematical and Physical Sciences and Engineering

We are requesting $268.3 million for MPE, an increase of $22.3 million over the FY 1978 level. This program supports the core of the Nation's basic research in physics, chemistry, materials, mathematics, computer science, and fundamental engineering studies.

Basic research in chemistry is broadened. Metal cluster chemistry and entirely new uses of lasers in chemistry are being supported; both are of great importance — for intrinsic scientific interest and their relevance to industrial processes. Research will be increased on submicron structures, essential for further developments in larger scale integrated electronic circuits and also of potential use in magnetic memory systems, biomedical monitoring systems of subcellular dimensions, and optical communication systems. If the submicron resarch efforts are as successful as we hope, the capacity of the best current small computers can be multiplied by a factor of 100,000, and stunning advances in miniaturized instruments will allow entirely new studies in chemistry, biology, medicine and other areas.

We continue to emphasize instrumentation and major facilities. This includes

continuation of support for the conversion of the Cornell Synchrotron to colliding beam capability for advanced research in elementary particle physics, and for the development of improved synchrotron radiation facilities at Stanford, and the University of Wisconsin.

Thus, though the instrumentation thrust in our FY 1978 budget provided some catch-up, it does not meet instrumentation needs for future years. The substantial additional research potential provided by new instruments and facilities requires continued funding for these tools of research.

Astronomical, Atmospheric, Earth and Ocean Sciences

We are requesting $227.3 million for Astronomical, Atmospheric, Earth and Ocean Sciences, an increase of $17.2 million over the FY 1978 level. This provides for research in all of the scientific areas mentioned as well as for the Arctic Research Program.

In astronomy, construction of the world's largest radio telescope, the Very Large Array, located near Socorro, New Mexico will continue. Increased scientific observations are plannned in FY 1979 with the partially completed VLA.

Climate research will be emphasized, involving solar astronomy, earth and ocean sciences as well as atmospheric research. Research on atmospheric chemistry and on severe storms also will be emphasized.

In earth sciences, planning and evaluation of a proposed new ocean drilling program will be substantially expanded. A high priority for the program would be to drill in the continental margins. This would provide improved understanding of the structure, composition and movements of the earth's crust. It would also provide information on the location and extent of natural resources including oil.

Because of an apparent misunderstanding reflected in the report of the House Authorization Committee I want to clarify and place in perspective this NSF proposal. The $4.2 million requested for FY 1979 is for planning and evaluation of a program that may be presented to the Congress in FY 1980. The FY 1979 amount is probably less than 1% of the cost of a ten-year program. The major elements of the $4.2 million are $2.1 million for design and systems integration studies of a 12,000 foot marine riser and subsea well control system. This system is required for environmentally responsible drilling in locations where striking oil or gas would be a possibility. An additional $900,000 is for engineering and cost studies for conversion of the government-owned Glomar Explorer into an advanced drilling ship. One million dollars is for geophysical surveys. These surveys would provide a framework for selection of the best future drilling sites. The remaining $200,000 is for scientific and technical review and program formulation. Each of the planning and evaluation elements above provides part of the information needed for a decision on the potentially valuable, but expensive ocean margin drilling project. Even if the decision made is not to go ahead with such a project, most of the study results would be useful either for government or privately supported deep ocean exploration. Since the limitation in the House report of planning and evaluation funds to $1.0 million would delay the project for one year at a minimum, I request that the committee authorize the full $4.2 million requested.

Earth sciences support also includes increased earthquake research. In addition, an increase for geochemical instrumentation will facilitate research related to the migration and location of ores.

Funds are included for construction of a coastal research ship needed for oceanographic research on the continental shelf. This a replacement ship. It will not increase the total of 29 ships now in the academic research fleet.

U.S. Antarctic Program

We are requesting $50.7 million for the U.S. Antarctic program, an increase of $2.5 million. NSF is responsible for all U.S. activities in Antarctica. This includes the management and support of four year-round research stations and the ships and aircraft required to carry out the research program. The increase will allow additional research efforts on antarctic marine life, on the antarctic ice sheet, and on atmospheric phenomena.

Biological, Behavioral, and Social Sciences

We are requesting $158 million, an increase of $15.8 million over the FY 1978 level, to support research on physiology, cellular, molecular and environmental biology; neural and other behavioral sciences; and the social sciences.

Major emphasis will be placed on research activities in neurosciences where through new techniques and equipment we can for the first time address fundamental questions about the central nervous system — particularly on how sensory systems operate on incoming signals and the "information processing" that occurs in the central nervous system. Other behavioral science areas which will be emphasized are archaeology, physical anthropology, and social anthrocological studies of contemporary cultures.

In the social sciences, development of new knowledge on the workings of economic and social institutions will be facilitated through larger scale studies and

improved data resources. A continued effort to develop a system of social indicators and to improve survey methodology is planned.

In the biology programs, instrumentation needs for cellular and molecular biology continue to be acute, and in addition there is an increased demand for facilities in which to do recombinant DNA research. Emphasis on biochemical, cellular, and physiological research in the plant sciences will continue.

The environmental biology programs will support important research on nutrient cycles, including the role of the terrestrial biomass in regulating the carbon dioxide content of the atmosphere.

Applied Science and Research Applications

We are requesting $67.0 million in New Obligational Authority for Applied Science and Research Applications, an increase of $9.1 million. With the FY 1978 deferral of $6.9 million, the program will total $73.9 million.

NSF recently completed a year-long assessment of the former Research Applications Directorate. The new ASRA program is the direct result of that assessment. The combination of focused programs, unsolicited applied research and new management procedures will improve coordination between basic and applied research at the Foundation and will accelerate the transfer of basic research into applications.

Of the increase for ASRA, $8.3 million is a part of the overall Federal program for earthquake hazards mitigation. This includes research on siting of structures and their earthquake-resistant design as well as policy studies.

Increased emphasis is also placed on research focused on toxic chemical hazards, community water management, and alternative biological sources of materials.

A $1.0 million increase is provided for a competitive program of unsolicited applied research.

A new Integrated Basic Research program is proposed as an organizing and planning technique to accelerate the advancement of promising areas of basic research relevant to existing or emerging major problems.

Support is continued for activities to strengthen the utilization of science and technology in meeting the problems of State and local government.

Scientific, Technological and International Affairs

We are requesting $24.3 million for Scientific, Technological and International Affairs, about the same amount as in FY 1978. It is important to note that the total represents the net of several increases and decreases in STIA programs.

Funding for international activities is increased to support scientific cooperation with Western Europe and developing countries. Support for the United Nations Conference on Science and Technology for Development will be decreased, since U.S. preparations will be nearing completion in FY 1979. The Information Science budget request has been reduced reflecting the elimination of user education and market studies and greater focus on information science. Funds are provided to expand analysis of data on science resources and to support policy research and analysis studies on the role of R&D in economic growth and other national priority areas.

These activities are intended to strengthen the U.S. scientific enterprise by providing increased knowledge and analyses of that enterprise, and by increasing the availability of scientific and technological information both within this country and from other countries.

Science Education Activities

The Foundation has the legal mandate to strengthen science education at all levels. For this appropriation we are requesting $77.6 million, an increase of $3.6 million over the FY 1978 level.

We are proposing to continue the Foundation's programs of support for the Nation's most talented students to pursue graduate study in science.

Increased support is planned for programs which provide a new emphasis on research related to the learning process (particularly school learning and instruction) and on improvement of science instruction at the junior high school level.

Strong support continues for programs which focus on improving the quality of science instruction at 2-year and 4-year colleges and undergraduate components of universities.

Support is increased for activities that facilitate greater understanding between scientists and nonscientists on ethical, social, and public policy issues connected with science and technology.

There is also a significant increase in support directed at stimulating more participation in the study of the sciences by minorities, women, and the handicapped. This includes support for the establishment of additional

Resource Centers for Science and Engineering designed to promote increased participation in science and engineering careers by minorities and persons from low income families.

These education programs complement NSF support of research in contributing to the future strength of U.S. science.

Special Foreign Currency Program

We are proposing a $6.0 million Special Foreign Currency Program, a $600,000 increase over FY 1978. This provides additional science support for the Joint Commissions for Economic Cooperation that the U.S. has established with Egypt and India.

Program Development and Management

We are requesting $54.8 million for PD&M, an increase of $2.8 million. Significant items in the increase are space rental, and data processing equipment. The request provides for no increase in the number of staff positions.

Geographical Distribution

In pursuit of one objective stated in the NSF Act — to avoid undue concentration of research — the Foundation proposes to undertake a geographical experiment. In this experiment, the NSF would provide planning grants in selected states. With these grants, an ad hoc committee would analyze the science and technology programs within the state and recommend steps to improve them. The NSF program would require some cost sharing and it would be carefully monitored and evaluated. About $1.0 million from the FY 1979 funds requested for Research and Related Activities would be used for this experiment.

The Need for Greater Industry/University Cooperation

In the opening part of my statement I discussed the importance of research to economic advance. If the United States is to meet foreign competition and if its industries are to provide jobs for American workers, I am convinced that there must be closer cooperation between academic and industrial researchers. To this end, in FY 1979 NSF plans to expand support of cooperative university-industry projects in the area of basic research. Proposals, jointly submitted by a university or college and an industrial firm, would be evaluated by the peer review process. Both universities and industries welcome such cooperative projects and the Nation's research programs will benefit from them in both the near and long term.

Conclusion

In this statement, Mr. Chairman, I have tried to emphasize the importance of the NSF program to the long-term scientific, technological and economic strength of this country. In discussing specific programs, I have pointed to the need for improvement of instrumentation and facilities. The FY 1978 increase for this purpose was not a one-time solution of this continuing need. In the earth sciences, restoration of full planning and evaluation funding for a possible ocean margin drilling project is of real importance to avoid costly delay if the decision is eventually made to proceed with such a project.

The review of NSF's program shows, I think, that it is a key investment in the Nation's future and the well-being of its citizens.

We shall be happy to answer questions that you or other members of the subcommittee may have on our authorization request.

STATEMENT OF DR. NORMAN HACKERMAN
CHAIRMAN, NATIONAL SCIENCE BOARD
BEFORE THE SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH
COMMITTEE ON HUMAN RESOURCES
UNITED STATES SENATE
APRIL 10, 1978

Mr. Chairman, Members of the Subcommittee:

It is a pleasure for me to be here today to present the views of the National Science Board on the Foundation's authorization request for fiscal year 1979. Through its planning process, the Board has been extensively involved in the formulation of the proposed program. Thus, it includes the priorities we feel are important, and are essential for the maintenance of a healthy scientific enterprise in this Nation, i.e., strong support of basic science and a strong commitment to excellence in science education. The current request reflects that and we cannot urge it too strongly. The details of the proposed support will be brought out in these hearings. I would now like to take a moment to report briefly on a couple of the recent activities of the National Science Board.

The National Science Board Forums: An Experiment with Public Participation in Science Policy Formulation.

The regional forums of the National Science Board were undertaken as an experiment in public participation in science policy formulation, as directed by the Congress in 1975.

At each of these meetings, which were designed to obtain public input into the programs, policies, and priorities of the Foundation, several Members of the Board and I have 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.

The Board has now conducted five such meetings, and the sixth will be held in Philadelphia on May 16, 1978. A planning meeting, to select the regional issues for discussion in May, was held last month in Boston. Also, at that time, two members of the Board, Dr. Lloyd M. Cooke and Dr. Alexander Rich, heard the views of a number of citizens in that area about three current concerns of the Board. These concerns are the supply and demand of younger researchers; careers in science for women, minorities, and the handicapped; and, alternative performers of research.

An interim report on the first three forums has been prepared, and copies have been forwarded to the Congress, the Office of Technology Assessment, and the Office of Science and Technology Policy. Nearly 200 individual suggestions or ideas emerged at these first meetings, and they are included in the report. Some of the suggestions relate to current NSF programs, some would require new NSF programs or a change in

policy, and the remainder appear to be more appropriate for other Federal agencies. These were sent on for transmission as feasible.

The comments at the last two forums in the sessions concerning Board issues are of particular interest to us. For example, we have heard useful suggestions for new or expanded programs to increase the participation of Blacks, Chicanos, and other minorities, women, and the handicapped in science and engineering. Many of these same ideas are included among the provisions of S. 2550, the bill recently introduced as the Women in Science and Technology Equal Opportunity Act.

These and other suggestions made at the last three forums in this series of six will be included in a final report on this experiment in public participation.

From our experience to date, several conclusions may be drawn about citizen participation in science policy formulation. First, some part of the public does want to speak out on science-related issues. The forums provide a mechanism by which they can be heard, and their views conveyed to several parts of the Federal Government. Second, the public represented by the participants, from a variety of backgrounds and interests, is sophisticated in its knowledge of regional problems and their relationship to science. Third, forum participants feel that the public should be involved in setting priorities in problem-related scientific research and in science education. They are

inclined to leave basic research priorities to the scientific community. Finally, participants have generally positive feelings about science and scientific research. The whole experience indicates a continuing need for scientists to communicate clearly and effectively with various publics.

The Board is now examining the objectives of the forums, their costs and accomplishments, and considering if, and in what form, it should continue its efforts with public participation.

Increasing Industrial Participation in NSF-Supported Programs

Support of research by the Foundation in nonacademic institutions has been a matter of concern to the Board and the Foundation for some years. The Federal role in support of industry was examined in the fourth annual report of the National Science Board, The Role of Engineers and Scientists in a National Policy for Technology. Some aspects of the needs for research in industry were addressed in the eighth NSB annual report, Science at the Bicentennial. Continuing special attention is given to industrial research and development in the Board's science indicators series.

A little over a year ago the Foundation transmitted to the Congress a report, Research in Industry: Roles of the Government and the National Science Foundation. This report reflected the views of the National Science Board at that time. During the past year the Board has continued to study

this matter and, as indicated above, has discussed it at some of the regional forums.

At the 195th Meeting in January, the Board approved a plan presented by the Director to develop a stronger national program in scientific research by increasing industry-university cooperation and mutual understanding. The plan proposed increased support for NSF programs involving cooperative research projects. The expanded activity will focus on fundamental research as contrasted to technological innovation and will require active participation by both industry and the universities.

The National Science Board has also unanimously decided that the Foundation's policy on support of basic research by private profit organizations should be modified as indicated by the following language to be incorporated in the Grants for Scientific Research booklet:

> The National Science Foundation welcomes unsolicited proposals from commercial firms. But it also wants to avoid substituting Federal support for normal commercial investment in research or compromising the vitality of research in educational institutions, where research makes a special added contribution to science education. Thus, unsolicited proposals for scientific research project

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support from commercial firms may be funded where: (a) the project is of special concern from a national point of view; (b) special resources are available in industry for the work; or (c) the project proposed is especially meritorious.

The National Science Foundation is also particularly interested in supporting research projects that couple the research resources and perspectives of industry with the research resources and perspectives of universities. It therefore especially welcomes proposals for cooperative research projects involving both universities and industry.

This language will be reflected in all National Science Foundation policy documents.

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NSF Proposed Program for FY 1979

As mentioned earlier, the National Science Board believes the Foundation's proposed program for fiscal year 1979 is well balanced. It has the Board's endorsement. I urge approval of the full authorization of $934 million.

Senator KENNEDY. Thank you very much for coming. As I understand, the Board has sent to the President recommendations for members of the Science Board to take office later this year. Is that correct?

Dr. HACKERMAN. That is correct.

Senator KENNEDY. What could we expect in terms of memberships? What considerations are being given to scientists among new members?

Also, did you give any thought to the inclusion in there of high school science teachers?

Dr. HACKERMAN. The list of people whose names we sent to the President include people in public life. It includes industrialists. I do not believe that it includes any who are particularly involved with high school science or junior college science right now.

The list contains a few functioning scientists as has been the case in the past; and, it has a geographical distribution as well as a distribution of disciplines.

We hope that the names we sent over will be of use, but I do not know who will be proposed finally.

Senator KENNEDY. How long ago did you send them over?

Dr. HACKERMAN. I would say September or October.

Senator KENNEDY. Last September or October?

Dr. HACKERMAN. Maybe a little later than that, maybe November. It was in the fall anyway.

Senator KENNEDY. What is the latest on that that you have heard? Have they given you any indication?

Dr. HACKERMAN. The indication is that nominations will be sent up within the next couple of weeks.

Senator KENNEDY. Can you elaborate a little bit in terms of the types of individuals which are included? Not getting into the names, but what are the skills, and what are the achievements or accomplishments or interests which these people have? Can you break that down?

Dr. HACKERMAN. Some are involved in engineering, both in the administration of university engineering and in the functioning area of engineering.

There are some physicists.

There are one or two people who have been in public life and have had no scientific background per se.

There are a couple of chemists, biologists, social scientists. And, one is an anthropologist.

I believe there is a mathematician in the group. I don't remember that there are particularly any large numbers of university presidents this time [laughter].

There were 24 names, by the way, sent forward. As you know, there are 8 appointments to be made.

Senator KENNEDY. I was looking at your "Science Indicators," your publication, I think probably 3 or 4 weeks ago, and read through it about a year ago as well.

How do you translate that into your own kind of policy, or do you?

What value does it have in terms of directions of the National Science Foundation or in terms of bringing this kind of material to the attention of the White House Science Adviser or to the Office of Management and Budget?

Dr. HACKERMAN. One place where it specifically has made a considerable impact is the question of innovation in industry and that

involves research and development in industry. That has caught outside attention and apparently will be a subject of considerable concern for a while.

Another area is quite clearly the question of whether the scientific enterprise has sufficient nourishment to carry on its current, effective functioning state.

Dr. ATKINSON. The Science Foundation sees itself in a coordinating role, being cognizant of other agencies, agencies who may use the Science Indicators and Science Resources Study.

It is our job to balance our programs so that they offer an appropriate dovetailing of the Federal effort. We work closely with Dr. Press both in planning and his input with other agency plans.

Senator KENNEDY. I was wondering about the interest of the public in terms of science and technology. It is an elaborate and enormously interesting view. It is an analysis unlike any other kind of reviews or studies and surveys which have taken place. It obviously refers to other surveys that are taking place, but it really adds some very special dimension and, as I think this has been reflected and as there had been some change in the public's concern and areas of interest in science and science policy, I am wondering what sort of impact this has in terms of the National Science Foundation and its own priorities?

It is just a study that is quite interesting reading for a number of people, or do you try to at least have some kind of input in terms of your own policymaking process?

Dr. HACKERMAN. The answer to the last question is a simple "Yes." The fact of the matter is that the indicators we started out with were based on the proposition that we had to have a series of them in order for them to be of any value. Standing alone, they did very little good. The converging trends have been the important thing.

Second——

Senator KENNEDY. This is the third one?

Dr. HACKERMAN. Yes; and the fourth is in preparation now.

Second, we knew that the input indicators we began with in 1972 would be less effective than output indicators. The whole science indicators operation has been pointed toward good output indicators of the impact of science. But, the development of output indicators is difficult.

There have been improvements in each of the three science indicators reports. You will find a very large improvement in the fourth one. We started out with little analysis. We tried to find something that indicated the strength or the weakness of the enterprise. Our analytical activity has increased more than proportionately with each successive issue and, again, I believe the fourth one will be a watershed issue because I believe our output analysis and output activity will be better.

Dr. RICH. I would like to enforce what Dr. Hackerman has said. I want to point out the way the indicators have been received by the press. I know that several science reporters from the New York Times. and other publications have asked me in advance when they will come out.

You may have seen the rather lengthy analysis that was published, with the second issue, "Science Indicators—1974."

I think that an analysis of the most recent issue, Science Indicators 1976, is under way now.

An area that I think is very important is the international indicators of sciences and technology. It shows considerable strength that we have in many areas and rather strikingly, some areas of weakness. I think those comparisons are quite valuable and serve to give us a measure of understanding about where we are going relative to where other nations are going.

Senator KENNEDY. When does you next report come out?

Dr. ATKINSON. It is scheduled every 2 years, so it is a continuing process.

Dr. HACKERMAN. It is scheduled for 1979.

That [indicating] is a 1978 science indicators which is scheduled for publication March of 1979.

Senator KENNEDY. I am interested in what you make up and how it either does or does not reflect—or how the results of this or the analysis of it or the trends of these reports are impacted.

I am sure there are a number of things which people already know and are working hard on.

Can we talk a little bit about this?

You are preparing your annual report for the White House office. Tell us a little about your relationship with the President's science adviser. What have you been called on to do?

What sort of services have you made available?

How is the relationship working?

Dr. ATKINSON. We are asked to provide two reports, an annual 1-year report which is the state of science. There are several parts, but in essence it is a look at where we are with regard to some of the key issues.

The second report we produce every other year. It phases with the science indicators. It is supposed to be a 5-year outlook at special opportunities and problems. We use the report to highlight that activity.

Senator KENNEDY. This is the first time you have been asked to prepare it.

Dr. ATKINSON. Yes, this is part of the original legislation that established the White House Technology and Policy Office.

Senator KENNEDY. Both the reports are due in May, both the annual report and the 5-year report is also due in May?

Dr. ATKINSON. No, the first issue of the 5-year report probably will be a year from this fall, about 13 or 14 months from now. The first annual report will be out late this spring.

Senator KENNEDY. In the fashioning of this report, is there any way you can give us a summary of what the conclusions are?

Dr. ATKINSON. No, there will be an array of conclusions in the 1-year report. And in the 5-year report, we will be identifying certain key areas and trying to concentrate on them because of their momentary and long-term importance.

Those areas will fluctuate from one report to another. Over the years, the reports should capture most of the key issues and raise them to the consciousness of the scientific community and the public.

Senator KENNEDY. In your working outline of the science and technology report—you are familiar with that?

Dr. ATKINSON. Yes, I am.

Senator KENNEDY. I guess the one area which is most precisely defined in the posture statement is the agricultural area; is that correct?

Dr. ATKINSON. What you are referring to, Senator Kennedy, is the annual report. There is a policy statement from the science adviser which will be the report's second section. It will give his overview of the state of science from the viewpoint of OSTP. The remaining issues include new research and development initiatives, other strategies, and a look at future initiatives.

We want to get input from the public and from the Congress on issues that they deem particularly important for future study.

Senator KENNEDY. At least in this initial one, agriculture is perhaps the only non—how would you define it? The only nonspecific scientific subject matter that appears, at least from looking through this in a very preliminary way?

Am I correct?

Perhaps climate research, but agriculture is the——

Dr. ATKINSON. That is an early summary of the posture statement. I have just seen it for the first time.

I know that agricultural research is of key interest to the science adviser, particularly a stronger thrust in basic research related to the plant sciences. He is planning to emphasize that.

Climate research is listed here too. That will certainly be key. There is also the breeder reactor and the Space Shuttle, and then the nonfuel mineral policies.

Senator KENNEDY. Well, I am just wondering how you set the kinds of priorities that you do in terms of why some go on and some go off in terms of this.

Dr. ATKINSON. Senator, that is a key issue. This is the first report; we have not had the kind of input we would like. The point of the final section of the annual report is to list some of the options we believe are important for future consideration.

By listing those options and seeking input from many sectors, we expect to find the specific topics to be taken up. The last section of the annual report is really an outreach to try to provide a further input from a wider source.

Senator KENNEDY. You cannot do the whole landscape. It will will have to be selected. It will be useful for the criteria being used, and the kind of input that you want.

I think it would be of some value to try to find out what the criteria are that you are using, and what sort of input you have. It will have to be a balanced factor, but I think that there are clearly a variety of different issues. They have an important impact that should or should not be considered in terms of the total review.

Maybe that is going to be done in terms of this report. But in any event, we will have a chance to evaluate this.

So you are getting that. Can you supply what else is the basis of the relationship now with the White House Science Office?

Dr. ATKINSON. We have a close working relationship through the enabling legislation. We are responsible for providing the science adviser with long term research and policy issues.

We have several activities in progress in that area. We have had close working relationships in both longer term policy issues, and in shorter term coordination efforts. The working relationship has been extremely satisfactory.

Dr. HACKERMAN. Senator Kennedy, the Board also has had good input.

Dr. RICH. You know, Dr. Press was a member of the Board for 6 years, and knows many of us intimately.

Senator KENNEDY. That was certainly the sense and expectation today. But I think it is important that it be stressed, and that it be reflected in terms of this process, because I think it is one of the most important features of strengthening our whole scientific input in terms of governmental decisionmaking.

Dr. PIMENTEL. Our interaction with Dr. Press has been continuous. He has been particularly influential in determining strategic science and technology decisions. How do we decide on the content? We consult with Dr. Press.

Senator KENNEDY. As I understand the awards priorities in the zero-based budget and process were quite different in science information than those indicated in the authorization request, can you tell us why?

Dr. ATKINSON. Senator Kennedy, I think you may have that information.

The Board's recommendations, forwarded to OMB, called for a higher level in science education than the request sent to Congress. The details for modifying the initial request are not available entirely to us. I believe the weighing of priorities across the Federal Government led to a modified view of our budget.

Senator KENNEDY. We have that available, both the request that you made of OMB and actually what you received.

As I understand, as a general rule of thumb, the general kinds of cuts were fairly much across the board in each of the areas, with the exception of science education, am I correct on that?

Dr. ATKINSON. There is a strong thrust in the basic science areas to maintain a high increase. The overall Foundation increase amounts to 8.8 percent. In basic research, it is 9.7 percent. To insure that sort of increase in basic research, science education took a substantial cut, I think it was 4.6 percent. So science education did, in this budget, emerge with somewhat less than the cost-of-living increase.

Senator KENNEDY. Why was that the one that received the brunt of the cuts?

Dr. ATKINSON. Senator Kennedy, it was in part an analysis of the science indicators that you were talking about earlier. The analysis showed the tremendous need to turn around the basic science effort in this country, to commit once again to a strong program of research in the sciences. That aspect of the analysis led to our particular thrust at the National Science Foundation. While there is an effort to maintain a minimum increase in the overall Federal budget, the process of insisting on a large increase in basic research forced cuts in other areas. In part the cut was made on science education.

Senator KENNEDY. Well, I think we ought to take a look at that ourselves, based upon the rather detailed analysis that you people did in terms of the preparation for thoses requests, and we will do that.

Can you tell us about the continued participation of small business in the restructured applied research program?

What can you tell us about the continued role?

Dr. ATKINSON. We have been pleased with our efforts in the small business area. Our initial concern, several years ago, was that we would not receive the flow of high quality proposals to justify the sort of funding we were contracting for. Just the contrary has occurred.

We have had an excellent stream of proposals, not only a goodly number, but of high quality, and the number of proposals we are now supporting in the small business area is up significantly.

I would be glad to provide the details for the record. I have it here before me, but there are a number of components to it that are not easily described.

Senator KENNEDY. Maybe you can provide that for us. Maybe you can provide for us what was done this year, and what you expect to be doing in terms of next year.

Dr. ATKINSON. Yes.

Senator KENNEDY. Can you summarize what you plan to do next year briefly?

Dr. PIMENTEL. I have the numbers for fiscal year 1977, some $10.6 million contract and grant awards were made to small business, 128 awards total.

Senator KENNEDY. What do you expect next year in terms of dollar figures?

Dr. ATKINSON. I think we are expecting an increase in activity in that area. I would like to provide that for the record.

Senator KENNEDY. Very well.

[The information referred to follows:]

SMALL BUSINESS ACTIVITY

In fiscal year 1977 there were 130 grant and contract awards totaling $10.6 million to small business firms by NSF program directorates (the data exclude purchase orders and similar procurements). Of the 130 awards, 95 were made by the Directorate for Applied Science and Research Applications for $7.6 million. Other NSF directorates and offices made 35 awards totaling $3 million.

In fiscal year 1978 it is estimated that there will be a total of approximately $10.3 million awarded to small business firms. It is expected that ASRA will award $6.8 million of these in meeting its statutory obligations. It is probable that approximately $3.5 million will be awarded to small business firms by other NSF directorates and programs.

For fiscal year 1979 we estimate that ASRA will award approximately $10.0 million to small businesses, which represents 15 percent of the ASRA total request of $73.9 million, less the $7.0 million requested for Integrated Basic Research, which funds proposals initiated through the Foundation's basic research directorates. It is estimated that other NSF programs would award $3.6 million to small businesses for a fiscal year 1979 total of $13.6 million.

Senator JAVITS. May I put one question in the record?

Senator KENNEDY. Surely.

Senator JAVITS. First, I would like to express my identification with the Chair's views on science education.

Also I would like to make a suggestion. Perhaps the National Science Foundation could research into the methods of teaching science education, or work with the NIE. You are pretty smart fellows. Maybe they are not teaching it right.

If you would, just think about it.

The question I would like to pose to you is this. I am appalled by our rate of productivity. We are seventh among the 7 major industrial nations, or the 10 comparative nations that generally relate to productivity.

I think, Dr. Atkinson, with our chairman's permission, if you could give us some information, we would be very happy. I do not want it now, because it would take a lot of time, but I would like to know where research and development would fit into that picture.

I have a deep feeling that we are falling behind on research and development, and we are falling behind on the modernization of our industrial plants—both.

The latter may not be your business, but anything you can contribute, sir, on that subject would be tremendously helpful.

Dr. ATKINSON. Senator, I will provide that for the record.

Ten years ago, we could not describe a relationship between research and development and productivity and industrial growth. There was a lot of anecdotal evidence, but very little firm data. Now there is data on investment in research and development and subsequent growth in productivity. It is that relationship that I will be adding for the record.

Your suggestion that the National Science Foundation join forces with the NIE to examine questions on science education is an interesting one. Last year we initiated such a joint program with the National Institute of Education.

Senator JAVITS. Thank you very much.

Senator KENNEDY. We will just recess briefly.

[The material referred to follows:]

THE IMPORTANCE OF R&D TO PRODUCTIVITY GROWTH

An investigation of long-term U.S. economic performance by Edward Denison has indicated that about 50 percent of measurable U.S economic growth between 1948 and 1969 derived from advances in knowledge. Denison delineates "advances" in knowledge as:

> "...what is usually defined as technological knowledge - knowledge concerning the physical properties of things, and of how to make, combine, or use them in a physical sense. It also includes 'managerial knowledge' - knowledge of business organization and of management techniques construed in the broadest sense."

This computation does not take into account improvements which are not measured by national income accounting techniques. Examples would include major qualitative changes in products (e.g., computer performance) or developments of new forms of business organization (e.g., self-service stores and supermarkets in retail trade).

Research and development are the predominant sources for these advances in knowledge which contribute so much to U.S. economic progress. Research advances scientific knowledge, which, in turn, enhances the intellectual skills individuals bring to their work and provides a source of ideas for new technologies. Technological development is necessary for the creation and adoption of new and improved products and production techniques. R&D increase productivity by providing improved machinery, materials, and production techniques. These investments result in new and improved goods and services for consumers. The products and new knowledge to produce them not only provide for a more satisfactory lifestyle but also enhance the productive capacity of individuals.

A number of studies suggest a strong association between R&D spending and growth of productivity and output. A recent study of selected U.S. industries shows a strong association between the ratios of their R&D spending to sales and their growth of labor productivity and output. The results show industries, e.g., chemicals, electrical machinery, which have high ratios, experience substantially higher growth of productivity and output than industries, e.g., textiles, which have low ratios. In addition, other empirical research studies have demonstrated substantial increases in output (netting out increased inputs of labor and capital) associated with expenditures for R&D. These studies show $30 to $50 increases in annual output associated with a $100 investment in R&D. These findings come from studies of R&D in chemicals, petroleum refining, and agriculture.

Investments in R&D not only result in greater productivity and output for the firms developing the new or improved technology but for the buyers as well. This diffusion of benefits has been noted especially for machinery (e.g., computers, electrical generating equipment) and for materials (e.g., plastics) or components (e.g., semiconductors). One recent attempt to quantify these benefits has estimated that for the manufacturing sector during the 1960's the average productivity returns to R&D conducted by the industry amounted to about 30 percent per year; the annual returns to R&D embodied in purchased inputs were about 50 percent. Another study of 17 technological innovations showed that more than half of the measurable economic returns from these innovations went to the buyers and users.

Several documents, which elaborate on the relationship between R&D and productivity, have been forwarded to the Committee. They are:

1. Text of "Remarks by Dr. Richard C. Atkinson at the Franklin Institute," November 2, 1977.

2. National Science Foundation, Research and Development and Economic Growth/Productivity, Papers and Proceedings of a Colloquium, December 1971.

3. National Science Foundation, Preliminary Papers for a Colloquium on the Relationship between R&D and Economic Growth/Productivity, November 9, 1977.

4. S. Okubo, R. Piekarz, and E. Thomas, "International Comparison of Levels and Industrial Composition of Enterprise Funded R&D in Manufacturing," paper presented at the Engineering Foundation Conference, Easton, Maryland, October 1977.

5. Rolf Piekarz and Eleanor Thomas, "U.S. Productivity Growth: An Assessment of Perceptions and Prescriptions," in H.R. Clauser, editor, Progress in Assessing Technological Innovation, 1974 (Westport, Conn.: Technomic Publication, 1975).

[Short recess.]

Senator KENNEDY. Let us resume.

Our next witness will be Irving Shain, chancellor, University of Wisconsin, Madison, Wis., who will be speaking to us on behalf of the American Association of Universities, the American Council on Education, and the National Association of State Universities and Land Grant Colleges.

STATEMENT OF DR. IRVING SHAIN, CHANCELLOR, UNIVERSITY OF WISCONSIN, MADISON, WIS., ON BEHALF OF AMERICAN ASSOCIATION OF UNIVERSITIES, AMERICAN COUNCIL ON EDUCATION, AND NATIONAL ASSOCIATION OR STATE UNIVERSITIES AND LAND-GRANT COLLEGES

Dr. SHAIN. Senator Kennedy, you have named all the institutions and the organizations which I am representing. The institutions involved perform virtually all of the academic basic research supported by the Federal Government, and they produce almost all of the Nation's highly trained scientific and technical manpower.

Mr. Chairman, the administration has proposed a renewed commitment to basic research in fiscal year 1979. The budget is a comprehensive strategy to restore needed growth in reasonable increments to the National Science Foundation, and to a number of other Federal basic research programs. These programs, and the academic research activities they support, are the foundation of our world leadership in science and technology.

In the past 2 years reasonable increases have been requested for the basic research programs of the National Science Foundation. We applauded those efforts because of the importance of support for basic research.

We worked closely with the Congress toward meeting those objectives. The broad effort proposed for fiscal year 1979 to strengthen the basic research across the mission agencies is most welcome, and the academic research community vigorously supports that strategy.

If the National Science Foundation is to continue to play its unique role among Federal agencies engaged in basic research, then it is necessary that its programs, the core of that Federal effort, also be strengthened.

We urge this subcommittee to provide the full amounts requested for National Science Foundation basic research, and within that request, there are some special concerns which I would like to emphasize.

This decline has been real in terms of simple obsolescence and inability to replace wornout equipment because budgets have been so badly eroded by inflation; and the decline has also been real in terms of missed research opportunities because institutions have been unable to purchase modern instrumentation in rapidly developing areas such as mass spectrometry and nuclear magnetic resonance spectrometry.

To illustrate the seriousness of this point, informed estimates of a minimum scientific equipment budget at a major research university are in the range of 10 percent of the research instrumentation inventory—simply to replace wornout and obsolete equipment—not counting the investments needed in new technology.

This does not seem unreasonable, since over a 10-year period—on the average—scientific instrumentation wears out and becomes obsolete. Yet, in many universities, equipment budgets are never more than 3 or 4 percent of the inventory value of the instrumentation, and frequently are of the order of 1 percent. Imagine having a 100-year replacement schedule for scientific equipment.

One factor which has been overlooked frequently is that the current inventory of equipment for both instruction and scientific research in the Nation's universities came through the capital budgets rather than the operating budgets.

Thus, during the sixties, when enrollments were increasing rapidly, we responded through intensive construction of new facilities. When we built labs, we equipped them with funds which were part of the building construction budgets. But now, all at once, this equipment is 10 to 15 years old. The microscopes are shot. The ovens are burned out. The spectrometers are unstable, and there is no captial budget available for replacement of all this equipment.

Please consider how many buildings went up in the sixties, and imagine how much 10- and 15-year-old equipment is housed in them, and you begin to see the magnitude of the problems. Our operating budgets are simply too small to replace that wornout equipment, especially at 1978–79 prices.

This instrumentation problem is extremely serious, and we urge the committee to continue the effort begun last year by providing the amounts requested for the basic research directorates.

Senator KENNEDY. You are all in substantial agreement with that kind of analysis?

Dr. ATKINSON. Very much so.

Senator KENNEDY. Your budget is $24 million or $26?

Dr. ATKINSON. Last year we had a special thrust, which we viewed as a continuing thrust over a long period of time. Some have misinterpreted it to indicate that a 1-year thrust would solve this problem. From our view Dr. Shain is exactly on target.

Senator KENNEDY. Have you an assessment in terms of national need? What percent of the need will you be able to go with with your budget, your assessment?

Dr. HACKERMAN. An earlier estimate was made that it required $200 million.

Dr. PIMENTEL. We are in a catch-up situation.

Senator KENNEDY. All right.

Thank you.

Dr. SHAIN. I would also like to point out that the National Science Foundation recently announced a new program to establish a limited number of regional instrumentation centers as sites for very costly equipment. This is right on target. To be used most efficiently, extensive instrumentation must be shared. We support this effort, and encourage its successful implementation.

Senator KENNEDY. Are the universities working that out comfortably?

Dr. SHAIN. We are in the proposal-writing stage at the moment. We are not sure how it will work out. We have a group working very hard putting together a proposal for a regional instrumentation center. If we can get the funds, it will have a tremendous impact, both on universities and other research sources.

Senator KENNEDY. You are setting that as sort of a criterion?

Dr. ATKINSON. It is one of our thrusts. We see it as an important one for this equipment. We will probably be funding only four or five centers. In one respect, it is an experiment. If the proposals look very good and the initial operation is very successful, then it might even be broadened.

Senator KENNEDY. You are giving priority to these shared facilities?

Dr. PIMENTEL. This will be a strong proponent for those that are funded.

Senator KENNEDY. Thank you.

Please proceed, Doctor Shain.

Dr. SHAIN. The second major point I would like to emphasize is our concern over the need to provide for a continued flow of talented young scientists into the Nation's leading science departments.

The fiscal year 1979 budget recognizes the seriousness of the problem, and we commend the responsiveness of the National Science Foundation budget.

As an illustration of the problem there is a very disturbing tendency in this country to tie support for the development of young scientists to a presumed foreknowledge of the job market. This shortsighted approach ignores the fact that the educational pipeline for a research scientist, starting as a freshman in college, is 8 to 10 years long.

Because there will be a more limited range of employment opportunities for young faculty in the next decade, some people argue that the pipeline ought to be closed down.

Just the opposite is the case. There is a crucial need to maintain the research capacity of this country so that we will have the scientific resources to respond to new national crises.

Considering the problems we face now—energy, environment, agriculture, health—we cannot afford to phase research capability.

Thus, as the declining enrollments of the 1980's reduce the numbers of young scientists being trained, we must make certain that the ones that are trained are provided with post-doctoral opportunities which will allow them to utilize their training, and allow society to benefit from the research capability they represent.

We must be ready for the next crisis with a strong and effective research capability in our Nation's universities. Our most important natural resource is the intellect of the next generation of young scientists in this country.

We urge that the budget requests for the basic research directorates be approved so that the current minimal program for postdoctoral research opportunities can be maintained. And in future years we strongly believe these opportunities should be expanded.

This, by the way, would tie in exceptionally well with the National Science Foundation's thrust toward cooperative research programs with industry, and could greatly strengthen transfer of basic research into applied areas.

Because the detailed organizational and funding arrangements required would vary by department and by field, the approaches to the problem would have to be carefully worked out. We stand ready to help the administration and the Congress in this task.

Our particular concern is because of economic reasons, the basic research done in the private sector has been sharply cut back. By allowing the National Science Foundation and the universities to enter into

a partnership with the private sector, that would enhance technology transfer.

Senator KENNEDY. We have begun to try to take some general steps in that direction.

Dr. SHAIN. Yes; I know that.

Senator KENNEDY. Not all universities we have heard from are in agreement with it because of the limited funds, but that is encouraging.

How do you look at it, Dr. Atkinson? We are very much aware of these demographic changes and fluctuations. We got into this to some extent on the mandatory retirement issues, the impact it was going to have of raising the age level.

How are you dealing with that? How much of a problem is that?

This is a theme we hear each year that seems compelling. How do we deal with that?

Dr. ATKINSON. It is at the top of our priorities. Next fall we will have the largest group of freshmen entering college; 1981 will be the maximum year for the college age population. Thereafter, in the following 15 years a 30-percent drop in the college population will occur. It will effect the training of scientists and engineers, particularly at the advanced level. And it is an issue that we must deal with at a fast pace. Dr. Shain's remarks are very much in our mind.

Senator KENNEDY. I suppose you would rather have them in your pocketbook in terms of funding or supporting these kinds of questions?

Dr. ATKINSON. Senator, if, by this time next year, some proposals do not come forth from the administration describing not one, but at least two or three avenues for dealing with the issues of young investigators and an insured supply in the sciences, then I will think we are way off the mark.

Senator KENNEDY. You are going to work closely with the associations?

Dr. ATKINSON. Yes. Dr. Press has been working closely with us in laying plans.

Senator KENNEDY. We will look forward to following this.

Dr. SHAIN. We have included a number of other points which concern us that are in the written statement. I will not mention them. I will only mention that we are concerned about the need for more stable funding so that effective planning can insure maximum benefit from the allocation of scarce resources.

Senator KENNEDY. That is primarily a matter for Congress.

It is true in just about every program we are dealing with. It is something I agree with.

Dr. SHAIN. Then I mentioned the importance of the cooperative research and development effort with industry in view of the reduced emphasis on basic research in the private sector, and the need for graduate student support which parallels the need for postdoctoral support.

We have made some comments on the importance of undergraduate sciences programs which insure broad access to science careers, and I cannot help but mention our regret at the termination of the flexible funding for the formula grant programs.

These points are discussed in more detail in the written statement. And in conclusion, Senator, I woudl just like to say that we strongly support the broad strategy of the President to strengthen the basic

research programs of the National Science Foundation. The Nation's colleges and research universities which conduct National Science Foundation basic research programs support the budget. We stand ready to be of assistance to you and to the members of this subcommittee as you consider the issues before you.

I will be pleased to respond to any questions that you have.

Senator KENNEDY. Why does the NIH get the flexible funding and you people do not?

Dr. ATKINSON. That is an interesting question, Senator Kennedy.

Senator KENNEDY. I was just interested. [Laughter.] We are taking a look at NIH.

Dr. ATKINSON. When the NIH comes aboard, they seem to walk away with a somewhat larger budget than the OMB has recommended. We always walk with a little less.

Senator KENNEDY. We are trying to take a look at that in terms of priorities and how they are set, so it is not just the whims of the pressure groups.

One believes strongly in the component of public input and interrelationship and interfacing between the science and the public. I am concerned about the type of input where Congress just comes and hands either more or protracts just on the basis of narrow political kinds of pressure. That is probably not as healthy a way of dealing with the issue as we can find.

Why is OMB willing to take the more flexible funding? I do not know. I am interested in what your views are. We will take a look. It seems to me that if it is working effectively there, that it would certainly appear to have some justification in your case.

Dr. ATKINSON. Senator Kennedy, we would have been much stronger for the basic stability grant program, much more so a year ago. Now, with the increase in flow of dollars to the mission agencies to support basic research, we will start to have a little more flexibility. We believe the basic stability type of support is a good idea. But in terms of our priorities and other activities in basic research, the priority is not as high today as it was a year or so ago.

Dr. SHAIN. As a university administrator, principal investigators sometimes have short gaps in their support and institutions do need an opportunity to provide seed money and to provide coverage between contracts and grants so that the principal investigator can make and keep long-range plans for research productivity.

We view it as a way of increasing the effectiveness of our use of the Federal dollar.

Senator KENNEDY. OK. Thank you.

Dr. SHAIN. That concludes my presentation.

Senator KENNEDY. Your complete prepared statement will be made a part of the record.

[The prepared statement of Dr. Shain follows:]

TESTIMONY

on the

FY 1979 Appropriation for the

National Science Foundation

Presented before the

Subcommittee on Health & Scientific Research

of the

Senate Committee on Human Resources

by

Dr. Irving Shain
Chancellor
University of Wisconsin-Madison

on behalf of

Association of American Universities

American Council on Education

and

National Association of State Universities
and Land-Grant Colleges

April 10, 1978

28-096 O - 78 - 6

Mr. Chairman and members of the Subcommittee:

I am Irving Shain, Chancellor of the University of Wisconsin at Madison. I am presenting testimony on behalf of the colleges and universities that are members of the Association of American Universities, the American Council on Education and the National Association of State Universities and Land-Grant Colleges. Together these institutions perform virtually all of the academic basic research supported by the Federal government, and they produce almost all of the Nation's highly trained scientific and technical manpower.

FY 1979 Budget for Basic Research

Mr. Chairman, the Administration has proposed a renewed commitment to basic research in FY 1979. The budget is a comprehensive strategy to restore needed growth in reasonable increments to NSF and to a number of other federal basic research progams. As this Committee is well aware, these programs, and the academic research activities they support, are the foundation stones of the world leadership our nation enjoys in science and technology. Our preeminence in many scientific and technological fields flows directly from our past investments in the search for new knowledge.

In the past two years relatively large increases have been requested for the basic research programs of the National Science Foundation. We applauded those efforts because they signaled a reversal in the decline of support for basic research and we worked closely with the Congress toward meeting those objectives. The broad effort proposed for FY 1979 to strengthen the basic research across the mission agencies is most welcome, and the academic research community vigorously supports that strategy. If the NSF is to continue to play its unique balance wheel function among federal agencies engaged in basic research, then

it is logical and necessary that its programs, the core of that federal effort, also be strengthened. We urge this Subcommittee to provide the full amounts requested for NSF basic research. Within that there are some special concerns which I would like to emphasize.

Instrumentation and Equipment

A top priority, and a reason we urge full support of the budget recommendations, is the continuing need to strengthen scientific instrumentation and equipment. The nation's inventory of research instrumentation in academic laboratories has suffered deterioration. There is consensus on that point. Last year the Association of American Universities sponsored a report funded by NSF, titled, The State of Academic Science, by Smith and Karlesky, which documented the decline in the scientific instrumentation resources of universities. This decline has been real in terms of simple obsolescence and inability to replace worn out equipment because budgets have been so badly eroded by inflation; and also in terms of forgone research opportunities because institutions have been unable to purchase modern instrumentation in rapidly developing areas such as math spectrometry and nuclear magnetic resonance spectrometry. To illustrate the seriousness of this point, informed estimates of a minimum scientific equipment budget at a major research university are in the range of 10% of the research instrumentation inventory -- simply to replace worn out and obsolete equipment -- not counting the investments needed in new technology. This does not seem unreasonable, since over a 10 year period -- on the average -- scientific instrumentation wears out and becomes obsolete. Yet, in many universities, equipment budgets are never more than 3% or 4% of the inventory value of the instrumentation, and frequently are of the order of 1%. Imagine having a 100 year replacement schedule for scientific

equipment. The FY 1978 NSF budget signaled the seriousness of the problem by placing a high priority on instrumentation programs. Last year 1/3 of the proposed budget increase was targeted there. The FY 1979 budget again emphasizes the seriousness of the problem and notes that special efforts will be made in physics, chemistry and other selected fields. We fully support these initiatives and we urge the Committee to continue the effort begun last year by providing the amounts requested for the Mathematical and Physical Sciences and Engineering; Atmospheric, Earth and Ocean Sciences and Biological, Behavioral, and Social Sciences basic research directorates.

The National Science Foundation recently announced a new program to establish a limited number of regional instrumentation centers as sites for very costly equipment. To be used most efficiently, expensive instrumentation must be shared. We support this effort and encourage its successful implementation.

Young Faculty

Concern is building over the need to provide for a continued flow of talented young faculty into the nation's leading science departments. The decade ahead will be a period of declining enrollments and diminished career opportunities for talented young academic investigators. To ensure a minimum infusion into science of fresh talent and new ideas, and to maintain the research capability of this nation, steps must be taken soon to provide the resources necessary to create a sufficient number of places for young faculty in the nation's leading academic science departments.

The FY 1979 budget recognizes the seriousness of the problem. Dr. Frank Press, the President's Science Advisor, Dr. Richard Atkinson, Director of the National Science Foundation and Dr. Norman Hackerman, Chairman of the National

Science Board, have announced plans to address the problem. We commend the responsiveness of the President's budget to this emerging problem. We will support and cooperate in efforts to respond to it.

The so-called young faculty issue is not a large-scale problem which will require vast sums to solve. It is, in our opinion, a relatively small, highly focused problem. The situation varies widely among and within universities, by academic department and by field. In some departments retirements and normal changes will provide a margin for renewal. Others face inflexible staffing patterns which provide no room for many years for growth or faculty replacement. The numbers of young faculty required to ensure the continuing renewal of key academic science departments, in most cases, may be small. An investment sufficient to support one, two, or perhaps, three junior faculty frequently will provide a department sufficient stimulus. It is important to bear in mind that the planning for such initiatives will have to be done on that relatively small and targeted scale.

Highly trained young people are essential to the nation's basic research effort because their vigor and freshness stimulate the continued renewal of academic science. In many fields, including chemistry, physics, and mathematics for example, their ideas and research productivity are the cutting edge of the discipline's research effort. They are the next generation of senior investigators and teachers. Unless special steps are taken now to ensure the continued placement in key departments of a minimum number of these individuals, the 1980's could become a decade of lower mobility, lost momentum, increasing stagnation and displaced talent. Even more important, however, is the crucial need to maintain the research capacity of this country so that we will have the scientific resources

to respond to new national crises. Considering the problems we face now -- energy, environment, agriculture, health -- we cannot afford to phase down research capability. Thus, as the declining enrollments of the 1980's reduce the numbers of scientists being trained, we must make certain that they are provided with post doctoral opportunities which will allow them to utilize their training and allow society to benefit from the research capabilities they represent. We must be ready for the next crisis, with a strong and effective research capability in our nation's universities.

Because the detailed organizational and funding arrangements required would vary by department and by field, the approaches to the problem would have to be carefully worked out. We stand ready to help the Administration and the Congress in this task.

Effectiveness of Funding

While we are gratified that the budget proposes sustained growth in NSF basic research programs, the effectiveness of federal support for academic science must be judged finally in terms of the impact which funds have on the quality of the science produced and on the productivity and efficiency of academic researchers. In recent years budgetary pressures have led to disruptive funding practices such as projects which are funded for unreasonably short-terms, sometimes for less than a year. Stable, long-term support, often has been lost. As budgetary steps are taken to strengthen the base of federal support for basic research, we urge the Congress and Executive agencies, including the National Science Foundation, to ensure a greater degree of stability and efficiency in the terms and conditions employed to support academic science.

New funding arrangements may be needed as we move into the 1980's. These associations and the nation's research universities hope to contribute to the formulation of new strategies and alternative approaches for the support of academic science. We will keep the Committee fully informed as our plans develop for initiatives in this area.

University-Industrial Cooperation

The role of R&D in the health of the economy has been underestimated. As reported by Science Indicators, 1976, "advances in knowledge" have accounted for about 1/3 of the growth in output in the forty-year period between 1929 and 1969. Investment in R&D brings consistently high rates of return to industries and to the society. But many industries have reduced their commitment to basic research to low levels which, if unchanged, could weaken our knowledge and technology base. Universities welcome the increases in support for academic basic research. The Nation is fundamentally dependent upon excellence in university research programs. But universities alone neither can nor should provide the spectrum of fundamental knowledge necessary to the development of new technologies and products. Strong university and strong industrial research programs each play important and complementary roles. Both are essential to our economic well-being. Therefore, we fully support efforts by NSF to foster closer cooperation between academic and industrial researchers.

Graduate Student Support

The NSF portable fellowship program is an important recognition of the federal interest in supporting the most able students in science. We were concerned that the number of new starts dropped precipitiously last year from more than

500 to slightly more than 400 new starts. We are gratified, however, that the number of fellowships for students enrolled as undergraduates in minority institutions will increase. We fully support that program. We would urge, however, that the Committee provide sufficent support to restore and stabilize the principal fellowship program at a minimum of 500 new starts per year.

Undergraduate Science Programs

The NSF undergraduate science education programs are a high priority of the Nation's colleges and universities. They should be continued at least at current levels adjusted to meet inflation. We regret that the Undergraduate Research Participation (URP) and Student Originated Studies programs are proposed to be terminated in FY 1979. We are pleased that the Committee on Science and Technology has recommended continuation of the URP program. The Comprehensive Assistance to Undergraduate Science Education (CAUSE) program has demonstrated great effectiveness and we urge that it be strengthened. The initiatives to ensure access to careers in science for minorities, women and the physically handicapped also have high priority. The emphasis on science education at the junior high school level is an important one which we fully support.

Basic Research Stability Grants

Turning to a matter of special concern to research institutions I will comment briefly on the formula grant program which was authorized and funded ($4.5 million) last year -- the Basic Research Stability Grant Program (BRSG). Modest sums of flexible funding are the most efficient and productive way to provide for a margin of flexibility in the conduct of research and to undergird the competitive project system. Seed funds for young investigators, unexpected instrumentation

needs, and new research opportunities are among the most important uses of these funds. We were disappointed at the termination in 1975 of the former Institutional Improvement for Science Program and we supported the reinstatement of the principle of flexible support last year.

Unfortunately the program as implemented, in our opinion, did not meet the stated objectives, and the Administration requested deferral of the funds. We understand these monies are being reprogrammed. It is regretable that the effort to restore the principle of flexible research support has been unsuccessful in NSF; we are gratified, however, that the Administration has affirmed the validity of the concept by requesting for the first time in about 5 years, continuation of the NIH program which serves this purpose for NIH basic research programs, the Biomedical Research Support Grant Program.

CONCLUSION

In conclusion Mr. Chairman, we strongly support the broad strategy of the President to strengthen the basic research programs of the NSF and mission agencies. The nation's colleges and research universities which conduct NSF basic research programs support the budget. We stand ready to be of assistance to you and to the members of this Subcommittee as you consider the issues before you.

I will be pleased to respond to any questions you may have.

Senator KENNEDY. We will hear next from a distinguished citizen from the State of Massachusetts, Dr. Robert Randolph, president of Westfield State College, Westfield, Mass., on behalf of the American Association of State Colleges and Universities, the Great Lakes Colleges Association, and the National Association of Independent Colleges and Universities.

STATEMENT OF DR. ROBERT RANDOLPH, PRESIDENT, WESTFIELD STATE COLLEGE, WESTFIELD, MASS., ON BEHALF OF THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES, THE GREAT LAKES COLLEGES ASSOCIATION, AND THE NATIONAL ASSOCIATION OF INDEPENDENT COLLEGES AND UNIVERSITIES

Dr. RANDOLPH. Thank you, Senator Kennedy, for inviting me to testify before you on the National Science Foundation fiscal year 1979 budget request.

As you know, the associations which I represent enroll considerably more than half of all students attending 4-year colleges in our Nation.

My testimony will primarily deal with the science education programs in the National Science Foundation budget. First, however, I want to express our opposition to moving the Science Education Directorate from the National Science Foundation and placing it under the jurisdiction of a proposed Cabinet-level Department of Education.

Science education and scientific research are interdependent. Congress recognized this interdependence when it established the National Science Foundation. We would not like this to be changed.

Senator KENNEDY. Could we get your reaction, Dr. Atkinson?

Dr. ATKINSON. The National Science Board has gone firmly on record in agreeing with the statement. We believe there should be a close relationship between the actual practice of science and the science education activities of the Foundation. The Foundation has compiled a dramatic record, given the small amount of dollars expended for science education. I think they have been effectively expended.

Dr. HACKERMAN. The Board was on record about a year ago, and again last month, on this subject.

Dr. ATKINSON. Even if there were a Department of Education, we believe our science education program should continue to exist as a separate program.

Senator KENNEDY. I suppose you would have a better idea after that Department gets functioning and working as well. You could make a preliminary decision to retain it and see where it goes before making a judgment. You could see how it goes.

Dr. ATKINSON. If our program were followed in a new Department of Education, given the sort of outline that was generally discussed, our program would amount to one two-hundredths of the budget. That fraction could hardly be a driving factor. I would worry that effectiveness of a science education program would be lost in such a large effort.

Senator KENNEDY. All right.

Dr. RANDOLPH. I would like to make some comments.

We strongly support the continuation of the undergraduate research participation program, URP. This program offers scientifically talented

and motivated undergraduates an opportunity to work on research projects with faculty scientists or with industrial scientists in their laboratories.

As you know, National Science Foundation officials reported to Congress that they had reluctantly decided to phase out the program this year because it did not, in the National Science Foundation's opinion, effectively identify scientific talent among minority and women students. We strongly oppose this stress. Indeed, speaking personally, I find it interesting that in a college like Westfield, 67 percent of the students are women. We now have minority students. Its timing is interesting. Now that women and minorities have discovered college, there is a recommendation to phase out this opportunity. We strongly oppose this.

Senator KENNEDY. Can you tell us a little bit about that program. Does it apply to undergraduates?

Dr. ATKINSON. It allows undergraduates to participate in individual research programs with individual faculty members. The program has had an excellent history. I have seen it in operation. I support it vigorously.

On the other hand, there are priorities. We cannot spin out large numbers of programs and undersupport each of them.

We found that we had too many programs supported at minimal levels. In order to deal with the budgetary constraints we were operating under, we decided this program, although it had an excellent record, should be phased out.

Senator KENNEDY. On the secondary program, what happened? Has that been phased out? Is there a program dealing with——

Dr. ATKINSON. There is what we call SOS, student originated studies. That program is also being phased out. There students initiated the studies quite independent of any particular faculty involvement. That program also is being phased out.

Senator KENNEDY. I understand it has been restored.

Dr. RANDOLPH. We recommend that the $2 million that the House put in for URP be increased to $5 million.

Senator KENNEDY. See, you get these people from Massachusetts down here.

Dr. RANDOLPH. I think this is terribly important.

Senator KENNEDY. I do, too.

Dr. RANDOLPH. This timing would really wipe out a scientific opportunity for many women and many minorities.

I understand the issues of priorities, having worked down here in Washington, but I think the nature of the day, the nature of the development of education vis-a-vis sex, vis-a-vis race is far more important than it was 20 years ago. This has to be recognized by the Government in its funding program.

Dr. PIMENTEL. The URP program was originated in the early 1960's to encourage an increase in the number of talented young people going into the sciences. It originally was not intended to direct more attention to minorities and women. Consequently, it is correct to say that this program has not focused on the needs of minorities and women.

More recently, and in light of budget constraints, the overall thrust of several programs was examined with respect to the needs of minori-

ties and women. URP was selected as one of the programs for phasing out. More emphasis was placed on other programs.

The priorities now are going to what you indicate. We are emphasizing programs specifically directed toward minorities and women rather than attracting more people into science.

Dr. RANDOLPH. There are a few other comments I would like to make.

Senator KENNEDY. Yes.

Dr. RANDOLPH. We request $9 million for the instructional scientific equipment program, ISEP. Much of our argument has been stated by Dr. Shain. It goes along with the philosophy he expressed concerning the state of equipment—we fully support that.

I think we need a clarification of the small research equipment program.

The congressional conferees on the fiscal 1978 National Science Foundation authorization bill urged the National Science Foundation to make some portion of the research funds available for instrumentation, facilities, and research resources costing less than $25,000. The instrumentation, facilities, and research resource funds are distributed through the programs in the research directorates of the National Science Foundation and clear instructions about the use of these funds for small research projects are not currently available.

We urgently request that the committee take steps to clarify the use of these funds. This program is particularly important to undergraduate college scientists who have modest equipment needs and modest budgets. We believe that the small research instrumentation grants program should be continued in fiscal 1979.

I might say that in Massachusetts, as an example, the State college system is very much involved with corporations such as Textron Equipment and Data General, on a contractual basis. Raytheon is also involved. This will continue in a very large sense. In future years, it will be hard to distinguish between these programs. I suspect this will be a national trend and, as usual, Massachusetts is in the lead.

Senator KENNEDY. See why he is down here?

Dr. RANDOLPH. But we, along with Dr. Shain, suggest real consideration for a 2-year National Science Foundation authorization bill. We support the concept.

Senator KENNEDY. Are they putting up any equipment for the schools?

Dr. RANDOLPH. Digital is very cooperative. It is a highly progressive organization founded by educators from MIT. They understand education. They want us to take a larger portion of their educational responsibilities from them. It has a lot to do with manpower development in the State.

We feel that the State colleges have a direct responsibility to work with them. We feel this has a lot to do with economic growth. It is highly scientific. You are dealing with micromini computer development. Massachusetts Institute of Technology and institutions of this kind have a major responsibility. Those of us on a 4-year level have a major responsibility in providing the kinds of personnel they need. We feel this has to be done jointly with them as educators and not as separate organizations.

Westfield State has three digital operations, so we are working very closely with them. I think this will increase, but it has a lot to do with

the National Science Foundation and its posture and our relationship with it.

We feel strongly about the 2-year authorization bill. However, we very strongly support the annual appropriation of National Science Foundation funds so that Members of Congress have an opportunity to review and consider the appropriation level which the administration requests each year.

Before ending my testimony, I want to tell you about the AASCU peer review submission program. Last year the AASCU Committee on Science and Technology developed an NSF peer review submission program. From more than 700 biographies submitted to the committee, its members selected 171 names to submit to NSF for consideration as potential peer reviewers. NSF officials have worked closely with the committee. We are pleased with their cooperation and interest in this project and hope the project will continue.

Thank you for inviting me to testify. I will be happy to answer any of your questions, and I will submit a copy of my formal statement.

[The prepared statement of Dr. Randolph follows:]

TESTIMONY BY

Dr. Robert Randolph, President
Westfield State College
Westfield, Massachusetts

On Behalf of

The American Association of State Colleges and Universities
The Great Lakes Colleges Association
The National Association of Independent Colleges and Universities

Before the

Subcommittee on Health and Scientific Research
Committee on Human Resources
United States Senate

April 10, 1978

Senator Kennedy and Members of the Subcommittee:

Thank you for inviting me to testify before you on the National Science Foundation Fiscal 1979 budget request. This morning I am representing the 325 members of the American Association of State Colleges and Universities, the 754 members of the National Association of Independent Colleges and Universities, and the twelve colleges of the Great Lakes Colleges Association.* Together, our organizations represent a large part of the higher education community and educate more than forty percent of all college undergraduates in the United States, as well as a substantial proportion of graduate students. They enroll considerably more than half of all students attending four-year colleges.

My testimony will primarily deal with the science education programs in the National Science Foundation budget. First, however, I want to express our opposition to moving the Science Education Directorate from the National Science Foundation and placing it under the jurisdiction of a proposed Cabinet-level Department of Education. Science education and scientific research are interdependent. Congress recognized this interdependence when it established the National Science Foundation. The law creating the Foundation charged it "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." The quality of science education and the quality

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* *The Great Lakes College 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, and the College of Wooster.*

of scientific research would suffer if either were deprived of the stimulus of the other.

I want to make some comments about the NSF science education budget and will follow-up with some specific observations about several NSF programs: Undergraduate Research Participation (URP), Instructional Scientific Equipment (ISEP), the Instrumemtation program, and the Science for Citizens program. Finally I will comment on the proposed 2-year NSF authorization and on the peer review program undertaken by AASCU, the association to which my own college belongs.

This committee has always recognized the value of science education programs, has strongly supported them, and has often approved more funding for them than NSF has requested. We hope that you will do so again this year.

Undergraduate Research Participation (URP)

We strongly support the continuation of the Undergraduate Research Participation program (URP). This program offers scientifically talented and motivated undergraduates an opportunity to work on research projects with faculty scientists or with industrial scientists in their laboratories. The students obtain research experience and expand their scientific knowledge. As you know NSF officials reported to Congress that they had reluctantly decided to phase-out the program this year because it did not, in NSF's opinion, effectively identify scientific talent among minority

and women students, and because "the need to nuture scientific talent (aside from women and minorities) is much less acute today than it was when the Undergraduate Research Participation Program began...." The first URP program announcement in 1958 said the purpose was "to accelerate and enrich the development of undergraduate science majors [later "students"] through direct experience in current research."

We would like to point out that the program certainly does enhance the development of all undergraduate students -- at colleges such as Florida A & M, Texas Southern, and Mount Holyoke, as well as such colleges as the College of Wooster and the University of Missouri -- all of which received awards under the program last year.

We are pleased that the House Science and Technology Committee has directed the National Science Foundation to use $2 million of FY 79 appropriations for the URP program. However, we would go further and recommend to this committee that the $2 million figure be raised to $5 million, to enable more undergraduate students to have an opportunity to compete for participation in this type of scientific educational experience. We also suggest that the program continue to operate under the current guidelines.

Instructional Scientific Equipment Program (ISEP)

We request $9 million for the Instructional Scientific Equipment Program (ISEP). The NSF budget request is $3 million,

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a decrease of $588,000 from the amount they plan to spend on ISEP in FY 78. Under the ISEP program the educational institution and the NSF match funds to purchase equipment to implement new or improved instructional programs in science and engineering. NSF grants are limited to $20,000 per project and must be matched from non-NSF and generally non-Federal monies. The matching fund arrangement insures that only high priority equipment is acquired. Many institutions that have been fortunate in acquiring scientific equipment through ISEP grants have worn out the equipment and need to replace it. Equipment replacement is more important for many colleges than is the acquisition of new equipment. Therefore, we request that Congress increase the funds for ISEP and expand the program to allow institutions to seek funds for worn out equipment.

Instrumentation: Clarification of the Small Research Equipment Program

The Congressional Conferees on the Fiscal 1978 NSF Authorization Bill urged NSF to make some portion of the research funds available for instrumentation, facilities, and research resources costing less than $25,000. The instrumentation, facilities, and research resource funds are distributed through the programs in the research directorates of NSF and clear instructions about the use of these funds for small research projects are not currently available. We request that the Committee take steps to clarify the use of these funds. This program is particularly important to undergraduate college scientists who have modest equipment needs and modest budgets. We believe that the small research instrumentation grants program should be continued in Fiscal 1979.

Science for Citizens

We continue to support this program and hope that it will fulfill its promise by making more and better scientific educational material available to American citizens and by improving scientific understanding within the general population.

Two-Year NSF Authorization Bill

We support the concept of a two-year NSF authorization bill to replace the current practice of Congressional consideration and enactment of an NSF authorization law every fiscal year, provided that NSF presents a carefully considered budget for each of the two fiscal years -- including the line item requests the Foundation currently makes for all its major programs under the one-year authorization. However, we strongly support the annual appropriation of NSF funds because we think it is important that Members of Congress have an opportunity to review and consider the appropriation level which the Administration requests each fiscal year. This is particularly important for the science education programs.

Before ending my testimony, I want to tell you about the AASCU peer review submission program. Last year the AASCU Committee on Science and Technology (formerly the Committee on NSF Liaison) spent a good deal of time developing an NSF peer review submission program. The reason was to involve our institutions, with their large numbers of science faculty and science majors, much more closely in the work of NSF -- thus broadening the spectrum of scientists and institutions with whom the Foundation works. The Committee solicited the names of potential NSF peer reviewers from

the presidents of all AASCU member institutions. From more than 700 biographies submitted to the committee, its members selected 171 names to submit to NSF officials for consideration as potential peer reviewers. Last April several members of the committee met with the following NSF officials to discuss this effort: NSF Director Richard Atkinson, Assistant Director Harvey Averch (then Acting Assistant Director for Science Education), Assistant Director Eloise Clark, and Deputy Assistant Director Jerome Fregeau.

We were pleased that NSF officials have been very cooperative and interested in the project. At Dr. Atkinson's request, we forwarded all 700 names to the Foundation. Subsequently the Directorate for Mathematical and Physical Sciences and Engineering informed us that more than 25% of the nearly 90 persons whose names we submitted to that directorate had been asked to serve as reviewers or panel members in the last two years. As I am testifying before you this morning, the AASCU Science and Technology Committee is meeting in Washington to screen the papers AASCU faculty and administrators have submitted this Spring for the NSF peer reviewer program.

Thank you again for inviting me to testify. I will be glad to answer any questions you may have.

Senator KENNEDY. OK. Now we go to Dr. Sells of the University of Maryland?

STATEMENT OF DR. LUCY W. SELLS, POLITICAL SOCIOLOGIST, UNIVERSITY OF MARYLAND, COLLEGE PARK, MD.

Dr. SELLS. Senator Kennedy, I am delighted and privileged to be here. I am a political sociologist with a background of interest and commitment to expanding opportunities for women in mathematics, the sciences, and technology. See appendix I.

It gives me personal and professional pleasure to be able to use the results of academic sociological research to support your own efforts, and those of the National Science Foundation to achieve the same goals.

I will submit my entire statement for the record, and I will summarize it.

I. The first section of my testimony concerns the underrepresentation of women in the sciences and technology. There is documentation contained in appendix II and appendix III which shows the systematic underrepresentation of women in the sciences. I include recent data on percentages of women at the bachelor, master, and doctoral levels by field.

This underrepresentation starts with the critical importance of high school mathematics which is used as a filter for keeping women out of these fields.

At most colleges and universities, majors in the sciences and engineering require a freshman calculus course, the fundamental building block on which the entire undergraduate curriculum rests.

The standard freshman calculus course generally requires a background of 2 full years of high school algebra, a year of geometry and a year of trigonometry analysis.

The University of California is a highly selective institution, admitting the top 12½ percent of the high school graduating class in the State, with at least a B average. It requires 1 year of algebra and 1 year of geometry for admission to their system.

In a study of entering freshmen in the fall of 1972, 57 percent of the men and only 8 percent of the women had 4 or more years of high school mathematics so a great number were effectively cut off and shut out from undergraduate majors in the hard sciences, 92 percent of the women were effectively shut out of majors in the sciences and engineering and were left with undergraduate majors in the humanities and social sciences on the Berkeley campus.

At a recent job fair at the University of Maryland, 24 of the 37 employer representatives were looking for people with training in mathematics, physical sciences, engineering, or computer sciences. This amounts to 65 percent of the potential employers who were seeking people in the mathematics-based fields.

Undergraduate majors in business and economics also require the standard calculus sequence. Increasingly, doctoral programs in the social science also require mathematical sophistication. This effectively relegates many women to graduate work in schools of education, social welfare, or criminology.

II. Support of S. 2550.

I am delighted with your proposed S. 2550 and its potential impact for expanding opportunities for women in science and technology. I have covered this more carefully in my testimony, but I want to make the point that it is critically important to develop science and health care literature for the vast army of citizens who do not choose to go to college. Solutions to many problems, such as energy, environmental pollution, and hunger and starvation require an informed electorate for effective selection of candidates, and in choosing positions on issues.

There is also a vast army of women who will subsequently become mothers and who will need to know everything they possibly can about the adequacy of prenatal nutrition so that they and their children can be healthy. It is important to train the future mothers of this Nation in the basic principles of health literacy. We know the importance of all these things, but we do not know enough about the psychology and sociology of motivation and distribution of goods and services which is necessary to get people to do these things.

How do we get pregnant teenagers to switch to milk and get them to eat food that will nourish their babies instead of eating junk food?

We know what is the biological relation between smoking and lung cancer, but we do not know enough about the sociology and the psychology of getting people to quit smoking.

One of the strengths of S. 2550 is that it supports constructive intervention at multiple levels—elementary, secondary, postsecondary, and postdoctoral levels, wherever appropriate. Appendix IV includes a number of highly successful intervention projects aimed at changing the impact of the mathematics filter. The very success of these projects shatters the myths that sex differences in mathematics achievement might be related to sex differences in mathematics ability. Their success derives both from the competence and enthusiasm of the teachers in these projects for mathematics as a subject, and the faith of the teachers in the capacity of students to master the material, regardless of sex, race, or age of students.

I had the privilege of working for 2 days with the Committee on Opportunities in Science, of the American Association for the Advancement of Science. This group is providing important leadership in showing our scientific and professional associations how to expand opportunities for women, minorities, and the handicapped in the sciences. The participants converged on the idea that the critical leverage for expanding opportunities for minorities, women, and the physically handicapped lies in programs which change teacher attitudes about students, based on the race, sex, or physical condition of the students.

It was clear from our discussion that the attitudes and expectations of teachers about students place upper and lower limits on the performance of students. It was equally clear that the limiting effects of teacher attitudes and expectations work at primary, secondary, postsecondary, and postdoctoral levels. There are two strategies for changing the attitudes and expectations of teachers about students. The first comes from the enlightened self-interest model, which leads teachers to discover that expanding opportunities for women in mathematics and the sciences expands the labor market for teachers of mathematics and the sciences, at every level. The second comes from

an "educational" model, in which attitudes and expectations are recognized as invisible belief systems which can be changed, by calling them to people's attention.

I support the intention of S. 2550 to provide multilevel intervention to expand opportunities for women in science and technology from elementary school through postdoctoral training. At the same time, I respectfully suggest additional leverage points for changes. These involve the transformation of climates of mistrust, hostility, suspicion, and conflict to climates of trust, good will, openness of communication, and cooperation between and among segments of society.

1. Between the families of students, and the school systems into which the student becomes embedded.

2. Between school systems—at primary, secondary, and post-secondary levels—and the local, State, and Federal political systems in which they are embedded.

3. Between school systems and the potential employers in the world of work, whom they seek to serve by training students to meet employer needs.

My impression is that such transformations occur when human beings, and the organizations and institutions in which they are embedded, shift from finding fault and placing blame on "them" or the "system" to taking responsibility for addressing the problems at hand.

Each of us, in our respective roles and positions in all of the above, is committed to the goal of making it possible for all students to develop abilities, talents and skills to fullest potential, regardless of sex, race, social class, age, physical condition, or other previous sociological constraints. The critical question for each of us is, "What can we do, as individual human beings, to make a difference in the world?"

As a human being, I am personally committed to taking responsibility for the transformation from conflict models to cooperative models between and among the segments of society.

As a social scientist, by birth, conviction, and doctoral training, I am equally committed to taking responsibility for the transformation of conflict models to cooperative models between and among the physical sciences, the biological sciences, the social sciences, the arts and humanities, and the professions.

I welcome the support of the political establishment, and of the scientific establishment, as well as artists, humanitarians, and professionals, in achieving this transformation.

The need for a 10-year sustained intervention program. It is clear from the intervention projects described in appendix IV that such projects make a temporary difference. It is also clear that we need longitudinal, long-term (10-year) data to measure and evaluate the impact of such intervention projects. Further, the sustained support of a 10-year project will create a momentum of commitment, energy, and enthusiasm for expanding opportunities in science and technology for women. The very fact of the introduction of S. 2550 suggests that the expansion of opportunity for women in science and technology is an idea whose time has come.

III. Acknowledgment of the role of the National Science Foundation in expanding opportunities for women in science and technology.

In my own experience, there are three ways in which the National Science Foundation has demonstrated leadership in expanding opportunities for women in the sciences:

a. Through its selection of members of peer review panels. See appendix V.

b. Through support of national conferences on women in the sciences.

c. Through support of projects aimed at transforming mathephobics into math enthusiasts, regardless of sex, age, or race of students.

Thank you for the opportunity to share the sociological perspective with the political establishment and with the science establishment. I would like to conclude with the observation that what is good fro women is good for human beings, and what is good for human beings is good for politics and for science. If there is any way in which my work might support yours, please call on me.

Senator KENNEDY. Maybe we can hear from Dr. Atkinson. Could you tell us a little about what you are doing in the program.

Dr. ATKINSON. Senator Kennedy, let me respond by saying first that the mathematics instruction for entering students is a critical item. Dr. Rutherford, who has just come to the Foundation as Assistant Director for Science Education, has taken an important role in this matter with respect to junior high school students. Too many students are dropping out of school at the junior high school level.

We have to insure stronger effort at the junior high school level to keep children in science, not only those who are going to go on to advanced degrees in science and engineering, but for other students. That is a key thrust. I do not know how you would like me to follow this up, Senator Kennedy. I will be happy to have you talk about your bill.

Is that what you had in mind?

Senator KENNEDY. You might do that, too.

The statistics point out as to the doctoral engineering work force, as I understand, 99 percent is male. The work force in physics, 98 percent is male. The work force in chemistry, 95 percent is male.

I suppose in terms of these broader interests, we have to consider whether we have effectively excluded, for whatever reasons, a major kind of work force from being involved in those particular disciplines.

I suppose the real question is how can we bring that kind of an opportunity for talent and skill into this. I know that women, minorities, and others wish to have a more meaningful involvement in those areas. We have to find out whether the program that is developed over there in the National Science Foundation is going to have much of an impact.

Dr. PIMENTEL. Could I speak about my experience in teaching freshman chemistry over a large number of years?

We made strenuous efforts to help both minorities and women from being excluded for the very reasons that Dr. Sells indicated. In my view, she quite correctly identified the keystone of the problem: mathematics preparation. It is not determined by intellectual ability, but rather by a cultural imprint before the student reaches a university. Consequency, it has been difficult for us at universities to address the problem.

For that reason, I believe the program that Dr. Rutherford is attempting to get underway at the junior high level—to focus on mathematics and other subjects—is aimed at exactly the right place.

I would take issue with Dr. Sells and, some aspects of the bill for focusing in a broad way at all levels. I feel that we have properly identified, for the reasons Dr. Sells indicates, where the problem can

be addressed most meaningfully. It is the junior high school age, the age at which the cultural imprint on both minorities and women tends to exclude them. At this age they do not have the opportunity to opt out as they do later on. This is the age at which special materials can be particularly helpful.

I would like to turn now to the statistical analysis that Dr. Sells has provided on page 74 of her appendix II and add some information.

That information on page 74 refers to 1972 data about the University of California at Berkeley. In evaluating legislation addressed to these important matters, and I am coupling minorities and women at this point, we should look not at a moment in time but at trends, and we should evaluate them carefully.

Take, for example, the tables identified in 1972, at the University of California, Berkeley. The number of chemistry undergraduate majors was 14 percent. Five years later, it had increased by a factor of 1.5, to 21 percent.

Much more dramatic is the change in engineering majors. This is really spectacular. In 1977–78, there are now 222 undergraduate majors in the college of engineering. That is a factor of 4 larger than in 1972, and no longer a statistically meaningless number. That fourfold increase really means something, and women represent 11 percent of the undergraduate enrollment in engineering at Berkeley now.

Dr. SELLS. You see, there is progress.

Dr. PIMENTEL. Yes, very exciting progress in my view.

Chemistry graduate students have gone from 12 percent in the years 1971, 1972, and 1973—to make a statistical meaningful number, I averaged over those 3 years—about 12 percent, and in 1976 and 1977, 20 percent. We have an increase factor of 1.7.

Let me add one more datum. I happened to visit the University of Delaware a few days ago. Fifteen percent of their engineering class consists of women. It was close to zero 5 or 6 years ago: Dramatic changes are occurring.

I believe that the junior high school is the place where we have the most opportunity for improving the situation. I think we should focus there.

Senator KENNEDY. I think it is useful to have an update on particular figures which have been submitted here, but are those typical or are those the efforts particularly at Berkeley of a rather aggressive effort on their part to move? How typical is that?

Dr. PIMENTEL. I do believe Berkeley has been particularly aggressive.

Senator KENNEDY. What do they say at other universities and colleges?

Dr. PIMENTEL. The only information I have is at the University of Delaware. I was astonished at this 15 percent.

Senator KENNEDY. Do you have it at other universities?

Dr. ATKINSON. We have full data but not here. For science and engineering doctorates in 1976, women received 16 percent of the doctorates. In 1955, the figure was 6 percent; there are significant trends.

One of the concerns we have is that too often women tend to enter the social sciences. It is difficult to bring women into the natural

sciences, the physical sciences. More concern in that direction is critical.

What Dr. Pimentel is pointing to, the significant trend here, is one that does not satisfy needs, but it certainly represents good effort that seems to be paying off.

Senator KENNEDY. Dr. Sells?

Dr. HACKERMAN. At the school of engineering at Rice, our percentage is 15 percent women.

Senator KENNEDY. Dr. Rich, what about MIT?

Dr. RICH. I do not have the figure for engineering. My guess is in excess of 10 percent, but probably not 15 percent.

Senator KENNEDY. Dr. Sells?

Dr. SELLS. I totally agree that the progress is very encouraging. One exciting thing that is going on, I just discovered that Berkeley changed its graduation requirements so all students will have to have the equivalent of 3.5 years of high school to graduate, which puts them in the competitive job market. I see that as the most constructive kind of affirmative action that an institution of higher education could generate. That is to raise the standards. If people want to compete equally, they need equal skills.

Senator KENNEDY. Dr. Atkinson, as you focus your program in terms of early training in terms of women, what are we talking about there? What are the resources there?

You are talking about $1.5 million for the whole program.

Dr. ATKINSON. It is minimal in terms of women, minorities and the handicapped. We will have an increase close to 10 percent over the 1978 budget, so it is a strong commitment on the Foundation's part. The directorate overall has an increase of about a 4.5 percent, but the actual dollar figure is small.

Senator KENNEDY. A $100,000 increase?

Dr. ATKINSON. About $11.2 million to $12.3 million.

Senator KENNEDY. That is the minority total and for women it is 1.2?

Dr. ATKINSON. That is correct.

Senator Kennedy, there is no question that the Foundation and the National Science Board are enthusiastic about S. 2550, certainly in the philosophy and the various suggestions outlined there.

I believe that a 10-year program is a good time period, and the funding you are talking about in this bill is an appropriate investment.

On the other hand, we have to be realistic. When the process is complete, we are going to have far fewer funds for this effort than are outlined in the bill.

I would rather have your bill before us as a set of suggestions about how the Foundation should build a stronger program rather than a mandate that each of these be part of the program.

We would like to work closely with you and the Hill in the development of programs. What worries me is this: As the bill now stands, we are going to have fewer dollars and a vast number of programs. With fewer dollars, we will not be able to implement any of those programs at a proper level.

Senator KENNEDY. We will get from you a more detailed analysis on that.

I suppose it is going to take a tuning kind of mechanism. As you

find some programs are successful, you will elaborate and close down on other kinds of programs.

We want to have a degree of flexibility also to be sure that a variety of different initiatives work, or at at least tried in these areas as well. But we will hear from you in greater detail about that.

[An interim statement on Women in Science follows:]

Interim Statement on
Women in Science

The National Science Foundation agrees that the underrepresentation of women in science and engineering careers is a significant national problem. The Foundation in its Science Education Directorate has supported programs addressed directly at this problem since 1973.

The Foundation is presently undertaking a review of the Women in Science problem in order to develop a renewed perspective of the NSF role, particularly in the light of S. 2550.

The report we expect to produce is tentatively outlined as follows:

Problem Description. This section would display available data on women in science (e.g., employment, degrees) including, where possible, breakdowns by fields, levels of education, and sub-specialities. An attempt will be made to compare different data bases to identify possible sources of inaccuracies, as well as to identify trends.

Causes. This section will be an attempt to analyze the causes for the phenomena described in the preceding section (e.g., relative significance of cultural conditioning, discrimination, early training).

Possible Actions. Various strategies will be reviewed in terms of their potential efficiacy in dealing with the problems. These will also be examined in terms of their degree of specificity to science as opposed to general relevance (e.g., provision of day care is a significant strategy but is not limited in relevance only to science).

NSF Perspective. Strategies will be reviewed in terms of the NSF role and their relative significance to that role.

Completion of the report is planned for June 30, 1978.

Senator KENNEDY. Dr. Sells, is there anything else you want to say?

Dr. SELLS. No.

Dr. HACKERMAN. Senator Kennedy, may I interject one thing?

Senator KENNEDY. Yes.

Dr. HACKERMAN. You heard about the diminution of the birth rate, and the fact that there will be a decrease in availability of 18-year-old enrollees at colleges and universities. At this time it will be important to maintain the participation of women and minorities in science. Roughly 45 percent of women go to college, and about 5 percent go to graduate or professional school. So if there is a new source of people who can maintain the vitality of the science enterprise, that will be very important to us.

Senator KENNEDY. Thank you.

Dr. Sells, your complete statement will be made a part of the record.

[The prepared statement of Dr. Sells and exhibits I through V follows:]

TESTIMONY BEFORE SENATE COMMITTEE ON HUMAN RESOURCES

SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH

April 10, 1978

Lucy W. Sells

MR. CHAIRMAN, AND MEMBERS OF THE COMMITTEE:

My name is Lucy W. Sells. I'm a political sociologist with a background of interest and commitment to expanding opportunities for women in mathematics, the sciences, and technology. (See Appendix I.)

It gives me considerable personal and professional pleasure to be able to use the results of academic sociological research to support your own efforts, and those of the National Science Foundation to achieve the same goals.

My testimony will consist of three sections:

1. Documentation of the under-representation of women in the sciences and technology.
2. Support for S. 2550 on three grounds:
    a. the need to expand mathematics and scientific literacy of women from the grass roots citizen level up through basic scientific doctoral researchers.
    b. the need for multi-level intervention strategies from elementary school through post-doctoral levels.
    c. the need for a ten year sustained intervention program to consolidate our gains and provide momentum for continued improvement.
3. Acknowledgement of the recently emerging role of the National Science Foundation in expanding opportunities for women in science and technology.

1. Under-representation of women in the sciences and technology.

* At most colleges and universities, majors in the sciences and engineering require a Freshman calculus course as the fundamental building block on which the entire undergraduate curriculum rests.

* The standard Freshman calculus course generally requires a background of two full years of high school algebra, a year of geometry, and a year of trigonometry-analysis.

* The University of California is a highly selective institution, admitting the top 12½ percent of the high school graduating class in the state, with at least a B average. It requires one year of algebra, and one year of geometry for admission.

* In a study of entering Freshmen, Fall, 1972, 57% of the men, and only 8% of the women had four or more years of high school mathematics. Ninety-two percent of the women were effectively shut out of majors in the sciences and engineering, and were left with undergraduate majors in the humanities and social sciences, on the Berkeley campus.

* At a recent job fair at the University of Maryland, 24 of the 37 employer representatives were looking for people with training in mathematics, physical sciences, engineering, or computer sciences. This amounts to 65% of the potential employers who were seeking people in the mathematics-based fields.

* Starting salaries for people with new Bachelor's degrees show considerable variation, depending on field of undergraduate major. Average job offers reported in March, 1978 were:

Engineering	$1389
Sciences	$1139
Business	$1062
Economics	$ 950
Social Sciences	$ 838
Humanities	$ 829

* Undergraduate majors in Business and Economics also require the standard calculus sequence. Increasingly, Doctoral programs in the social science also require mathematical sophistication. This effectively relegates many women to graduate work in schools of education, social welfare, or criminology.

Documentation of earlier data on under-representation of women in the sciences is contained in Appendix II. The most recent data on percentages of women at the Bachelor, Master, and Doctoral levels, by field, is contained in Appendix III.

2. Support for S. 2550

a. The need to expand scientific literacy at every level

In an increasingly technological society, it is important that all citizens, including those who choose not to go to college, become literate in the basic principles of science. Solutions to many problems, such as energy, environmental pollution, and hunger and starvation require an informed electorate for effective selection of candidates, and in choosing positions on issues.

More importantly, in the context of a bill to expand opportunities for women in science and technology, is the special biological role in the bearing and nurturing of babies. While it is important to develop the pool of trained doctoral scientific researchers to full potential, it is equally important to train the future mothers of this nation, and of the world, in the basic principles of health literacy: the importance of nutrition, physical exersize, and avoidance of known carcinogens.

Expansion of science literacy for women, whether college bound or not, will enhance the effectiveness of health care delivery systems by providing future mothers with the knowledge they need to take responsibility for their own bodies, as well as those of their unborn babies. Further, it will give them the knowledge they need to teach their children to take responsibility for their own bodies.

b. The need for multi-level intervention strategies, from elementary school through post-doctoral levels

One of the strengths of S. 2550 is that it supports constructive intervention at multiple levels: elementary, secondary, postsecondary, and post doctoral levels, wherevere appropriat . Appendix IV includes a number of highly successful intervention projects aimed at changing the impact of the mathematics filter. The very success of these projects shatters the

myths that sex differences in mathematics achievement might be related to sex differences in mathematics ability. Their success derives both from the competence and enthusiasm of the teachers in these projects for mathematics as a subject, and the faith of the teachers in the capacity of students to master the material, regardless of sex, race, or age of students.

I had the privilege of working for two days with the Committee on Opportunities in Science, of the American Association for the Advancement of Science. This group is providing important leadership in showing our scientific and professional associations how to expand opportunities for women, minorities, and the handicapped in the sciences. The participants converged on the idea that the critical leverage for expanding opportunities for minorities, women, and the physically handicapped lies in programs which change teacher attitudes about students, based on the race, sex, or physical condition of the students.

It was clear from our discussion that the attitudes and expectations of teachers about students place upper and lower limits on the performance of students. It was equally clear that the limiting effects of teacher attitudes and expectations work at primary, secondary, postsecondary, and postdoctoral levels. There are two strategies for changing the attitudes and expectations of teachers about students. The first comes from the "enlightened self-interest" model, which leads teachers to discover that expanding opportunities for women in mathematics and the sciences expands the labor market for teachers of mathematics and the sciences, at every level. The second comes from an "educational" model, in which attitudes and expectations are recognized as invisible belief systems which can be changed, by calling them to people's attention.

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I completely supoort the intention of S. 2550 to provide multi-level intervention to expand opportunities for women in science and technology from elementary school through post-doctoral training. At the same time, I respectfully suggest additional leverage points for change. These involve the transformation of climates of mistrust, hostility, suspicion, and conflict to climates of trust, good will, openness of communication, and cooperation between and among segments of society.

1. Between the families of students, and the school systems into which the student becomes embedded.

2. Between school systems (at primary, secondary, and postsecondary levels) and the local, state, and Federal political systems in which they are embedded.

3. Between school systems and the potential employers in the world of work, whom they seek to serve by training students to meet employer needs.

My impression is that such transformations occur when human beings, and the organizations and institutions in which they are embedded, shift from finding fault and placing blame on "them" or the "system" to taking responsibility for addressing the problems at hand.

Each of us, in our respective roles and positions in all of the above, is committed to the goal of making it possible for all students to develop abilities, talents, and skills to fullest potential, regardless of sex, race, social class, age, physical condition, or other previous sociological constraints. The critical question for each of us is:"What can we do, as individual human beings, to make a difference in the world?"

As a human being, I am personally committed to taking responsibility for the transformation from conflict models to cooperative models between and among the segments of society.

As a social scientist, by birth, conviction, and doctoral training, I am equally committed to taking responsibility for the transformation of

conflict models to cooperative models between and among the physical sciences, the biological sciences, the social sciences, the arts and humanities, and the professions.

I welcome the support of the political establishment, and of the scientific establishment, as well as artists, humanitarians, and professionals, in achieving this transformation.

c. The need for a ten year sustained intervention program

It is clear from the intervention projects described in Appendix IV that such projects make a temporary difference. It is also clear that we need longitudinal, long term (ten year) data to measure and evaluate the impact of such intervention projects. Further, the sustained support of a ten year project will create a momentum of commitment, energy, and enthusiasm for expanding opportunities in science and technology for women. The very fact of the introduction of S 2550 suggests that the expansion of opportunity for women in science and technology is an idea whose time has come.

3. Acknowledgement of the role of the National Science Foundation in Expanding Opportunities for Women in Science and Technology

In my own experience, there are three ways in which the National Science Foundation has demonstrated leadership in expanding opportunities for women in the sciences:

a. Through its selection of members of peer review panels. (See Appendix V).

b. Through support of national conferences on women in the sciences.

c. Through support of projects aimed at transforming mathephobics into math enthusiasts, regardless of sex, age, or race of students.

Thank you for the opportunity to share the sociological perspective with the political establishment and with the science establishment. I'd like to conclude with the observation that what is good for women is good for human beings, and what is good for human beings is good for politics and for science. If there is any way in which my work might support yours, please call on me.

lws

4/10/78

EXHIBIT I

Resume

Lucy Watson Sells
4313 Knox Road # 204
College Park, MD 20740

Office (301) 454-2052
Home (301) 699-8512

Permanent Address
1181 Euclid Avenue
Berkeley, CA 94708

(415) 524-0397

PROFESSIONAL PURPOSE

To translate academic sociological research and dissemination skills to meet the needs of potential markets in business, government, and industry.

SUMMARY OF BACKGROUND

Twelve years of experience in all phases of the research process-developing, funding, executiving, analyzing, writing, disseminating.

Three years of administrative and managerial experience.

Worked effectively with:

* Students, faculty, and administrators within institutions of higher education.

* Political decision makers at local, state, and Federal levels.

* Advocates, adversaries, and enforcers of affirmative action.

PRIMARY CONTRIBUTION

Identification of high school mathematics as the critical filter for minorities and women, and as critical leverage for opening opportunities in the world of education, and the world of work.

EDUCATION All at the University of California, Berkeley

B. A. with Honors in Communication and Public Policy
June, 1962
M. A. in Sociology, December, 1967
Ph. D. in Sociology, December, 1975

Dissertation: Sex, Ethnic, and Field Differences in Doctoral Outcomes

CONSULTANT

Race and sex differences in educational achievement and job opportunities.
Political sociology of education
Intra-group problem identification and solutions
Inter-group problem solving and solutions
Conflict resolution within and among groups
Conflict resolution within and among social systems
Multi-level and multi-system approaches to problem solving

WORK EXPERIENCE

Acting Assistant to the Vice Chancellor for Academic Affairs, University of Maryland, September 1977 to present. Using tools, perspectives, and data of sociology to raise the awareness of people at every level within the system, and in other systems, of the implications of traditional race and sex bias for higher education.

Executive Specialist for Minorities and Women, The American Sociological Association, September 1975 through August 31, 1977. Using research on sex and ethnic differences in educational achievement as leverage to open opportunities for minorities and women in sociology, and to open opportunities for sociologists in business, government, and industry.

TEACHING EXPERIENCE

Teaching Assistant, Introductory Statistics, Introductory Methods, Advanced Research Methods, two years, University of California, Berkeley.
Associate, Social Science Integrated Field Major, one year, University of California, Berkeley.
Assistant Professor, Sociology, University of Maryland, one year.

Lucy W. Sells

INVITED PRESENTATIONS BY EXECUTIVE SPECIALIST FOR MINORITIES AND WOMEN, AMERICAN SOCIOLOGICAL ASSOCIATION

* "Minorities, Women, and Mathematics as the Critical Filter in Keeping People from Equality of Access to the Sciences and Engineering," paper presented at a Symposium on Science Careers for Minorities and Women, sponsored by the Committee on Special Scholarships of the Academic Senate, University of California, Berkeley, California. May 12, 1977.

* "Scientific Achievements of Minorities and Women: the Removal of Psychological and Sociological Barriers," opening address, Mid-America Association of Educational Opportunities Program, and U. S. Office of Education, Region V, Mathematical Skills Workshop: Addressing the Instructional Needs of Under-prepared College Students in Technical Subjects. Interlaken Lodge, Lake Geneva, Wisconsin. April 28, 1977.

* "Interdisciplinary Perspectives on Race, Sex, and Social Class Differences in Educational Achievement," paper presented at an Interdisciplinary Working Conference on COMPLEXITY: A CHALLENGE TO THE ADAPTIVE CAPACITY OF AMERICAN SOCIETY, sponsored by the Society for General Systems Research, Washington Chapter, Loyola College Conference Center, American City Building, Columbus, Maryland. March 25, 1977.

* "Sociological Determinants of Sex and Race Differences in Mathematics Achievement," paper presented as panelist for Symposium on Women and Mathematics, sponsored by the State University of New York, Albany, New York. March 24, 1977. Videotaped for national dissemination to schools.

* "Uses of Sociological Research in Expanding Opportunities for Women in Science," paper presented at conference, New Directions for Women, Portraits of 21 Women in Science, sponsored by the National Science Foundation, Yale University, New Haven, Connecticut. March 5, 1977.

* "Sociological Perspectives on Violence in the Schools," paper presented as one of six responses to the keynote address of Senator Birch Bayh, in 15th Annual Conference on Human and Civil Rights in Education, Violence in the Schools, sponsored by the National Education Association, Mayflower Hotel, Washington, DC. February 25, 1977.

* "Transforming Mathephobics into Math Enthusiasts," paper presented as part of a three day workshop on Minorities, Women, and the Handicapped: Programs that Work," at the Annual Meeting of the American Association for the Advancement of Science, Denver, Colorado, February 22, 1977.

* "The Sociology of the Mathematics Filter," Colloquium with the Departments of Sociology, Mathematics, and Business Administration, Georgetown University, Washington, DC. February 16, 1977.

* "The Mathematics Filter and Administrative Alternatives," paper presented as panelist on Administrative Alternatives: Opportunities or Straightjacket for Women Faculty and Staff?, sponsored by Sociologists for Women in Society, Princeton University, Princeton, New Jersey. February 7, 1977.

* " The Sociology of Expanding Opportunities for Women in Business and Industry," paper presented as guest speaker for the monthly meeting of the Soroptimists of Washington, Sheraton Carleton Hotel, Washington, DC. January 19, 1977.

* "Overcoming Mathephobia to Expand Opportunities for People in Continuing Education," presentation at the monthly meeting of the Washington Lifelong Learning group, Trinity College, Washington, DC. December 9, 1976.

* "Mathematics as a Critical Filter for Determining Civil Service Careers of minorities and Women," presentation to the Federal Women's Program Coordinators, U. S. Civil Service Commission, Washington, DC. November 24, 1976.

* "The Status of Women in the Social Sciences," presentation at a meeting called by the Committee on the Status of Women, at the Annual Meeting of the American Anthropological Association, Washington Hilton, Washington, DC. November 19, 1976.

* "The American Sociological Association's Committee on the Status of Women: Its Past, Present, and Future," presentation at the Annual Meeting of the Federation of Organizations of Professional Women (FOPW), Upward Mobility for Women, Wellesley College, Wellesley, MA. Nobember 6, 1976.

* "Analysis of Information on Differential Participation of Male, Female, and Minority Sub-groups in Preparation for Employment in Education Research and Development," National Institute of Education, Washington, DC. September 22, 1977.

INVITED PARTICIPATION OF EXECUTIVE SPECIALIST FOR MINORITIES AND WOMEN, AMERICAN SOCIOLOGICAL ASSOCIATION

* Participant, Teachers Teaching Teachers, a working conference of mathematics educators on planning and conducting workshops to transform class-room teachers from mathephobes to math enthusiasts, at the invitation of the Oregon Mathematics Education Council, under a grant from the National Science Foundation, Marylhurst, Oregon. July 4-11, 1977.

* Participant, Orientation on Approaches for the Increasing Minority Participation in Engineering, at the invitation of the Committee on Minorities in Engineering of the National Research Council, for the National Alliance of Businessmen, Washington, DC. June 13, 1977.

* Facilitator, session on "Power and the Structure of Change," at the Spring Conference of Directors of Projects funded under the Women's Education Equity Act, at the invitation of the Project Directors, sponsored by the U. S. Office of Education, Shoreham Hotel, Washington, DC. April 25, 1977.

* Participant, working Conference on Women and Mathematics, to establish research priorities, at the invitation of the National Institute of Education, Arlington, Virginia, National Motor Hotel. February 23, 1977.

* Participant, Conference on Minority Participation in the the Sciences, at the invitation of the National Science Foundation, Quality Inn, Pentagon City, Virginia, January 14-15, 1977.

* Participant, Sex Roles Institute, at the invitation of the Psychiatric Institute Foundation, Washington, DC. December 2, 3, 4, 1976.

INVITED SERVICE OF THE EXECUTIVE SPECIALIST FOR MINORITIES AND WOMEN, AMERICAN SOCIOLOGICAL ASSOCIATION

* Served on a panel to review proposals for Women's Educational Equity, for the U. S. Office of Education, Washington, DC. June 6-10, 1977.

* Served on a panel to review Pre-College Teacher Development in Science Proposals, for the Science Manpower Improvement Division of the National Science Foundation, Mayflower Hotel, Washington, DC. March 31-April 2, 1977.

* Served on Human Subjects Review Committee for the Americand Psychological Association, Washington,DC. February 16, 1977.

* Served as the only sociologist on Task Force B, Vocational Education, for U. S. Office of Education, Washington, DC. Special concern that guidelines written for new vocational education legislation not perpetuate traditional sex and race role expectations. December 13-14, 1976, and January 12-13, 1977.

EXHIBIT II

Data on sex and ethnic differences in academic achievement document a pervasive climate of different expectations about behavior on the basis of sex and ethnicity and indicate the need for affirmative action at five critical points in the academic system.

critical points for affirmative action

lucy w. sells

Effective affirmative action at faculty hiring levels, as required by federal policy, rests ultimately on increasing availability pools of women and minorities at each of five critical points in the educational structure where career decisions are made: (1) enrollment in high school mathematics, (2) application for graduate school, (3) survival in doctoral programs, (4) faculty recruitment and hiring, and (5) faculty promotion and tenure. Data to support the importance of these five filtering points come from a variety of sources.

high school mathematics

The first filtering point is adequate high school mathematics preparation in order to keep students' choice of undergraduate major open. There is considerable variation in the amount of mathe-

This chapter is based on part on data gathered by the Carnegie Commission on Higher Education from its National Survey of Higher Education with support from the United States Office of Education.

matics required for admission to college by type of institution, whether research university, state college, community college, or private college, but some majors at all institutions are effectively closed to students if they fail to take enough mathematics in high school.

The University of California is a good example of a research oriented public university where policies operate to filter women and minorities out of certain majors. Its data can be extended to many other institutions as well. The university requires the equivalent of two years of high school mathematics for freshman admission to any of the nine campuses. It further specifies three and a half years of mathematics in high school as the prerequisite for the standard freshman calculus course—a course required for majoring in chemistry, engineering, some agricultural sciences, some business administration, all of the hard sciences, most of the biological sciences, and the advanced quantitative methods required in doctoral programs in the social sciences. Until very recently, there was no formalized mechanism for students entering Berkeley to overcome deficiencies in this prerequisite.

To test the contention that inadequate mathematics preparation in high school presents a serious constraint on women's choice of undergraduate major in college, I hypothesized that women applying for admission at Berkeley would be less likely to have taken advanced mathematics than men. (It was not possible to code by ethnicity because state law forbids the collection of data on ethnicity on applications for admission lest it be used to discriminate against ethnic minorities.) A systematic sample of transcripts from the applicants for admission as freshmen at Berkeley for the fall of 1972 revealed that while 57 percent of the men had prepared themselves for the standard calculus course by taking the three and a half units of mathematics, only 8 percent of the women had done so. The difference of forty-nine percentage points is evidence both of dramatic differences in the ambitions and aspirations of young men and women and important sociological differences in expectations for them by individuals who are significant in their lives: parents, peers, teachers, and counselors.

To test the hypothesis of differing climates of expectations and social support leading to decisions to take mathematics in high school, members of an upper division social science class completed a questionnaire about performance in elementary school arithmetic

and in high school mathematics; expectations and encouragement by teachers, parents, and peers; extent of high school mathematics training beyond the minimal two unit requirement; and an open-ended question, "What do you consider to be the most important factor which influenced your interest and aptitude for doing mathematics?" A strong relationship was obvious between presence or absence of encouragement and whether or not students took mathematics beyond the minimal requirement for admission to the University of California. ($Q = 0.94$, statistically significant at the 0.01 level.) A strong relationship also appeared between having social support for mathematics and performing well in the advanced mathematics courses. These data point to the need for experimental projects designed to increase the level of social encouragement for undertaking advanced high school mathematics, independent of sex or ethnicity. In this connection, a dramatic increase occurred between 1972 and 1973 at Berkeley in the percentage of freshmen women taking the high school prerequisite to the standard calculus course; from 8 percent to 32 percent, while the percentage of men preparing for the course rose from 57 percent to 65 percent. It appears that the high school counselors are doing a more effective job in helping all students keep their options open as far as free choice of undergraduate major is concerned.

Table 1 shows how the high school mathematics filter operates to keep women out of university majors which require calculus in their curriculum. The only two exceptions to this pattern among the 15 schools listed are in agricultural sciences, where 88 percent of the students in nutritional science are women despite intensive mathematics and chemistry requirements, and in law, which has a low proportion of women and no mathematics requirement. In both cases, it appears that traditional sex role stereotyping about "appropriate" careers for men and women are operating in choice of field. Otherwise, the more mathematics required in an undergraduate curriculum, the lower the proportion of women enrolled—whether one looks at schools and colleges or at the four fields within letters and science (humanities, social sciences, biological sciences, and physical sciences) or at individual majors within fields.

It should be pointed out that aggregation of departments within fields conceals sharp variation among those departments. When a high requirement of mathematics is in the curriculum, the result is a low percentage of undergraduate women majoring in the

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Table 1. University of California, Berkeley: Percentage of Women at Undergraduate and Graduate Levels by Schools and Colleges Controlling for Mathematics Requirement in the major

	Percentage of Women		*Total Number of Students*	
School or College	*Undergraduate*	*Graduate*	*Undergraduate*	*Graduate*
Mathematics Required				
Agricultural Sciences (including Nutritional Science)	48	30	651	242
Chemistry	14	9	358	394
Engineering	3	2	1361	1336
Environmental Design	17	25	748	424
Business Administration	17	9	693	565
Forestry and Conservation	7	6	132	89
Optometry	17	12	121	112
Letters and Science:				
Biological Sciences	33	29	1085	465
Physical Sciences	22	11	664	817
Total	20	12	5813	4444
Mathematics Not Required				
Criminology	46	38	201	57
Education	NP	54	NP	953
Journalism	NP	50	NP	42
Law	NP	25	NP	851
Librarianship	NP	66	NP	205
Social Welfare	NP	59	NP	245
Ethnic Studies	55	NP	33	
Letters and Science				
Humanities	58	48	2001	965
Social Sciences	46	33	3754	1082
Total	50	41	5989	4400
Mathematics Difference	30*	29*		

Source: University of California, Berkeley, *Campus Statistics, Fall 1972* and *Year 1971 1972*, Table 6, pages 22-25.

NP = No program at this level.

*Percentage difference is statistically significant at the 0.05 level, using a conservative estimate of a two-tailed test.

department. This relationship is even stronger among majors in the humanities and social sciences than it is between these broad fields and the physical sciences. For example, while Table 1 shows that 58 percent of the undergraduates in the humanities are women, compared with 22 percent in the physical sciences (for a difference of 36 percent) within the humanities, 83 percent of the undergraduates in history of art (which requires no calculus) are women, compared with 24 percent of the undergraduates in philosophy (which requires logic)—a difference of 59 percent. In the social sciences, the within field difference is 47 percent: 61 percent of the anthropology majors are women, compared to 14 percent in economics, which requires completion of the high school trigonometry sequence. These within field differences point up the dangers inherent in aggregating fields for estimating availability pools and for measuring underutilization at the faculty hiring level.

The patterns of choice of undergraduate major among ethnic minorities is similar to those of women students, except that Asian minorities are over-represented in the mathematics based fields. Table 2 shows the percentage of letters and science students majoring in the physical sciences, life sciences, or mathematics, by sex and ethnicity. There is a strong interaction between sex, ethnicity, and choice of these three fields. While 68 percent of the Asian men are enrolled in these curricula, only 17 percent of nonminority women and 17 percent of all other minority women are majoring in them. Conversely, the percentage of Asian women in these fields slightly exceeds that of nonminority men and other minority men. I attribute these very large sex and ethnic differences to cultural factors rather than to genetic factors.

Table 2. Percentage Majoring in Physical Sciences, Life Sciences, and Mathematics by Sex and Ethnicity

	Percentage			*Total Number*	
	Men	*Women*	*Sex Difference*	*Men*	*Women*
Asian	68	45	23*	615	538
All Other Minority	37	17	20*	697	412
Nonminority	41	17	24*	4094	3040
Total	44	21	23*	5406	3990

Source: University of California, Berkeley, Student Resource Survey, Spring 1972.

*Percentage difference is statistically significant at the 0.05 level, using a conservative estimate of a two-tailed test.

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application to graduate school

The second filtering point in educational achievement for women and minorities is the decision to apply for graduate study. Table 3 shows the dropoff in the percentage of women in undergraduate and graduate study at Berkeley. This dropoff directly affects the availability of women for recruitment and hiring at the faculty level. Thus, while 22 percent of the undergraduates in the physical sciences are women, only 11 percent of the graduate students are women. A similar pattern exists in the reduction of Asian and other minority students from undergraduate to graduate study.

Table 3. Dropoff in Percentage Women from Undergraduate to Graduate Level

	Undergraduate	*Graduate*	*Dropoff*	*Dropoff Rate***
Mathematics Required				
Agricultural Sciences	48	30	−18*	−0.38
Chemistry	14	9	− 5	−0.36
Engineering	3	2	− 1	−0.33
Environmental Design	17	25	+ 8*	+0.47
Business Administration	17	9	− 8*	−0.47
Forestry and Conservation	7	6	− 1	−0.14
Optometry	17	12	− 5	−0.29
Letters and Science				
Biological Sciences	33	29	− 4	−0.12
Physical Sciences	22	11	−11*	−0.50
Total	20	12	− 8*	−0.40
Mathematics Not Required				
Criminology	46	38	− 8	−0.17
Letters and Science				
Humanities	58	48	−10*	−0.17
Social Sciences	46	33	−13*	−0.28
Total	50	40	−10*	−0.20

Source: Calculated from data in Table 1.

*Percentage dropoff from undergraduate to graduate level is statistically significant at the 0.05 level.

**Dropoff rate is calculated by the formula

$$\frac{\%\ \text{Undergraduates} - \%\ \text{Graduates}}{\%\ \text{Undergraduates}}$$

At the second filter it is clear from the data provided by the Berkeley Graduate Division that women and minorities are being admitted in the same proportion in which they apply. The problem is that they are not applying to graduate school in the same proportion as they earn undergraduate degrees in their respective schools, colleges, fields, and departments.

Recent data from Berkeley show large and statistically significant sex and ethnic differences in the percentage of students reporting the doctorate as the highest level of education they plan to complete. In the College of Letters and Science, 63 percent of the men compares to 36 percent of the women aspire to the doctorate. The fields in the college are reported in Table 4, with the humanities and social sciences grouped, and with physical sciences, life sciences, and mathematics as another group. In both groups, men

Table 4. Percentage of Doctoral Aspirants by Sex and Ethnicity, Controlling for Field

	Percentage of Doctoral Aspirants		*Sex Difference*	*Total Number of Students*	
	Men	*Women*		*Men*	*Women*
	Humanities and Social Sciences				
Minority					
Asian American	44	21	23*	195	295
All Other Minority	59	34	25*	438	343
Nonminority	57	33	24*	2419	2511
Total	56	32	24*	3052	3149
	Physical Sciences, Life Sciences, and Mathematics				
Minority					
Asian American	65	32	33*	420	243
All Other Minority	72	62	10	259	69
Nonminority	75	58	17*	1675	529
Total	73	51	22*	2354	841
	Field Difference				
Minority					
Asian American	21*	11*			
All Other Minority	18*	25*			
Nonminority	13*	28*			

Source: University of California, Berkeley, Student Resource Survey, Spring, 1972.

*Percentage difference is statistically significant at the 0.05 level.

are more likely to plan on the doctorate than women, and non-Asians more likely to do so than Asians.

If we assume that talent and willingness to work are randomly distributed between the sexes and among ethnic groups, the data suggest both a differential climate of encouragement and support for application to graduate school and a differential climate of aspirations about one's career goals, based on sex and ethnicity. In most social systems based on meritocracy and achievement, aspirations to move up the ladder are very much shaped by those who have already demonstrated their achievement, independently of the standards of evaluation and criteria for achievement involved. In the academic system, this means that faculty have the power to encourage potential talent regardless of the sex or ethnicity of the person who displays that talent. The primary goal of affirmative action is to free all persons to develop their talents and energies to highest potential, regardless of sex or ethnicity. Faculty members should recognize that their values of scholarship and excellence will be enhanced through affirmative action by removing previous constraints on the development of talent.

graduate support

The third filter in educational achievement for women and minorities involves survival in doctoral programs. Because there are insufficient data available on minorities at this level, the remainder of this paper is based on data about women. However, it is clear that the causal mechanisms which operate to filter women out of the doctoral pool operate even more intensely against minorities. These mechanisms include a social climate which systematically lowers aspirations, expectations, sense of competence, and self-esteem, both actively by discouragement and passively by absence of support and encouragement.

The facts in this section come from a secondary analysis of data gathered on Woodrow Wilson Fellows who entered graduate school from 1958 through 1963 (Mooney, 1966). At the time of the study, 49 percent of the Woodrow Wilson Fellows had not yet earned the doctorate, and were no longer in graduate school. Among the men, 44 percent had dropped out, compared with 64 percent of the women. Table 5 shows both large sex differences and field differences in dropouts. Interestingly enough, however,

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Table 5. Woodrow Wilson Fellows, 1958-1963
Dropouts by Sex and Discipline

	Percentage			*Total Number*	
	Men	*Women*	*Sex Difference*	*Men*	*Women*
Humanities	52	66	14*	1966	1192
Social Sciences	46	64	18*	2123	667
Physical Sciences	26	62	36*	1182	172
Biological Sciences	20	36	16*	112	69
All Disciplines	44	64	20*	5383	2100
Discipline Difference	32*	30*			

Source: The original Mooney data were obtained for secondary analysis by permission of Janet Mitchell, director of the Woodrow Wilson Dissertation Fellowship Program.

*Sex and discipline differences of dropouts are statistically significant at the 0.05 level.

women in the biological sciences were less likely to drop out than men in the humanities and social sciences. The contrast between the sexes in dropout rates between the physical sciences and the biological sciences--36 percent compared to 16 percent--suggests a more supportive climate for women in the biological sciences.

The effect of having second year financial support on dropout rates operates differently for men and for women. In the humanities, dropouts among men with no second year support are 57 percent, compared with 43 percent for those with second year support, a difference of 14 percent. For women with no second year support, 72 percent dropped out, compared with 43 percent of women with second year support, a difference of 29 percent. In the physical and biological sciences, the effect of second year support is even more dramatic for women. Dropout rates for men go from 33 percent to 16 percent, for a 17 percent decline, with second year support, compared with a reduction from 66 percent to 26 percent, or a 40 percent decline, for women.

This large difference reflects the special kind of self-esteem and assertiveness it presently takes for a woman to think her work is good enough to justify applying for support. If she thinks well of her work, she is free to communicate her worth to others. Traditional female socialization has taught young girls that assertiveness is unfeminine, just as traditional ethnic socialization had taught blacks that the Uncle Tom role was the key to their survival in a racist society.

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After the first year of graduate school, department chairmen were asked to rate the Woodrow Wilson Fellows compared with other graduate students in their respective departments. Table 6 shows the effect on sex differences in dropouts when graduate rating by faculty is controlled. A reasonable assumption is that in a pure meritocracy, where talent and willingness to work are the primary determinants of success, dropout rates would be low among those rated *excellent* by their faculty, and high among those rated *average*. In fact, the overall sex difference in dropouts of 20 percent rises to 26 percent among those rated *excellent*. When field is also controlled, it rises to 38 percent in the physical sciences. The critical point is that there is no statistically significant difference in the dropout rates of women rated *excellent* and of men who are rated *average* by their faculty. This fact points to a second major goal of affirmative action—to make it possible for the achievements of women and minorities rated *excellent* to surpass those of white men rated *average*.

From 1962 to 1968 a dramatic reduction occurred in the fourth year dropout rates among women doctoral students at Berkeley. In the entering cohort of 1962, 22 percent of the 1093 men had dropped out of the doctoral program by the fourth year. In that same cohort, 42 percent of the women had dropped out by the fourth year. Six years later, the sex differences in fourth year dropout rates had disappeared for the 1968 cohorts. By 1972, 27 percent of the men had dropped out, compared to 27 percent of the women.

Reduction of attrition among women at Berkeley has been

Table 6. Woodrow Wilson Fellows, 1958-1963
Dropouts by Sex and Graduate Rating

	Percentage			*Total Number*	
Graduate Rating	*Men*	*Women*	*Sex Difference*	*Men*	*Women*
Excellent	32	58	26*	860	270
Very good	44	67	23*	677	271
Average	61	80	19*	455	175
Graduate Rating Difference	29*	22*			

Source: *Supra.*

*Sex and rating differences of dropouts are statistically significant at the 0.05 level.

most dramatic in the English and history departments. In the entering class of 1962, 88 percent of the women in English had dropped out by the fourth year, compared with 47 percent of the women in the class of 1968, a reduction of 41 percent. In the entering class of 1962, 81 percent of the women in history had dropped out by the fourth year, compared with 41 percent of the entering class of 1968, a reduction of 40 percent.

This reduction of attrition of women doctoral students has occurred independently of difficult efforts to achieve a meaningful affirmative action plan by the administration. It can be attributed both to the powerful social support of the women's movement, and to the fact that faculty at Berkeley are learning not to impose expectations and stereotypes based on the behavior of some women in the 1960s on the behavior of other women in the 1970s.

faculty recruitment

The fourth filtering point in educational achievement of women and minorities is the traditional academic recruiting system, sometimes called the "old boy" or "buddy" system. Until federal policy on affirmative action required open search and recruitment procedures, job openings at first rate doctoral institutions had often been limited to acquaintances and colleagues of those in a position to do the recruiting and hiring.

In 1968, the Carnegie Commission on Higher Education sponsored a national survey of higher education (Trow and others, 1972). Analysis of the data on faculty members at a sample of universities designated *high quality* shows very large sex and discipline differences in the percentage of affirmative responses to the question, "As a graduate student, was there a faculty member who acted as your sponsor when you were looking for your first job?" (See Table 7.) With the exception of the social sciences, in which there were no sex differences, the pattern of sex and discipline differences in sponsorship is consistent with the pattern of dropouts by sex and discipline in the Woodrow Wilson data. That is, smaller proportions of women received this kind of important support, and smaller proportions of people in the humanities received it than in the biological and physical sciences. The discipline difference is almost twice as large for women (27 percent) as it is for men (15 percent).

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Table 7. Faculty at High Quality Universities Who Reported Having Had a Faculty Sponsor, by Sex and Field**

	Percentage			*Total Number*	
Field	*Men*	*Women*	*Sex Difference*	*Men*	*Women*
Humanities	56	41	15*	1719	235
Physical Sciences	66	45	21	1526	65
Social Sciences	71	68	3	1445	146
Biological Sciences	64	46	18*	1069	110
Total	64	50	14*	5759	556

Source: Secondary Analysis of Data Gathered by the National Survey of Higher Education, Sponsored by the Carnegie Commission on Higher Education.

*Statistically significant at the 0.05 level.
**The Carnegie Commission data based on institutions designated *high quality university* do not include medium or low quality universities, four year colleges, or junior colleges.

The pattern of sex and discipline differences in dropouts is repeated in the pattern of graduate student responses to the Carnegie Commission survey question, "Does the Professor with whom you have the most contact outside the classroom regard you primarily as: a colleague; an apprentice; an employee; a student; no contact outside the classroom." The discipline differences are larger than the sex differences, with 72 percent of the men in psychology reporting collegial or apprentice relations with their primary faculty contact, compared with 39 percent of the men in mathematics. Nevertheless, among the women in psychology, 53 percent reported collegial or apprentice relations with their primary faculty contact, compared with 22 percent of the women in mathematics.

promotion and tenure

The fifth filter in educational achievement for women, but probably not for minorities, is the underutilization of women who have pulled themselves into the availability pool for faculty hiring by virtue of having earned the doctorate. Table 8 shows the juxtaposition of availability pools and utilization for selected disciplines. The availability pools are defined here as the percentage of women earning the doctorate in the decade of the 1960s for each field. Utilization is defined here as the percentage of women among those persons with a doctorate on the faculties of high quality universities

in the Carnegie survey. This gives a conservative estimate of underutilization, since the proportion of women earning doctorates is higher among the high ranking institutions than among other universities (Sells, 1973, pp. 15-20).

Underutilization is largest in the humanities, which has an availability pool of 18 percent of the doctorates granted in the 1960s to women, but where only 8 percent of the faculty members with doctorates are women, giving an underutilization rate of 10 percent. A detail of this underutilization not shown in the summary information of Table 8 is an availability pool of 24 percent for women with doctorates in English, and utilization of only 5 percent, resulting in 18 percent underutilization.

Not only is the available pool of qualified women being underutilized in the sample of high quality universities; it is also disproportionately distributed at the lower end of faculty ranks. Table 9 shows the percentage of women among the faculty with doctorates by rank and field. For each field, the percentage of women gets larger down the ranks from full professor to instructor or lecturer. There are large and statistically significant differences in all but the physical sciences, where the small size of the availability pool places an artificial ceiling on underutilization.

The difference in the percentage of women from full professor to instructor or lecturer grows *larger* with each increase in the length of time spent at the institution. Among those who have been at their institution up to three years, the rank difference is fourteen

Table 8. Women in Availability Pools and Women Ph.D.s on Faculties of High Quality Universities for Academic Disciplines

Discipline	*Availability Pool Percentage (Number)*	*Utilization Percentage (Number)*	*Underutilization*
Humanities	18 (22,392)	8 (1525)	10*
Social Sciences	15 (22,854)	8 (1319)	7*
Biological Sciences	14 (17,708)	8 (957)	6*
Physical Sciences	5 (31,902)	3 (1388)	2
Total Academic	12 (94,856)	7 (5189)	5*

Source: *Availability Pools:* Women's Equity Action League, *Proportion of Doctorates Earned by Women, by Area and Field, 1960-1969*, June 1971. *Utilization:* Secondary Analysis of the National Survey of Higher Education, sponsored by the Carnegie Commission on Higher Education.

*Statistically significant at the 0.05 level.

Table 9. Women Among Faculty Members with Doctorates, by Rank and Field

	Full Professor Percentage (Number)	*Associate Professor Percentage (Number)*	*Assistant Professor Percentage (Number)*	*Instructor, Lecturer Percentage (Number)*	*Rank Difference*	*Total Percentage (Number)*
Humanities	3 (588)	7 (332)	12 (529)	30 (76)	27*	8 (1525)
Social Sciences	2 (490)	6 (298)	11 (441)	27 (90)	25*	8 (1319)
Biological Sciences	2 (393)	8 (235)	13 (287)	33 (42)	31*	8 (957)
Physical Sciences	1 (587)	3 (292)	5 (390)	4 (119)	3	3 (1388)
Total Academic Fields	2 (2058)	6 (1157)	10 (1647)	20 (327)	18*	7 (5189)

Source: Secondary Analysis of Carnegie Data.

*Statistically significant at the 0.05 level.

Table 10. Women Among Faculty with Doctorates by Rank and Number of Years at Institution

	Full Professor Percentage (Number)	*Associate Professor Percentage (Number)*	*Assistant Professor Percentage (Number)*	*Instructor, Lecturer Percentage (Number)*	*Rank Difference*	*Total Percentage (Number)*
Less than, or up to three years	2 (326)	5 (423)	7 (1513)	16 (291)	14*	7 (2553)
Four to six years	4 (296)	4 (533)	13 (633)	23 (71)	19*	8 (1533)
Seven or more years	2 (2391)	8 (833)	25 (142)	30 (76)	28*	5 (3442)
Total All Fields	2 (3013)	6 (1789)	10 (2288)	19 (438)	17*	6 (7528)

Source: Secondary Analysis of Carnegie Data.

*Statistically significant at the 0.05 level.

points. Among those who have been at the institution seven or more years, the rank difference in percentage of women is twenty-eight points. (See Table 10.)

The data demonstrate both the underutilization of those women who already belong to the pool of qualified persons in a national sample of faculty at high quality universities, and the differential distribution of women at the ranks of instructor and lecturer. Berkeley shows a similar pattern to the Carnegie data, but with only 5 percent women among the assistant professors, and 27 percent women among the instructors and lecturers (*Report of the Committee on Senate Policy*, page 25). At Berkeley, these latter ranks are separate, nonladder ranks, from which it is impossible to transfer into the ladder ranks assistant, associate, and full professor for promotion and tenure.

Colleges and universities are making tremendous progress in new appointments at the assistant professor level. As Robert Johnson pointed out in an earlier chapter, 27 percent of the new hires at Berkeley in 1973-1974 were women, compared to only 3 percent in 1967-1968, and similar progress has been reported by administrators at Stanford, Princeton, and Yale. In all four cases administrators have assured me that the caliber of new hires under affirmative action recruiting has increased, rather than decreased. This is an important refutation of the argument that affirmative action on behalf of women and minorities will destroy standards of scholarship and excellence. These kinds of results indicate that traditional recruitment patterns are changing. It is hoped that traditional patterns of promotion and tenure are also changing, and that the assistant professorship will not become a revolving door for women and minorities.

summary

This chapter has identified five major filtering points which have operated to keep women and minorities from achieving fullest potential in the educational system. Effective affirmative action for colleges and universities requires that special attention be given to these points:

1. Failure to take high school mathematics limits choice of undergraduate majors. Women and non-Asian minorities are systematically underrepresented in undergraduate majors requiring calcu-

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lus. This requires improved counseling in high school to match changing role expectations for women and minorities.

2. Women and minorities are considerably less likely to plan to work for a doctorate. This requires raising levels of ambition and aspirations consistent with levels of talent and changing role expectations based on traditional sex and ethnic stereotypes.

3. Until very recently, women graduate students have had higher dropout rates than men. Attention needs to be paid to ways of increasing social support for women and minorities, to keep them in doctoral programs long enough to taste the rewards of success in the field.

4. Academic recruitment and hiring has been limited by reliance on the "old boy" or "buddy" system. Attention needs to be paid to opening up search and recruitment procedures to include qualified women and minorities, at ladder level appointments, rather than at dead end levels.

5. Promotion and tenure procedures need to be examined to make sure that standards of evaluation do not assume that, by definition, being female or a member of an ethnic minority are demerits.

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toward affirmative action

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issue editor

Jossey-Bass Inc., Publishers
San Francisco • Washington • London

EXHIBIT III

EARNED DEGREES CONFERRED IN 1976, ALL INSTITUTIONS:
PERCENTAGE WOMEN, BY FIELD

Field	Baccalaureate		Master's		Doctorate	
	% Women	Total Degrees	% Women	Total Degrees	% Women	Total Degrees
Agriculture, Natural Resources	18%	19,460	14%	3,351	7%	928
Architecture, Environ. Design	19%	9,168	21%	3,215	16%	82
Area Studies	55%	3,111	45%	945	32%	182
Biological Sciences	35%	54,913	32%	6,621	22%	3,397
Business & Management	20%	145,035	7%	66,537	5%	956
Communications	41%	21,282	42%	3,128	25%	204
Computer and Information Sci.	20%	5,654	14%	2,603	9	244
Education	73%	156,528	64%	128,410	33%	7,769
Engineering	3%	46,717	4%	16,349	2%	2,823
Fine and Applied Arts	61%	42,371	49%	8,820	28%	620
Foreign Languages	76%	15,587	67%	3,541	48%	864
Health Professions	79%	54,339	66%	12,696	29%	577
Home Economics	96%	17,523	92%	2,187	71%	178
Law	19%	531	12%	1,442	4%	76
Letters	57%	52,292	58%	11,356	37%	2,452
Library Science	93%	843	78%	8,084	45%	71
Mathematics	41%	16,085	34%	3,863	11%	856
Physical Sciences	19%	21,559	15%	5,485	9%	3,433
Psychology	54%	50,363	47%	7,859	32%	2,581
Public Affairs and Services	44%	33,592	45%	17,333	32%	319
Social Sciences	38%	127,936	32%	15,902	22%	4,160
Theology	27%	5,537	32%	3,292	4%	1,033
Interdisciplinary Studies	45%	30,800	46%	3,791	32%	273
Total	46%	934,443	46%	313,001	23%	34,076

Source: National Center for Education Statistics. Compiled from table printed in THE CHRONICLE OF HIGHER EDUCATION, October 11, 1977.
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EARNED DEGREES CONFERRED IN 1976, FIRST PROFESSIONAL DEGREES:
PERCENTAGE WOMEN BY FIELD

	Public Institutions		Private Institutions		All Institutions	
Field	% Women	Total Degrees	% Women	Total Degrees	% Women	Total Degrees
Dentistry	4%	3,202	5%	2,276	5%	5,478
Medicine	15%	7,901	17%	5,639	16%	13,540
Optometry	12%	297	6%	678	8%	975
Osteopathic Med.	14%	119	6%	699	4%	1,518
Pharmacy	33%	125	28%	314	30%	439
Podiatry	-	-	3%	428	3%	428
Veterinary Med.	17%	1,392	29%	140	18%	1,532
Chiropractic	-	-	9%	1,577	9%	1,577
Law, general	20%	13,041	19%	19,494	19%	32,535
Theological Professions	-	-	8%	5,709	8%	5,709
Total	16%	26,077	15%	36,954	15%	63,731

Source: National Center for Educational Statistics. Compiled from table printed in THE CHRONICLE OF HIGHER EDUCATION, October 11, 1977.

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EXHIBIT IV

The Forum

Mathematics—a critical filter

Lucy W. Sells

Any knowledgeable secondary school counselor can tell you that a background of four years of high school mathematics will increase one's chances of succeeding in a college science program. Yet, untold numbers of young women—and many minorities as well—continue to be the victims of the invisible "mathematics filter," which operates to deny them access to undergraduate majors in the sciences and hence to related career opportunities.

Science teachers at the junior high and high school levels must make their students understand that by choosing not to take basic secondary courses in mathematics, they dramatically limit their career options, not only in science and technology, but also in business, landscape architecture, computer science, management, and a host of other fields.

"Everybody knows," except parents and students, that a career in the sciences requires considerable college-level mathematics, including calculus. "Everybody knows," except parents and students, that the most efficient and effective way to qualify for the calculus sequence in college is to take as many as possible of the following high school mathematics courses:[1]

- First year of *algebra*, to include in addition to the basic topics: linear equations, systems of equations, integer exponents, special products, and factoring.
- One year of *geometry*, to include basic properties of geometric figures in two and three dimensions, applications of formulas for perimeters, areas, volumes, and surface areas.
- Second year of *algebra*, to include in addition to the basic topics, quadratic equations (including the method of completing the squares), polynomial functions, rational expressions, graphs of functions, fractional exponents, radicals, logarithms, exponential and logarithmic equations, arithmetic and geometric sequences, the binomial theorem, infinite geometric series, linear and quadratic inequalities.
- One year of *pre-calculus mathematics*, including the study of elementary functions and the equivalent of one semester of trigonometry. Topics in trigonometry should include: trigonometric functions and their graphs, degree and radian measures, trigonometric identities and equations, inverse trigonometric functions and their graphs.
- Highly recommended, too, is a course in probability and statistics, and/or a course in computer programming.

In spite of this "common knowledge," I found in a 1972 survey that, among the top 12.5 percent of high school graduates admitted to the University of California at Berkeley, 43 percent of the entering men and 92 percent of the entering women did *not* have the second year of algebra and the pre-calculus trigonometry background required to prepare for the standard freshman calculus sequence.[2] Thus, 92 percent of the women in this class were effectively relegated to five fields: the humanities, music, social work, elementary education, and guidance and counseling.

Recent data on SAT math scores tell a similarly dismal story: Among high school seniors taking the test in preparation for 1975–76 college admission, 23 percent of the men scored over 600 on mathematics skills, compared with only 10 percent of the women.[3] Again, "everybody knows," except parents and students, that SAT scores are strongly related to the number of mathematics courses taken in high school, and to the number of English composition courses taken in high school.

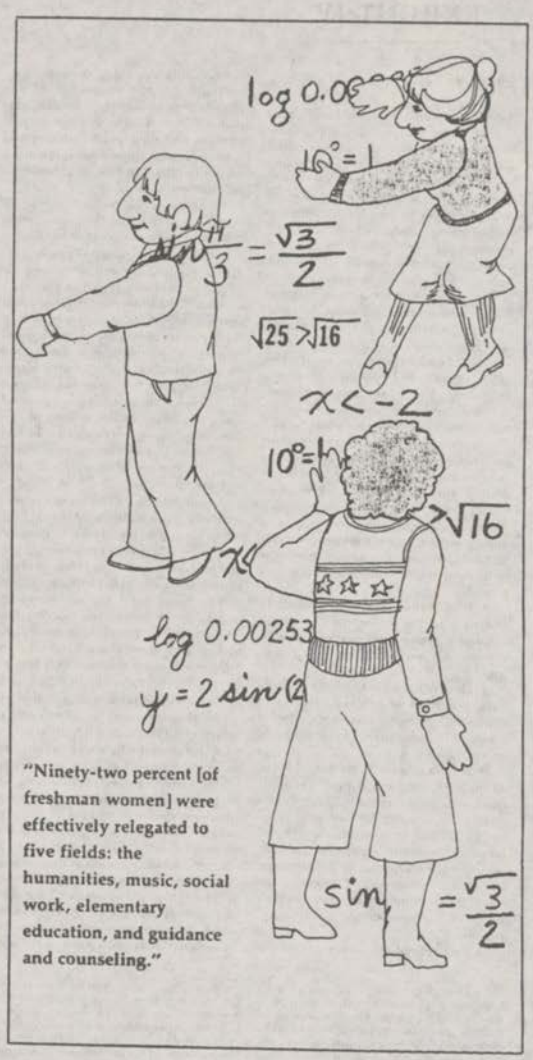
Some will be quick to suggest that traditional differences in mathematics achievement might be a reflection of "innate" sex-related difference in ability. But sufficient numbers of highly successful "intervention" projects addressing the problem of women's avoidance of mathematics suggest that the case for "innate" differences is not a strong one, and that we should instead look to such factors as teacher competence, their enthusiasm for the subject, and their faith in the capacity of their students. The following are some of the more notable of these projects, which vary in target populations: by age, by social class, by sex, and by race. Taken

Lucy W. Sells, acting assistant to the vice chancellor for academic affairs at the University of Maryland, College Park, did graduate work in sociology at the University of California, Berkeley, where her dissertation research was on "Sex, Ethnic, and Field Differences in Doctoral Outcome." She would like TST readers to inform her of successful intervention projects in mathematics, other than those mentioned in this article. (Address: Office of the Vice Chancellor for Academic Affairs, University of Maryland, College Park, MD 20742.)

[1] Adapted from *The Math in High School . . . You'll Need for College*. Mathematical Association of America, 1225 Connecticut Ave. NW, Washington, DC 20036. (This leaflet—free in quantities up to 50—spells out mathematics prerequisites for beginning study in a variety of college programs. It was prepared with the cooperation of the National Council of Teachers of Mathematics.)

[2] Sells, L. W. "Critical Points for Affirmative Action." In *Toward Affirmative Action* #3, Autumn 1974. *New Directions for Institutional Research*, edited by L. W. Sells. Jossey-Bass, San Francisco, Calif.

[3] *College Bound Seniors 1975–1976*. Admissions Testing Program, College Entrance Examination Board, prepared by Educational Testing Service, Princeton, N.J.



"Ninety-two percent [of freshman women] were effectively relegated to five fields: the humanities, music, social work, elementary education, and guidance and counseling."

together, their success shatters traditional myths about "ability" and achievement.

1. *Project SEED* (Special Elementary Education for the Disadvantaged) has worked effectively with fourth- and fifth-grade children from "disadvantaged" urban schools, using trained mathematicians who love and understand the subject to lead students to discover and master the tools of college-level algebra. Awareness of potential in mathematics has resulted in similar discoveries in other basic skill areas, including the sciences. (Inquiries may be directed to: Bill Johntz, Project SEED, 1011 Keith, Berkeley, CA 94708.)

2. *Math for Girls* provides small after-school and weekend classes for elementary and junior-high school girls, in which they discover that mathematics can be fun. "Hands-on" experiences in manipulating objects and puzzles give participants the opportunity to discover their own potential. (Inquiries may be directed to: Nancy Kreinberg, Lawrence Hall of Science, University of California, Berkeley, CA 94720.)

3. *Pre-Calculus Laboratory* familiarizes students with the language of calculus *before* they get involved in its operation. The laboratory course prepares students for the calculus sequence, regardless of earlier preparation. The mean Graduate Record Examination (GRE) scores of students participating in the lab were 100 points higher than the mean GRE's of nonparticipants. (Inquiries may be directed to: Dr. Lenore Blum, Director, Computer-Science Mathematics Department, Mills College, Oakland, CA 94613.)

4. *The Oregon Mathematics Education Council* aims to transform classroom teachers at the elementary and secondary levels from mathephobics into math enthusiasts. The success of the project suggests that people are never too old to discover the delights of mastering mathematics skills, and that people are freer to discover those delights when among colleagues and peers. (Inquiries may be directed to: Dr. Eugene Maier, OMEC, 325 13th St. NE, Unit 301, Salem, OR 97301.)

Ours is an increasingly technological society in which those who have no training in basic computation and the use of numbers and symbols will become virtual "illiterates." Thus we must encourage *all* of our students to keep their career options open by taking as much mathematics as possible at the secondary level. ■

EXHIBIT V

DISTRIBUTION OF PANEL ON PRE-COLLEGE TEACHER DEVELOPMENT IN SCIENCE BY SEX AND FIELD: NATIONAL SCIENCE FOUNDATION

Field	Men	Women	Percent Women	Total
Education				
Elementary	2	16	89%	18
Secondary	21	20	49%	41
Post-secondary Schools of Ed.	41	10	20%	51
State Dept. Ed.	1	4	*	5
Local District	5	8	*	13
Total Educators	70	58	45%	128
Sciences				
Mathematics	27	7	21%	34
Physics	13	-	*	13
Biological Sci.	8	3	*	11
Chemistry	8	1	*	9
Geological Sci.	7	-	*	7
Engineering	4	-	*	4
Sociology	1	2	*	3
Environmental Sci.	2	-	*	2
Medical School	2	-	*	2
Psychology	-	1	*	1
Computer Science	1	-	*	1
Social Science	1	-	*	1
Science	1	1	*	2
Total Scientists	73	15	17%	88

* Numbers are too small for stable percentages. Among those in education, and between those in education and the sciences, the patterns are clear, and statistically significant.

This table was compiled from the list of panelists for March 31-April 2, 1977 review of proposals on pre-college teacher development in science, by Lucy W. Sells, Executive Specialist for Minorities and Women, American Sociological Association.
3/31/77

DISTRIBUTION OF EDUCATORS AND OF SCIENTISTS ON PANEL ON PRE-COLLEGE TEACHER DEVELOPMENT BY RACE: NATIONAL SCIENCE FOUNDATION, 1977

	Educators	Scientists	Total
Black	9	9	18
Chicano	1	4	5
Puerto Rican	2	-	2
Native American	1	5	6
Asian	4	1	5
Total Minority	17	19	36
White	111	69	180
Total	128	88	216
Percent Minority	13%	22%	216

Compiled from list of panelists for March 31 - April 2, 1977 review of proposals on pre-college teacher development in science, by Lu y W. Sells, Executive Specialist for Minorities and Women, American Sociological Association. 4-6-77

"Educators" include classroom teachers and administrators at primary and secondary levels, and people in schools of education at the post-secondary education level. "Scientists" include faculty at colleges and universities in mathematics, engineering, physical sciences, biological sciences, and the social sciences.

Senator KENNEDY. Mr. Helminski, director, energy and natural resources program, National Governors' Association, and former director, National Council of State Legislatures, Office of Science and Technology.

STATEMENT OF EDWARD L. HELMINSKI, DIRECTOR, ENERGY AND NATURAL RESOURCES PROGRAM, NATIONAL GOVERNORS' ASSOCIATION FORMER DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY, NATIONAL CONFERENCE OF STATE LEGISLATURES

Mr. HELMINSKI. My statement today is presented not only on behalf of the Nation's Governors, but reflects the concerns of other major public interest organizations representing State and local governments, namely the National Conference of State Legislatures and the U.S. Conference of Mayors.

I will paraphrase my statement. Each group did, however, desire to address the committee independently, but we agreed on having one spokesman today. I think both organizations will submit written statements.

The intent of my statement is threefold:

1. To request that the committee authorize in fiscal year 1979, $42 million over a 5-year period for the implementation phase of the State science, engineering, and technology program.

2. To support a continued and strengthened research applications effort within the reorganized applied science and research application directorate of the Foundation.

3. To request the chairman's support, and the support of other members of the subcommittee, for the institutionalization of effective intergovernmental mechanisms within the National Science Foundation, particularly within the applications directorate to assure that the programs are responsive to the needs of State and local governments.

I would like to first compliment you, Senator Kennedy, on behalf of the Governors, legislators and all State and local officials and their associated organizations for your continued and unfailing support of efforts to develop and strengthen the scientific and technological capacity of State and local governments.

Your recognition of the complex problems that face State and local governments and the responsibility of the Federal agencies to assure that the vast amount of moneys expended on civilian R. & D. are meeting State and local needs has been the impetus behind the continued strengthening of the Foundation's intergovernmental science program and applied research activities.

The State science, engineering and technology program, authorized in fiscal year 1977 could not have been initiated without your strong support. The National Governors' Association and all the organizations representing State and local officials on behalf of their constituents are indebted to you and look forward to working with you and the subcommittee on programs that will assure the evolvement of a strong National Government able to meet the complex problems of today and the future through the development of an effective partnership between the Federal, State and local governments, where all have the capacity to identify, define, and communicate their R. & D. needs.

This increased influence of science and technology on public policy

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poses a unique challenge to State and local governments. The bulk of research spending has occurred in the private sector and in the Federal Government: State and local governments have not been suppliers of a new technology.

Indeed, the function of these governments as providers of traditional services has offered little reason to develop a scientific capacity. New technology has been introduced to State and local services as independent vendors.

In recent years, however, the relationship between scientific knowledge and the performance of governmental institutions has taken on a different meaning. For example, growing awareness of man's destructive effect upon the physical environment has introduced expanded governmental regulatory power. As a result of this expansion, decisions by State and local policymakers have a far-reaching and long-range effect upon the social, economic and physical health of their constituents. Nuclear power development, air pollution and groundwater resource exploration are now the objects of Government intervention. The knowledge that erroneous or ill-advised policies can bring disastrous consequences has brought sobering, new obligations to elected officials.

Recognizing that an expanding set of public policy issues have scientific and technical dimensions, it is critical now more than ever that the initiative that began with the study grants under the SSET program in 1977 be carried through without interruption, into an implementation phase in fiscal year 1979.

The National Governors' Association and the National Conference of State Legislatures supported by the other State and local organizations request that the committee authorize to the National Science Foundation $42 million in fiscal year 1979 for a 5-year implementation phase of the State science and engineering technology program. This funding level is designed to provide each branch of State government with a $100,000 maximum for the first 2 years, $80,000 for the third and fourth years, and $60,000 for the fifth and final year.

This type of seed money program will allow the States to demonstrate the effectiveness of an increased S/T capacity to their constituencies and enhance the possibility of a continued program with State funds.

The intergovernmental program within NSF has proven such a seed money program can be successful.

Several demonstration S/T capacity building projects supported by the NSF over the last several years have resulted in the institutionalizing of S/T mechanisms within both the legislative and executive branches of State government.

In Hawaii, NSF seed money was instrumental in the institutionalizing of a center for science and technology assessment, now almost wholly supported by the State government. The Governor of Michigan has requested $50,000 of State money this year to continue a program started, and proven effective through the use of NSF seed money. In the legislatures of Minnesota, Massachusetts, New York, Illinois, and Pennsylvania NSF demonstration project support paved the way for continued State funding.

Support for the SSET implementation program is based on the belief that simultaneous efforts in all the States, coupled with a co-

operative Federal posture, would provide a mutually reinforcing impetus to establish an effective nationwide S/T capacity.

Under the study grant program which was authorized last year, the amount of money involved was $2.5 million. It only provided $25,000 to each branch of government in the State. Yet, 49 executive branches are participating, and 42 State legislatures are involved in the program, and the States themselves have matched the Federal money with over $1.5 million.

In addition to the SSET program, the public interest groups are also very interested in other programs within the National Science Foundation, and have closely monitored the reorganization of RANN into the ASRA Directorate, and though generally approving of the reorganization, remain concerned about the role of applied research benefiting State and local government.

Doctor Atkinson, the Director of the NSF, and Doctor Sanderson, the Assistant Director for ASRA, have to their credit met with the executive directors of the various State and local groups to explain the objectives of ASRA, and have stated their intent to assure that existing efforts with State and local governments will be strengthened. Our input has been solicited and welcomed.

On behalf of the interest groups, I would, however, like to express some of our concerns and ask your support and the subcommittee's cooperation, so that State and local government needs will continue to be met.

Although ASRA is intended to maintain and strengthen the past activities of RANN, not much progress will be made until the NSF recognizes the importance of the role of applied problem-solving research. From our vantage point, this recognition will not be accomplished until State and local officials have representation on the NSF Board of Directors and therefore have a voice in establishing NSF programs and priorities.

In addition to membership on the Board, State, and local government representatives must be directly involved, through institutionalized mechanisms, in the planning and evaluation of ASRA programs. The Intergovernmental Science, Engineering, and Technology Advisory Panel's Task Force on Science and Technology of the OSTP, chaired by Mr. Ted Tedesco, has made similar observations and recommendations.

I would ask the chairman's permission to submit the task force's report for the record.

All the major public interest groups are represented on this task force, and endorse the stated recommendations.

I have a copy of it here, and I will provide it to your staff.

[The following was received for the record:]

National Governors' Association

William G. Milliken
Governor of Michigan
Chairman

Stephen B. Farber
Director

April 13, 1978

Ann Strauss
Professional Staff Member
Special Subcommittee on the
National Science Foundation
Senate Committee on Labor and
Public Welfare
Senate Courts Bldg
120 C St NE Room 308-C
Washington, DC 20510

Dear Ann:

Enclosed are the materials which I sought to introduce into the record of the NSF authorization hearing of April 10.

On behalf of NGA, NCSL, the Conference of Mayors and the other public interest groups, I would like to thank Senator Kennedy and the Committee for the opportunity to appear in person to testify on the concern and interest of state and local government in the continuing operations of the National Science Foundation and the Applied Science and Research Applications Directorate.

We look forward to working with the Committee to assure the continuation of the State Science, Engineering and Technology Program within the states during FY 79 as Senator Kennedy discussed on Monday.

Sincerely,

Edward L. Helminski
Director
Energy and Natural Resources
Program

Enclosures

SCIENCE AND TECHNOLOGY

STATE AND LOCAL GOVERNMENTS ARE CONFRONTED BY AN EVER INCREASING NUMBER OF PROBLEMS THAT ARE COMPLICATED BY SCIENTIFIC AND TECHNOLOGICAL CONSIDERATIONS. MANY OF THESE PROBLEMS ARE BROUGHT ABOUT AS A RESULT OF FEDERAL PROGRAMS AND REGULATIONS IMPOSED UPON THE STATES.

AT THE SAME TIME, THE FEDERAL GOVERNMENT SUPPORTS A MULTI-BILLION DOLLAR RESEARCH AND DEVELOPMENT BUDGET WHICH DOES NOT EFFECTIVELY MEET STATE AND LOCAL NEEDS. ALTHOUGH MANY GOVERNMENT-FINANCED DISCOVERIES IN SCIENCE AND TECHNOLOGY HAVE BEEN ADAPTED FOR PRACTICAL USE, THIS APPLICATION HAS OFTEN BEEN MERELY COINCIDENTAL BECAUSE FEDERAL RESEARCH AND DEVELOPMENT GENERALLY IS NOT UNDERTAKEN TO ADDRESS SPECIFIC AREAS OF CONCERN AS DEFINED BY STATE AND LOCAL GOVERNMENTS.

IF THE GENERAL PUBLIC IS TO DERIVE MAXIMUM BENEFIT FROM THE CIVILIAN-ORIENTED RESEARCH AND DEVELOPMENT BUDGET SUPPORTED AT GREAT TAXPAYER EXPENSE, ITS INVESTMENT MUST BE RECONSIDERED TO EMBRACE THIS BROADER RANGE OF SCIENTIFIC AND TECHNICAL PROBLEMS.

IN ORDER TO ACHIEVE THIS GREATER RETURN FOR STATE GOVERNMENTS AND THEIR CITIZENS, A STRONGER LONG-TERM RELATIONSHIP WITH THE EXISTING FEDERAL SCIENCE AND TECHNOLOGY ESTABLISHMENT MUST BE FORGED. THE CREATION OF THE INTERGOVERNMENTAL SCIENCE, ENGINEERING AND TECHNOLOGY ADVISORY PANEL (ISETAP) UNDER THE CHAIRMANSHIP OF THE DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY PROVIDES THE MECHANISM FOR DIRECT COMMUNICATION WITH THE FEDERAL GOVERNMENT. THE DEGREE TO WHICH ISETAP REALIZES ITS POTENTIAL IS DEPENDENT UPON THE BREADTH OF INTERPRETATION WITH WHICH THE PANEL ADDRESSES ITS CHARGE.

IN ORDER TO MEET STATE RESPONSIBILITIES, STATE CAPABILITIES MUST BE IMPROVED TO ENCOMPASS A GREATER RECOGNITION OF THE IMPORTANCE OF THE SCIENTIFIC AND TECHNO-

LOGICAL ELEMENTS IN STATE POLICY ISSUES. THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY (SSET) PROGRAM WAS CREATED BY THE CONGRESS, WITH THE SUPPORT OF THE NATIONAL GOVERNORS' ASSOCIATION, TO ASSIST STATE EXECUTIVES AND LEGISLATORS IN DEVELOPING THIS CAPACITY.

THE NATIONAL GOVERNORS' ASSOCIATION HAS ENDORSED, AND VIRTUALLY ALL OF ITS MEMBERS ARE PARTICIPATING IN, THE PLANNING PHASE OF THE SSET PROGRAM. IT HAS BEEN WELCOMED AS A COOPERATIVE EFFORT TO BUILD WITHIN THE STATES A GREATER CAPACITY FOR RESOLVING POLICY ISSUES THAT HAVE SIGNIFICANT SCIENTIFIC OR TECHNOLOGICAL CONTENT.

HOWEVER, CAPACITY-BUILDING IS A GRADUAL AND LABORIOUS PROCESS. NEW INSTITUTIONS CREATED THOUGHTLESSLY SELDOM SURVIVE, AND OLD INSTITUTIONS YIELD SLOWLY TO PRESSURES FOR CHANGE. PROGRAMS LIKE SSET MUST BE SUSTAINED AT REASONABLE LEVELS AND FOR A REASONABLE TIME IF THEY ARE TO SUCCEED.

WE ARE THEREFORE DISMAYED BY THE UNEXPECTED DELETION OF FEDERAL SUPPORT FOR SSET FROM THE 1979 EXECUTIVE BUDGET. SSET OBJECTIVES CANNOT BE ACHIEVED UNLESS PLANNING STUDIES CURRENTLY UNDERWAY ARE SECURED BY A COMMITMENT TO IMPLEMENTATION.

THE NATIONAL GOVERNORS' ASSOCIATION URGES CONGRESS TO RESTORE SSET FUNDING FOR FISCAL YEAR 1979 AT A LEVEL OF $100,000 PER STATE FOR THE EXECUTIVE BRANCH, WITH AN EQUAL APPORTIONMENT FOR EACH STATE LEGISLATURE. IN ORDER TO ENSURE THE LONG-TERM COMMITMENT REQUIRED FOR MEANINGFUL IMPLEMENTATION, WE FURTHER URGE CONSIDERATION FOR A FIVE-YEAR AUTHORIZATION ACT.

Replaces existing F. - 13

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE • BOSTON 02133

MICHAEL S. DUKAKIS
GOVERNOR

March 21, 1978.

The Honorable Edward W. Brooke
U.S. Senate
421 Russell Building
Washington, D.C. 20510

Dear Senator Brooke:

As you consider the National Science Foundation's appropriation for FY 79, I urge that you keep in mind the importance which the States, including Massachusetts, have placed on the State Science, Engineering and Technology (SSET) program. Created through the NSF authorization in 1977, the SSET program has made study grants available to each state executive and legislative branch to enable them to study ways to better integrate scientific and technical resources into their governing process. Both my office, through the Department of Environmental Affairs, and the state legislature are now conducting SSET studies which will be completed this fall. We understand that although the Administration is supportive of the program's objectives and had seriously considered including funds for it in the FY 79 budget, a decision was made to postpone the implementation phase of the program until 1980. This decision was part of an overall decision not to fund new programs in 1979. However, our programs, like those in most other states, will be ready far in advance of FY 80. In order to avoid a year's gap which could seriously impede our progress in this area, we ask that the NSF appropriation be increased by $10 million for the SSET program in 1979.

Sincerely,

Michael S. Dukakis

MSD/s

bcc: Evelyn F. Murphy
Commissioner Richard Kendall
Peggy Carey

INITIAL REPORT ON

THE NATIONAL SCIENCE FOUNDATION

PREPARED FOR THE

INTERGOVERNMENTAL SCIENCE, ENGINEERING, AND

TECHNOLOGY ADVISORY PANEL

BY

ITS TASK FORCE ON

SCIENCE AND TECHNOLOGY TRANSFER

March 20, 1978

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20500

March 15, 1978

The Honorable Frank Press
Chairman, Intergovernmental Science,
Engineering, and Technology Advisory Panel
Executive Office of the President
Washington, D. C. 20500

Dear Dr. Press:

This initial report on the National Science Foundation presents a summary of the information provided by NSF to the Science and Technology Transfer Task Force, and the general findings and recommendations of the Task Force.

NSF occupies a key position in the Federal establishment because of its strong ties to the scientific and engineering communities, its commitment to scientific quality and its role in assisting in the formulation of national science policies. The absence of narrow mission constraints, which often strongly influence the research and related activities of other Federal agencies, provides NSF unique opportunities for innovative and responsive approaches to improving the payoff to State and local governments of the national investment in science and technology. NSF has in the past often recognized these opportunities and should be commended for the leadership it has shown in the intergovernmental science and technology area.

The importance of State and local governments in carrying out national policies, the magnitude and urgency of problems facing these governments and the significant contributions which science and technology can make to State and local policy-making and service delivery calls for a strengthened commitment to applied science and technology. Serious consideration of the Task Force's findings and implementation of its recommendations will visibly demonstrate that commitment and increase the utility and effectiveness for State and local governments of NSF's programs.

The Task Force welcomes the opportunity to continue to work with NSF on ways to improve the delivery of the benefits of science and technology to State and local governments and the citizens they serve.

Sincerely,

Ted

Ted Tedesco
Chairman, Science and Technology
Transfer Task Force

PREFACE

The Congress created the Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP) by Public Law 94-282. The Panel was charged to "(A) identify and define civilian problems at state, regional and local levels which science, engineering, and technology may assist in resolving or ameliorating; (B) recommend priorities for addressing such problems; and (C) advise and assist the Director in identifying and fostering policies to facilitate the transfer and utilization of research and development results so as to maximize their application to civilian needs."

ISETAP is located in the Office of Science and Technology Policy, Executive Office of the President. The Panel currently consists of 16 state, regional and local government officials, plus the Director of the National Science Foundation and the Director of the Office of Science and Technology Policy, who serves as Chairman. Governor George Busbee of Georgia serves as Vice-Chairman.

The Panel has established the following five working Task Forces: Science and Technology Transfer; Energy; Human Resources; Transportation, Commerce and Community Development; and Natural Resources and Environment. The Task Forces are working with Federal agencies on ways to improve the utility of their R&D and technology transfer activities to state and local governments. The Task Forces are also working with the state and local government communities through their representative organizations to consolidate and set priorities on problems which science and technology might usefully address.

On February 25, 1977, President Carter, by memorandum reminded the heads of all Executive Departments and Agencies of his "firm commitment to State and local officials that they would be involved in the development of policy and budget priorities and programs." This report on the National Science Foundation was prepared by the Science and Technology Transfer Task Force. It is part of ISETAP's efforts to work with Federal agencies to involve the state and local government communities in setting R&D agendas and in improving the dissemination, transfer and utilization of R&D results.

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I. BACKGROUND

This report follows up the briefing of the Task Force on December 20, 1977, by officials from the National Science Foundation. The briefing was scheduled in response to a letter from Acting Director of the Office of Management and Budget, Mr. James McIntyre, to the Director of the National Science Foundation (NSF), Dr. Richard Atkinson. That letter noted that participation with the Task Force can help meet requirements of President Carter's memorandum on intergovernmental participation.

The Task Force briefing covered programs in three Directorates within NSF: The Directorate for Science Education (SE), the Directorate for Scientific, Technological and International Affairs (STIA), and the Directorate for Research Applications, which after reorganization will be retitled the Directorate for Applied Science and Research Applications (ASRA). Representing NSF at the briefing were: Dr. Jack Sanderson, Assistant Director for Research Applications; Dr. Harvey Averch, Assistant Director for STIA; Dr. David Roessner, Policy Analyst, Division of Policy Research and Analysis, STIA, and Dr. Alexander Morin, Director, Office of Science and Society, SE.

Task Force members at the session included Mr. Ted Tedesco, Chairman, Mr. Stanley Cowle, Mayor Charles Horn, and invited participants - Mr. Picot Floyd, and Representative Gordon Voss.

Representing the public interest groups were Mr. Alan Beals, National League of Cities; Mr. John Gunther, U.S. Conference of Mayors; Mr. Mark Keane, International City Management Association; Mr. Robert Burgher, American Public Works Association; Mr. Robert Havlick, Public Technology, Inc; Mr. John Reuss, National Conference of State Legislatures; Mr. Bud Thar, National Governors Association; Mr. Graham Watt, National Training and Development Service.

This report serves two purposes. First, it is intended to identify problems and opportunities for improvement in the way NSF carries out its programs of interest to State and local governments. Toward this end, Section II presents the Task Force findings (pp. 3-8) and recommendations (pp. 9-10). Secondly, the report serves to provide information about the programs, priorities and procedures of NSF to the State and local government communities. Section III and Appendices A through C contain information and statements as presented by NSF, without alteration or comment by the Task Force.

II. GENERAL FINDINGS AND RECOMMENDATIONS

NSF has been a leader within the Federal establishment in building an intergovernmental science and technology capability. In large measure as a result of the programs and activities of the NSF described at the briefing and later in this report, there is a substantial and growing awareness among State and local governments that science and technology properly applied can make a significant contribution to the solution of pressing domestic problems. Particularly noteworthy have been many of the programs within the Division of Intergovernmental Science and Public Technology (ISPT).

NSF should be commended for its strong support of ISETAP in providing two staff positions and in its cooperative work with the Panel. Particularly noteworthy have been the efforts of both ISPT and the Division of Policy Research and Analysis (PRA). NSF should also be commended for its use of State and local government personnel--through Intergovernmental Personnel Act assignments--in some of its programs. Again, ISPT is especially noteworthy.

The State and Local Government Interest in Science and Technology

The Task Force believes that State and local governments are increasingly recognizing that they have a large stake in the nation's scientific enterprise. Because of its unique mission, NSF is a key agency to reflect that interest. This interest goes beyond the support of individual programs or projects to issues of national science policy related to the generation and application of knowledge to the solution of national problems.

The importance of science and technology to State and local governments derives in part from the importance of these governments in implementing national policy and in maintaining the everyday quality of life. In his memorandum to heads of Federal agencies in February 1977, President Carter observed that "State and local sectors constitute the delivery mechanisms for most of the actual services the Federal government provides." State and local governments play a large and crucial role in the American system of government.

The importance of science--and the technology which it spawns--also derives from the potential contribution it can make to the solution or amelioration of problems at the State, regional and local levels. This point was clearly made in a Science magazine editorial last year by Dr. Frank Press and Governor George Busbee, co-chairman of ISETAP: "Properly designed and directed toward state and local

needs, federally supported R&D could help to protect regional and local environments, reduce demands on energy and various natural resources, and improve the delivery of state and local services."

The scientific community often makes the point that the justification for science is the improvement in human well-being which it produces. That point was made clearly in a 1976 report from the National Academy of Sciences:

> Science is one of the powerful tools that Man has developed for deepening his understanding of the physical, biological and human world around him; for increasing his ability to act intelligently and effectively in that world; and for enabling him to estimate the environmental and social consequences of his actions.

There is, however, a substantial gap between the promise and the reality from the persective of State and local governments. The potential described above by Dr. Press and Governor Busbee and the National Academy of Sciences is far from being realized. The Task Force believes the problems facing State and local governments are too important and the potential benefits from their resolution too large not to take every reasonable step to mobilize the appropriate scientific and technological resources on their behalf.

The basic point that the State and local government communities are making is that they should be viewed as important consumers of science and technology, and the NSF and other Federal agencies should mount effective, collaborative programs to respond to those aspects of their needs which can be met through R&D. Many, if not most, of the other pleas heard by NSF are from various parts of the scientific community seeking larger shares of the resources to produce science and technology.

A great deal of attention has recently focused on the need for Federal action to ensure the continued health of basic science in the U.S. While the Task Force recognizes and supports the importance of fundamental science, there is a concern that the commitment to applied science--and particularly that directed toward the needs of State and local governments--be maintained and strengthened. Increased support of basic research should not be at the expense of applied research and research utilization programs. The commitment of NSF to maintain the Intergovernmental Science and Public Technology (ISPT) program "at full strength" is an important, although partial, step in this direction.

The Task Force does not see the issue as "basic versus applied science." Both are clearly important and should be seen as mutually supportive rather than competitive. Over the long run, many important

applications flow from new basic discoveries. On the other hand, history provides evidence--from astronomy through the social sciences--that applied scientific work itself often leads to fundamental breakthroughs in scientific knowledge.

The Research Applications Reorganization

The NSF reorganization of the Research Applications Directorate recognizes the interdependence of basic and applied research. As stated by NSF, the reorganization in part is intended to "increase the interaction with NSF basic research programs." This strongly implies a two-way flow and a strengthened opportunity for the problems of State and local governments to be reflected in basic as well as applied research agendas.

The Task Force is very supportive of the new Applied Science and Research Applications Directorate's objective "to improve the ties between research application activities and user groups in State and local government . . ." It believes that the goal is to strengthen the science applications efforts, and it applauds NSF's apparent intention to do better what the old Research Applied to National Needs (RANN) program set out to accomplish.

It is noteworthy that the criticisms of the old RANN Program were not directed at its general objectives. In fact, most of the evaluations of RANN endorsed the importance of applied research. The problems cited in these evaluations were generally directed toward the ways RANN carried out its programs in pursuit of its objectives.

RANN was an innovative program which was continually trying to break new ground. As faults are noted, the difficulty of the task should also be kept in mind. The important point is to learn from both the successes and shortcomings of that program about how to increase the payoff from science and technology.

From the State and local government perspective, many of the ISPT programs number among RANN successes. These programs are widely recognized among the State and local government communities as directly addressing their needs through capacity strengthening and problem identification. However, only a relatively small portion of the appliled research supported by RANN would be recognized by these communities as being directly relevant to them.

While the Task Force is encouraged by much of what it has heard from NSF about the reorganization, the formal evaluations which led to that reorganization typically included little if any direct involvement of State and local government officials. The point again needs to be stressed that State and local governments have a significant stake in Federally supported science and technology and their legitimate views should be incorporated in such evaluation processes.

More generally, the Task Force notes that there is a common perception that NSF is more supportive of long-established programs in universities than it is of innovative attempts to generate socially useful knowledge. While that perception is probably not justified, NSF might find it advantageous to take additional steps to ensure that all facets of society which have an immediate interest in the nation's scientific enterprise also feel that they have an appropriate voice in decisions affecting the direction of that enterprise.

The Need for Better Interaction

The Task Force's support for ASRA's intention "to improve the ties between research application activities and user groups in State and local government . . . " was noted earlier. Recognition of the importance of this point appears to be spreading.

In this regard, it is interesting to compare a statement made at the briefing session with a statement from a recent report of the American Association for the Advancement of Science (AAAS).

At the briefing, an NSF official observed "There will always be a tension between users and the scientific community. The scientific community has a deep seated view that long term payoff will occur with limited user contact."

In its report "Interdisciplinary Research Management" (October 1977), the AAAS stated

> all too frequently interdisciplinary research teams do not incorporate the perspectives of the users of the research output at the beginning of their research, and too frequently these perspectives are not even taken into account in the output stage. This situation calls for broad education among the community of science and other professionals who would engage in such applied research.

The findings of NSF's own studies of innovation diffusion also seem to strongly support the proposition that the likelihood of incorporating appropriate science and technology is related in substantial measure to how well the users, producers and funders are linked. If, as the Task Force believes, the proper test of applied research programs is the benefits derived from actual applications, then it seems appropriate to call upon NSF to provide the leadership necessary to overcome those "deep seated views" as suggested by AAAS.

Two Areas for Joint NSF - ISETAP Effort

There are two areas where concentrated joint effort by ISETAP and NSF promise to gain substantial benefits in the near term. The first is in the State and local government agenda building process which ISETAP has recently undertaken. Working through the representative organizations of these communities, ISETAP is developing a process to consolidate and set some priorities on problems at the State, regional and local levels which are amenable to solution or amelioration by science and technology. The Task Force believes that this process is directly responsive to the suggestion by NSF at the briefing that ISETAP work to "aggregate user needs" and help establish a "more unified voice for State and local governments." NSF staff has been working supportively with ISETAP staff on this effort. A major objective--and one in which NSF can play a crucial role--is to improve Federal processes for receiving, considering and responding to these identified State and local government problems.

The second area relates to the recommendations of the Task Force concerning enhanced participation of the State and local government communities in peer review of proposals, and in various program and project advisory and evaluation committees. A frequent observation of federal R&D officials and others is that it is often difficult to identify appropriate State and local government practitioners to call upon for such functions. The Task Force proposes that it undertake an effort, working with the representative organizations of these communities, to generate a substantial talent pool upon which NSF could draw. If NSF agrees to this proposal, it will be important to document the actual usage of the pool, and at the end of some reasonable period to evaluate the process to ensure that it was yielding qualified and useful input from State and local governments.

Dissemination Activities

Dissemination of results appears to be a general problem in applied research. While the briefing session with NSF touched only briefly upon this area, the information presented by NSF on its activities (see p-30) suggests that substantially more effort could usefully be applied to the design and implementation of a coherent and comprehensive approach to dissemination. It appears clear that reliance for dissemmination upon the R&D performer alone is often inadequate, inappropriate or both. There is often need for accumulating findings from several sources and for externally validating results before widespread dissemination. Moreover, performers often communicate poorly to users. Representatives of the intended user communities should be involved in the design of dissemination efforts, especially as these relate to user needs identified through the ISETAP and other efforts.

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Continuing Federal Support for Intergovernmental Networks:
An Emerging Issue

A major issue which the Task Force thinks appropriate to begin considering is the appropriate Federal role in continuing support of various State and local government problem identification mechanisms. NSF (and other Federal agencies) has supported the establishment of various intergovernmental network mehanisms largely as experiments. These mechanisms provide one of the cornerstones of the ISETAP problem consolidation effort discussed earlier. If they prove effective as devices to generate a comprehensive and representative enumeration of State and local problems--and the evidence so far is most promising--then the question becomes one of whether they should be viewed as a useful if not necessary component of an ongoing applied R&D system. Just as with other parts of the R&D system, the benefits accruing to State and local governments and society generally far outweigh those to the individual participants. Moreover, the results even of applied public sector R&D are somewhat unpredictable and the period between problem identification and applicable results is often long from the State and local perspective. Therefore, the incentives to individual State and local governments cannot be relied upon to bring forth adequate support for such mechanisms. The Task Force would like to pursue this issue with NSF in the near future.

RECOMMENDATIONS

A. NSF is strongly encouraged to take a leadership role and additional steps in recogniton of the legitimate science and technology interests of State and local governments. These steps include:

1. Appointment to the National Science Board of individuals who have knowledge of and credentials in the State and local government communities;

2. Consideration of the problems in and opportunities for improving the utilization of science and technology by State and local governments in such Congressionally required reports as the five year outlook and the annual science and technology report;

3. Full inclusion of State and local perspectives in future NSF program evaluations.

B. NSF should strengthen its interaction with the State and local government communities by the inclusion of professionals from these communities in all aspects of program planning, implementation (including project advisory mechanisms), evaluation, and dissemination.

1. Because the Office of Problem Analysis in the new Applied Science and Research Applications organization will play a key role in program planning, the staffing of that office is important. In recruiting staff for OPA, NSF should seek key individuals with relevant State and local government experience.

2. It is also important that State and local government perspectives be fully included in program advisory mechanisms. The Advisory Committees for both the Directorate for Applied Science and Research Applications and the Directorate for Scientific, Technological and International Affairs should include State and local officials among their membership. Program advisory committees in the Office of Science and Society where lacking, could also benefit by the inclusion of State and local officials.

3. While in the past NSF's applied research Directorate has had a few individuals with local government experience in its research funding divisions, the staff mix currently is weak in this regard. State and local personnel on IPA assignments should be encouraged in the research as well as ISPT Divisions.

4. Involvement of State and local government practitioners in the review of proposals for projects of interest to these communities should be strongly encouraged. The Task Force is prepared to work with ASRA on ways to strengthen that aspect of the peer review process.

C. NSF should strengthen its efforts to ensure that its research activities meaningfully address the needs of State and local governments.

1. It should continue work with ISETAP in the State and local problem consolidation process including support for workshops, conferences and other activities to identify the scientific and technological implications of identified problems.

2. It should also take steps to ensure that the results of that effort are incorporated into its program planning.

D. NSF should take a leadership role with the scientific community in promoting the coupling of appropriate scientific and technological resources with the problems and needs of State and local governments. The Task Force encourages NSF to develop ways to accomplish this.

E. NSF should devote more effort to the design and implementation of a coherent and comprehensive approach to dissemination of research results. The Task Force would particulary like to learn how ASRA intends to approach the synthesizing, evaluation and communication of applied research findings to intended State and local government users.

F. The State Science, Engineering and Technology (SSET) program is promising but fragile. It is important that early momentum built up by the States not be lost. Once lost, it might never be regained. NSF should take every step possible to ensure that there is no avoidable delay between the planning phase and whatever implementation phase is to follow.

G. The programs of the Division of Policy, Research and Analysis (PRA) are of interest and relevance to the State and local government communities. The linkages between PRA's programs and these communities should be strengthened through somewhat more formal interaction. Review of program plans and participation in peer review of proposals are suggested as places where interaction can be increased.

H. NSF should examine the implication of PRA's analyses of public sector innovation diffusion for its various research support programs. For example, PRA studies indicate the importance of staff capacity in State and local governments in achieving successful incorporation of scientific and technological innovation (See pp. 16-17 for additional discussion of some of these findings).

CONCLUSION

The briefing and discussions with NSF provided a large amount of information and covered a substantial range of topics. This present discussion considered only some of the more important--and often general--concerns and recommendations of the Task Force. There are a number of specific problems--such as long administrative delays experienced by State and local applicants to NSF--which have not been touched at all. It is hoped that the productive relationship established between the Task Force and NSF will continue to lead to more effective application of science and technology to the solution of pressing domestic problems.

The findings and recommendations of the Task Force are intended to strengthen the prospects for better utilization of science and technology by the nation's State and local governments, a goal which the Task Force believes is--or should be--shared by NSF. The Task Force would like to meet again with key NSF officials to hear how they view and will respond to these findings and recommendations.

III. SUMMARY OF THE NSF PRESENTATION

A. OFFICE OF SCIENCE AND SOCIETY, DIRECTORATE FOR SCIENCE EDUCATION

This office coordinates NSF efforts to respond to the problems arising out of the changing relationship between the scientific and technological communities and the larger society. Its programs are in general intended to bring about greater understanding of this relationship and to help in solving important ethical, social, and political issues connected with science and technology and their applications.

The programs in the Office have been established partly by Congressional mandate and partly as a result of NSF initiative. All of them are potentially useful to state and local governments in their efforts to reach decisions about public policies involving science and technology. State and local governments are eligible to receive grants from the programs. Moreover, many of the grants made by the programs involve state and local government officials and are directed toward the resolution of issues that arise at state and local levels.

Total funding for FY 78 is $5.4 million, divided among three programs:

o The Public Understanding of Science program focuses on improving the content and processes of communication between the scientific and the nonscientific communities. Grants are made to institutions and organization involved in informal public education on matters of science and technology, including institutions supported by state and local funds such as colleges and universities, museums, etc. Emphasis is placed on major issues of policy involving science and technology, such as energy alternatives, the environmental impact of new technologies, health care and delivery. The program generally aims at large scale, mass communications projects such as the NOVA television series. (FY 78 - $2.4 million)

o The Science for Citizens program is intended to increase the knowledgeable participation of both scientists and nonscientists in the resolution of major public issues involving science and technology. Grants are made (1) to individual scientists and engineers and students of science and engineering (as Public Service Science Residents and Interns), who put their expertise at the service of citizen groups and units of state and local government; and (2) to institutions and organizations (again including units and agencies

of state and local governments) to develop forums, conferences, and workshops involving scientists and nonscientists in an effort to clarify and resolve important science-related issues. (FY 78 - $1.7 million)

o The Ethics and Values in Science and Technology program is aimed at identifying, understanding, and helping to resolve the ethical and social dilemmas that arise in the work of scientists and engineers and in their interaction with citizens affected by their work. This program conducts research and also workshops and conferences directed at understanding-and ultimately helping to resolve--the issues of conscience and policy that involve or grow out of the work of scientists and engineers. Such issues include, for example, mechanisms for rate-setting, policy-making, and dispute settlement, which are of special interest to state and local government bodies. (FY 78 - $1.3 million)

Several examples of projects in the Science for Citizens program that involve state or local governments were cited:

o Briefing on "Conservation, Technology, and Energy Policy" for media personnel, government advisors, and educators in Michigan

o A Town Meeting on research on aging, sponsored by the Town of Lexington (MA) Forum on Aging Committee

o Statewide conferences on energy conservation and alternatives, and development of energy options for consideration in developing comprehensive energy policy for Hawaii

o Development of local consumer energy conservation program for the Greenville (PA) Municipal Government

o Development of statewide educational programs on groundwater policy issues with the Madison (WI) Department of Local Affairs and Development

o Preliminary survey and analysis of citizen participation mechanisms and their impact on the development of state weather modification policy

B. DIRECTORATE FOR SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS (STIA)

STIA has three functions:

o To monitor and analyze the nation's science and technology enterprise--investigation of innovation processes is included in this function

o To facilitate scientific and technological information exchange-recently, the scope of this function has been broadened to include investigation of scientist-user communication.

o To assist in the development and implementation of foreign policy

The current budget for STIA is $20 million. There are four Divisions within STIA:

- o Division of Policy Research and Analysis (PRA)
- o Division of Science Information
- o Division of International Programs
- o Division of Science Resources Studies

The Technology Assessment program, formerly part of the Directorate for Research Applications, has been transferred to the Division of Policy Research and Analysis. This program encourages policy studies that systematically define, explore, and evaluate direct and indirect economic, social, environmental and institutional consequences of the introduction of a new technology into our society or of the expansion of an existing technology.

The Division of Science Resources Studies, with support from other groups within the Foundation, has initiated surveys of R&D activities in State and local agencies. This will be the fourth State survey and the third local government survey and should yield valuable information on the direction of State and local support for the involvement in scientific activities. The surveys are to be completed by the end of Fiscal Year 1978.

The Division of Policy Research and Analysis (PRA), which is the STIA Division of most relevance to state and local governments, has three functions:

o Study the impact of science and technology on economic growth, social objectives and income distribution

o Research on innovation processes

o Study the tradeoffs among energy, environmental, and resource objectives.

Within PRA, the program "Innovation Processes in State and local Government" is of particular interest. This program includes both internal analysis and extramural research support (about $250 thousand annually, which usually supports two or three projects). Abstracts of extramural projects and reports from internal analysis are available on request. A list of these projects and reports appears in Appendix A.

The primary clients for the programs are Federal officials, particularly those within the Executive Office of the President and NSF. ISETAP is viewed as one such important client. R&D managers and "Technology Transfer" officials in other Federal agencies are also important.

Secondary clients are the public interest groups and State and local officials.

Client involvement occurs through the following:

o Interaction with officials in the Federal agencies and the Executive Office of the President. Especially important recently has been ISETAP staff.

o Review of program plans by these officials and by State and local government officials.

o Review of individual research proposals by these Federal and State and local government officials.

o Direct interaction with State and local government officials, especially through the Intergovernmental Science and Public Technology Division in Research Applications.

For purposes of this program, "innovation processes" are defined broadly to include the processes by which new products, techniques and ideas are developed, disseminated, adopted and used by agencies of State and local governments. "Innovations" include hardware, software, managerial and analytic techniques (e.g., "team policing," PPBS). The program addresses questions of why certain outputs are related to particular inputs, especially inputs that are influenced by public policy.

o Who decides whether to adopt or reject innovations?

o Where do the resources and information used to implement innovations come from?

o What are the most important factors leading to the use or rejection of an innovation?

The program does not presume that all innovations are "good"; in fact, in many cases solving problems and innovating not only may be different, but also may be contradictory.

The initial focus of the program was on the "users" through studies of innovation diffusion and adoption in State and local government line agencies. The program is now moving to study of roles of

o public interest groups and professional associations in technology transfer

o "Urban oriented industries"

o management of Federal R&D and technology transfer programs

o the decision process within State and local governments, especially what happens after a decision is made to adopt an innovation.

Some findings of recent research and possible implications for Federal policy follow. The findings are tentative, pending replication in other studies, so the policy implications should be viewed as suggestive only.

1. States and localities differ immensely, probably more than many Federal officials realize. Social and political characteristics, laws and regulations, and--most important for innovation--priorities differ very widely among jurisdictions and change rapidly over time within jurisdictions.

Implication: Wherever possible, Federal agencies should avoid attempts to develop and foster the use of particular "solutions": technologies, techniques or systems. It is probably more efficient to work toward building capacity of state and local jurisdictions to define the technical aspects of problems, identify and evaluate alternatives.

2. Public interest groups, professional associations and informal communications networks (the "grapevine") are essential ingredients in innovation processes. However, their function and effectiveness differ greatly across functional areas and by type of organization involved.

For example, professional organizations such as the American Public Works Association play very different roles from those whose primary objective is to influence Federal policy and legislation. Highly integrated, well financed systems such as found in highways differs significantly from the loose, relatively weak systems found in urban mass transit. Professional associations can and do serve as focal points for informal sharing of knowledge about new ideas and products.

Implications: Federal programs to disseminate innovations and technical information need to take these differences into account. This is especially important when intermediaries are employed by Federal agencies because of their potential credibility and access to state and local officials. At the same time, Federal agencies would be unwise to ignore the significance of existing professional networks in distributing information about new technologies or ideas. If Federal agencies want to be effective in reaching clients, they must learn about the world those clients live in, how it operates, what are information channels and sources.

3. a. In a great many cases of local government innovation, the difference between success and failure is due to events that happen after the decision is made to adopt (that is, commit resources to) the innovation. Where substantial resources are involved, Federal programs--especially money--seem to be present in most cases of innovation adoption at the local level. However, the presence of Federal resources does not appear to affect the ultimate success or failure of the innovation (that is, its long term incorporation by the local agency).

b. A key ingredient in successful innovation appears to be what might be called "organizational capacity." This means means the presence of a person (or persons) willing and able to take the role of "entrepreneur," an individual who has a high degree of "professionalism": contact with peers in other jurisdictions, strong ties to regional and national professional organizations, and concern for service quality. It also means understanding the need for support from important groups both inside and outside the innovating agency: involvement and support of clients in problem definition and the search for solution; involvement and support of key elected officials in decisions to adopt; involvement and support of practitioners in implementation and coordination.

Implications: This suggests a need to shift emphasis in Federal support for innovation from virtually exclusive focus on "front end"activities to the post-adoption period.

C. DIRECTORATE FOR RESEARCH APPLICATIONS

This Directorate is pending reorganization. After reorganization, it will be called "Directorate for Applied Science and Research Applications (ASRA)." It represents less than 10 percent of NSF activities. The appropriation for FY 78 was $63 million. A budget "cross walk" showing how the old programs relate to the new organizational structure, provided after the briefing, appears in Appendix B.

NSF involvement in applied science dates from the late 1960's. Its charter was revised in 1968 to allow it to support applied research. The first response to the broadened mandate was a program called Interdisciplinary Research Regarding Problems of Society (IRRPOS). In late 1971, the Research Applied to National Needs (RANN) program was created. Late in 1976, the Director of NSF established a Science Applications Task Force, chaired by Dr. John Whinnery. The "Whinnery Committee" submitted its recommendations in the summer of 1977. The Whinnery Committee report and general guidelines for the reorganization were presented to the National Science Board at its August meeting.

The general rationale for the Applied Science and Research Applications Directorate (ASRA) remains essentially intact. Many national problems (both public and private sectors) have major science and technology components. In many cases, private sector or a mission agency has responsibility to assure that science and technology are appropriately used. In other cases, NSF has a unique ability to contribute to the understanding of major problems, particularly targeted towards the longer range solution of these problems. NSF can provide selective support that will enable more rapid application of basic scientific understanding. The NSF Act insures NSF support to these activities for the public good without weakening the Foundation's primary mission in basic science.

The purposes of the reorganization are as follows:

- Improve process for selection of research areas.
- Increase interaction with NSF basic research programs.
- Minimize potential conflicts with Federal mission agencies.
- Provide response to both user-oriented and research-oriented recommendations.

In short, the reorganization is designed to provide a more sharply focused scientific and engineering attack on emerging or existing national problems and to help build a better bridge between basic research and the solution of such problems.

GOAL: To focus scientific and technical resources on research and related activities having the highest potential for contribution to the understanding and resolution of significant problems.

OBJECTIVES:

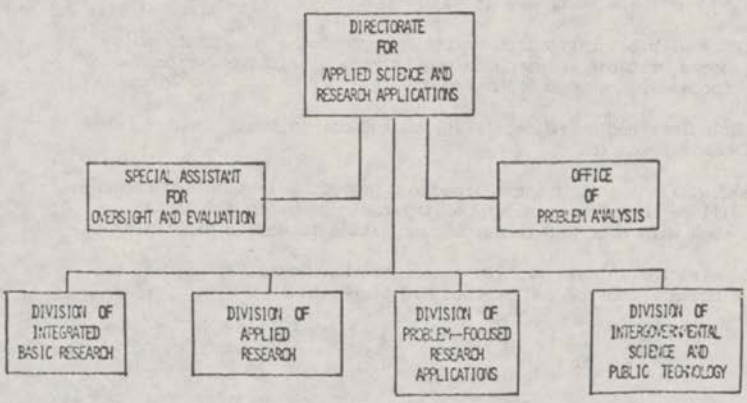
To strengthen the links between applied and problem-oriented research and the basic research activities of the foundation;

To improve the ties between research applications activities and user groups in state and local government, private industry, and other Federal mission agencies;

To focus problem-oriented research applications on a more limited set of national issues in order to increase the impact of the Foundation's programs;

To provide a funding source for high quality, applied research consistent with the 1968 amendments.

The ASRA organizational structure is depicted below:



In addition to the Assistant Director (Dr. Jack Sanderson), there will be a Deputy Assistant Director, Director of Operations, and Programs and Resources Officer in the Office of the Assistant Director. There will also be a Special Assistant for Oversight and Evaluation. The functions of the office include policy development, general management, and program reviews and coordination.

A key unit in the new organization is the Office of Problem Analysis (OPA). It is responsible for strategic and programmatic planning. In performing its functions, it will work with federal and non-Federal organizations and institutions and will prepare problem assessments. A steering committee comprised of the line division directors will oversee OPA's operation.

The four line divisions carry out ASRA's programs.

Division of Integrated Basic Research (IBR)

IBR's purposes are:

o To provide a direct link between ASRA and the basic research directorates in NSF

o To assist the basic research directorates in insuring that basic research related to significant national problems is identified and carried out.

In carrying out these purposes, it will

o Work with basic research units throughout the Foundation to identify areas of basic research in one or more disciplines which might be focused on broad problem topics.

o Stimulate and coordinate research support in these focused areas of basic research.

IBR itself will not make grants. Specific project selection and research support will be the responsibility of the basic research divisions. IBR will work with user and research communities to define problem areas.

Two candidates for initial problem areas are the Global Carbon Dioxide Cycle and Climate Control and Weather Modification.

Division of Applied Research (DAR)

DAR will be responsive to a broad range of problems and proposals, some of which will come out of basic research. It will support coherent research in areas where scientific capability is emerging.

DAR's purposes are:

o To support applied research which will provide an improved understanding of a range of social, economic, and technical problems and policy users;

o To improve the breadth and quality of potential long-range solution of these users;

o To identify and stimulate the growth of new technologies and processes based on discoveries in various fields of science.

In carrying out these functions, it will:

o Work closely with research programs throughout the Foundation;

o Be receptive to proposals for applied research from the broad scientific and engineering communities to which the Foundation relates;

o Work closely with the scientific community and the potential users of applied research in state and local government, other mission agencies, and private industry to insure that their views and priorities are included in its planning and review activities.

Division of Problem Focused Research Applications (PFRA)

The purpose of PFRA is to support the application of scientific and technological capabilities to selected social problems of critical national importance.

It will work closely with other research units in the Foundation, state and local government, mission agencies, scientific, technical, and professional groups and societies, and representatives of the potential user community, to insure that its activities are closely related to and coordinated with the activities, needs, and views of these other groups.

The initial emphasis of DAR will be in the following four areas:

- o Earthquake hazard mitigation
- o Chemical threats to man and the environment
- o Biological alternatives for industrial feedstocks
- o Community water management

Division of Intergovernmental Science and Public Technology (ISPT)

ISPT remains unchanged in the reorganization. This division has a substantial number of staff with state and local government experience.

ISPT's function is to encourage the integration of science and technology into program and policy planning and execution by state and local governments, and to test and evaluate selected incentives which the Federal government may use to stimulate R&D investment in the private sector where new technology is needed in the national interest.

In carrying out its functions, ISPT

- o Uses grants, contracts, and cooperative agreements;
- o Acts to stimulate use of problem-focused research results by state and local governments;
- o Supplements its permanent staff by personnel assigned under the Intergovernmental Personnel Act from universities, state and local governments, and on detail from Federal laboratories.

Activities supported by ISPT include:

- o Urban Consortium for Technology Initiatives
- o State, Regional, and National Innovation Networks
- o Innovations Transfer Projects (administered by the Council of State Governments and the International City Management Association)
- o Implementation of State Science, Engineering, and Technology Program
- o Increased Use of Federal Laboratories as a Resource
- o Industry - University Cooperation through Regional Innovation and Research Centers

A noteworthy current program is the State Science, Engineering and Technology (SSET) program. SSET was authorized in FY 1977. It appeared as a line item with the following appropriation:

- $2.5 million: Study grants to States (Executive and Legislative Branches)

- $0.4 million: Regional or National Forums and Workshops

- $0.1 million: Evaluation of Intergovernmental Programs

Both the legislative and executive branches of state government are eligible. Awards of up to $25,000 are available to each branch in each state. While the program requires a one-third match by the state, so far the actual match has been substantially greater (about 40 per cent). SSET provides study or planning grants for either developing a new program or improving an existing program. There are three closing dates for submission of proposals: July 15, 1977; October 30, 1977; and February 28, 1978.

Through the October 30 "second round," 74 out of the 100 eligible units had applied (43 Executive, 23 Legislative, and 8 joint proposals). The expectation is that there will be close to 100% participation by the completion of the third round.

ASRA Programs and Priorities

The table below shows budgetary information for FY 78. The request submitted to Congress totaled $78 million for RANN. The Congressional appropriation substantially cut the request to $63 million. The first two columns of the table show the request by the old RANN Division. The two right hand columns show the allocation by the new ASRA Division. (These data are more recent than those presented at the briefing. See Appendix B for additional budget information.)

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ASRA FY 1978 PROGRAM DESCRIPTION

BUDGET LEVELS

(BASED ON A $63 MILLION APPROPRIATION)

	FY 1978 REQUEST	FY 1978 APPROPRIATION		FY 1978 CURRENT ALLOCATION*
RESOURCES	$11,500,000		IBR	$ 1,900,000
ENVIRONMENT	34,500,000		PFRA	27,300,000
PRODUCTIVITY	23,000,000		DAR	17,800,000
INTERGOVERNMENTAL SCIENCE AND R&D INCENTIVES	7,000,000		ISPT	6,000,000
EXPLORATORY RESEARCH AND TECHNOLOGY ASSESSMENT	2,000,000		OPA	1,500,000
	$78,000,000	$63,000,000		$54,500,000

* Does not include $1.7 M prior year carryovers, $1.7 M for SSET Program or $1.5 M for Technology Assessment; reflects a 2% reduction for the Director's Reserve

The difference between the appropriation ($63 million) and the new ASRA total ($54.5 million) is in part the result of transferring the Technology Assessment program ($1.5 million) to STIA.

There were three requirements, or mandates, imposed by Congress in FY 1978:

o Not less than 25 percent of the RANN appropriation is to be available for "Applied Social Research" and for "Policy-related Scientific Research."

o Not less than 12.5 percent of the amount authorized is to be available for small business concerns.

o $500,000 increase in research on nitrogen fixation.

In FY 1978, there is no latitude within ASRA for starting new programs. FY 1978 will see the orderly phase-out of selected programs, the transfer of some programs to other NSF Directorates, and the reduction of scope in some other programs.

In FY 79, ASRA's policy or process priorities will be

- o Greater involvement of user communities in selection of program areas and priorities
- o Greater interaction between researchers and users

Techniques for accomplishing these priorities will include workshops, seminars, meetings with groups such as ISETAP and meetings between researchers and users.

Programmatic priorities in FY 1979 under Problem Focused Research will be:

- o Earthquake Hazard Mitigation
- o Chemical Threats to Man and the Environment
- o Alternative Biological Sources of Materials
- o Managing Risks to Community Water

In Applied Research, program priorities will include:

- o Public Policy and Regulation
- o Public Service Delivery and Urban Problems
- o Industrial Organization and Markets
- o Individuals and Group Processes
- o Physics and Mathematics
- o Biology and Ecology
- o Environment and Geophysics

The Integrated Basic Research as well as the Intergovernmental Science and Public Technology Programs will also be priorities, as will the Problem Analysis activities of OPA.

"Major thrusts" for FY 79 were identified as:

- o Unsolicited Applied Research
- o Integrated Basic Research
- o Earthquake Hazards Mitigation
- o SSET Evaluation
- o Systematic Problem Analysis

The following programs will be phased out or terminated:

- o Technology Assessment
- o Weather Modification
- o Excavation and Tunneling
- o Nonconventional Foods
- o Mineral Processing Technology
- o Medical Instrumentation
- o Distribution and Equity
- o Productivity Measurement

The point was stressed that the process of working with state and local governments currently is very ad hoc, and NSF hopes that ISETAP can strengthen the formal involvement, and increase the focus, of state and local governments.

The ASRA processes for program identification, establishing program priorities, and for developing agendas within program areas will stress involvement of all interested groups. The Directorate's Advisory Committee currently has some members who have had state or local government experience.

Important in program identification will be ASRA's encouragement of broad participation and "partnerships" among researchers and users. Conferences, "white papers," seminars, etc., will be used to examine current programs, determine required modifications and new directions. Users will be involved in program and project design.

Establishing priorities among programs is difficult. Different approaches are called for in different areas. There is a broad spectrum of parties interested in establishing priorities: the National Science Board, OMB, Congress, the research community and the user community.

Program identification and priority setting will involve consultation with the research community on questions of likely cost and probability of success. This includes all parts of the research community: academic, private sector, the Federal government (including the Federal laboratories) and state and local governments.

The user community will be consulted on questions of the estimated value and probability of use. Included will be industrial associations, state and local governments, professional societies, public interest groups and Federal mission agencies.

Others, such as NAS/NAE and ISETAP will also be consulted. ASRA plans to notify ISETAP, the public interest groups and others of major conferences and network meetings and hopes they will reciprocate.

Key elements in the process for developing agendas within program areas are as follow:

o New program areas:

- Workshops and conferences for research and user community representatives to determine focus for total program and identify important elements

- Office of Problem Analysis will recommend program structure and content, including costs, level of effort, major milestones, and potential performers and users

- o Continuing program areas:

  - Unsolicited proposals with peer review by research and user communities

  - Regular workshops and conferences for research and user community representatives to review progress and recommend future directions

  - Program announcements and solicitations as warranted

The following criteria will be applied in selecting individual projects for support:

- o Scientific and Technological Quality
  - Competence of research team
  - Adequacy of facilities
  - Scientific merit
- o User Communities (e.g., state and local government)
  - Involvement for research design and implementation
- o Relevance and utility of research
- o Organizational structure for research plan
- o Composition of project advisory committee

ASRA is currently setting up a number of review panels to evaluate the results of RANN programs. NSF wants state and local government involvement in these program evaluations. A number of projects in the Intergovernmental Program have been evaluated. Two major evaluations (SSET and Urban Technology Systems) are being initiated. A plan for comprehensive program evaluation is being developed.

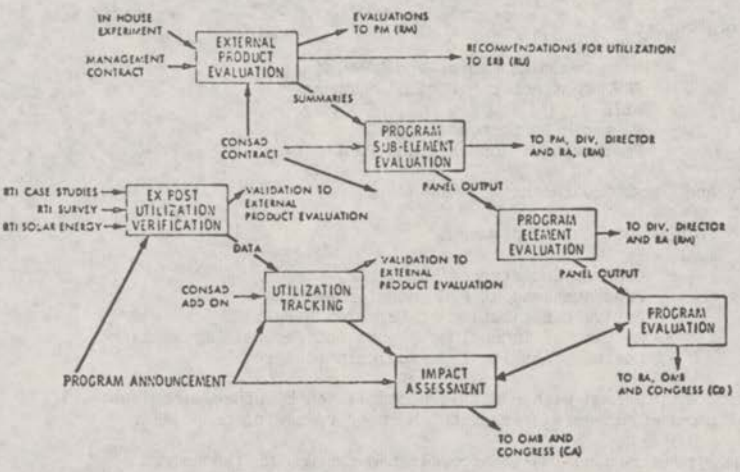
A number of product evaluations have been completed:

- o External Product Evaluation - 42 complete
- o Program Subelement Evaluation - 2 complete
  (Earthquake and Public Sector Productivity)
- o Ex Post utilization Verification - Survey: 100 complete

  Case studies: 51 complete
- o Utilization Tracking - 1 in process (with 100 projects)

The program and product evaluation process followed by RANN is depicted in the chart below.

PLAN FOR ACHIEVING OBJECTIVES



The following information on dissemination techniques was provided:

General

- o Products
  - Reports
  - Books
  - Movies and other audio-visuals
  - Computer Programs
  - Articles
  - Conference Presentations
  - Briefing Seminars
  - Technical Briefs and Summaries
- o Sources
  - Rann Document Center and RANN staff
  - RANN contractor - Capitol Systems
  - NTIS
  - Research Performers
  - Professional Journals and Publications

State and Local Government

- o Dissemination Techniques
  - Grantee Conferences - IG, UTS, UC
  - Presentations at PIG annual meetings
  - Active Distribution of Research Results
  - Meeting of Technology Agents and Federal Lab Meetings
  - Use of state/local periodicals (future)

Coordination of programs within NSF is accomplished by program reviews, individual program manager interaction and peer review of proposals.

External program coordination is accomplished through NSF sponsored interagency panels (as well as direct agency discussions), ISETAP, meetings with public interest groups (annual as well as periodical), meetings with university associations (e.g., NASULGC) and industrial associations (e.g., Small Business), and peer review of proposals.

APPENDIX A

PRA STUDIES OF TECHNOLOGICAL INNOVATION AND TRANSFER
IN STATE AND LOCAL GOVERNMENTS

External Research

- Title: An Investigation of the Adoption of Technological Innovations by Law Enforcement Agencies

  Investigator/Institution: David Tansik; University of Arizona

  Status: Completed

- Title: The Role of Intermediary Organizations in Technology Transfer

  Investigator/Institution: Jules J. Duga; Battelle Memorial Institute

  Status: Active

- Title: Diffusion and Adoption of Computer Applications Software in Local Governments

  Investigator/Institution: James R. Perry; University of California, Irvine

  Status: Active

- Title: Comparison of Innovation in Public and Private Sectors: An Exploratory Study

  Investigator/Institution: Marshall W. Meyer and Robert O. Williams, III; University of California, Riverside

  Status: Completed (Reports dated 1977)

- Title: The Adoption of Innovation by Local Government

  Investigator/Institution: Richard D. Bingham and Thomas P. McNaught; Marquette University

  Status: Completed (Report dated 1975)

- Title: Toward a Theory of Innovation

  Investigator/Institution: George W. Downs, Jr. and Lawrence B. Mohr; University of Michigan

  Status: Completed (Report dated Febrruary 1977)

- Title: The Innovation Process in Public Organizations: Some Elements of a Preliminary Model

  Investigator/Institution: John D. Eveland, Everett M. Rogers and Constance Klepper; University of Michigan

  Status: Completed (Reports dated March 1977)

- Title: Diffusion of Technology in State Mission-Oriented Agencies

  Investigator/Institution: Irwin Feller, Donald C. Menzel and Alfred J. Engel; Pennsylvania State University

  Status: Completed (Reports dated October and December 1974)

- Title: Diffusion of Innovations in Municipal Governments

  Investigator/Institution: Irwin Feller, Donald C. Menzel and Lee Ann Kozak; Pennsylvania State University

  Status: Completed (Reports dated June 1976)

- Title: A Review of Case Studies of Technological Innovations in State and Local Services

  Investigator/Institution: Robert K. Yin, et al; Rand Corporation

  Status: Completed (Report dated February 1976)

- Title: Adoption and Utilization of Urban Technology: A Decision-Making Study, Analysis and Conclusions

  Investigator/Institution: W. Henry Lambright; Syracuse University Research Corporation

  Status: Active (Interim Report dated January 1977)

o **Title:** Professional Associations as Intermediaries in Transferring Technology to City Government

Investigator/Institution: Richard D. Bingham; University of Wisconsin

Status: Active

Internal Analyses and Papers

Federal Technology Transfer: An Analysis of Current Program Characteristics and Practices, (National Science Foundation, NSF 76-400, December 1975)

J. David Roessner, "Incentives to Innovate in Public and Private Organizations," Administration and Society, vol 9, no 3 (November 1977)

J. David Roessner, "Policy Issues and Policy Research in Public Technology," Policy Studies Journal 5, 205-211 (Winter, 1976). Reprinted in J. Haberer, ed., Science and Technology Policy: Developments and Perspectives (D.C. Heath, Lexington Books, 1977) and in S. Nagel, ed., Policy Studies Review Annual (Sage Publications, 1977)

J. David Roessner, "Federal Policy and the Application of Technology to State and Local Government Problems," Policy Analysis (forthcoming)

J. David Roessner, "Barriers to the Adoption of New Technologies in Public Service Agencies," in Refocusing Government Communications Policy, An Occasional Paper/The Aspen Institute for Humanistic Studies Series on Communications, 1976

J. David Roessner, "Policy Options for Public Technology," in Serving Social Objectives via Technological Innovation: Possible Near-Term Federal Policy Options, Office of National R&D Assessment, National Science Foundation, May 1973

J. David Roessner, "The Structure of Federal Technology Transfer Activities: Implications of Current Research," presented at the first annual meeting of the Technology Transfer Society, Los Angeles, California, June 25, 1976

APPENDIX B

ASRA SUPPLEMENTARY BUDGET INFORMATION

This appendix contains supplementary budgetary information supplied by ASRA subsequent to the briefing.

Five tables are presented which show the fiscal relationships of the old RANN programs to the new ASRA programs. (In budget jargon, these tables are called "crosswalks.")

The Tables are as follow:

B-1 FY 1978 Appropriation

B-2 FY 1978 Current Plan: New Obligational Authority (NOA) and Prior Year Funds

B-3 FY 1978 Current Plan: NOA Only

B-4 FY 1978 Deferrals

B-5 FY 1978 Estimated Obligations Related to the "Scheuer Amendment." (This is a Congressional mandate that not less than 25 percent of the RANN appropriation is to be available for "Applied Social Research" and for "Policy-related Scientific Research")

This table shows the 1978 maximum amount appropriated.

NOTE: $61.40 M
1.50 M Transfer of T.A. to STIA
0.10 M Pay raise
$63.0 M

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ASRA/RANN CROSSWALK

FY 1978 APPROPRIATION

(Dollars in Millions)

ASRA / RANN / PROGRAM	INTEGRATED BASIC RESEARCH	APPLIED RESEARCH: Public Policy & Reg.	Public Serv. Deliv.	Indus. & Consmr Mkts.	Indiv. & Group Process	Phys. & Math. Applcns	Biol. & Ecol. Applcns	Envir. & Geophys Applcns	PROBLEM-FOCUSED RESEARCH APPLCTNS: Earthquake: Siting	Earthquake: Design	Earthquake: Policy	Chemical Threats	Biol. Sources	Comm. Water	INTERGOVERNMENTAL SCIENCE & ADJ: Intergovernmental: Local Gov't	Intergovernmental: State Gov't	Intergovernmental: S&T Resrcs	Intergovernmental: SSET	Industr. Program	PROBLEM ANALYSIS	TOTALS
Resource Systems							.75	1.20					.20							.25	2.40
Innov. Biosynthesis													2.10								2.10
Nonconvntal Food							1.70														1.70
Biomass Utilization													1.70								1.70
Mineral Mkt Behavr				1.00																	1.00
Resource Dev. & Cons.						.50		.20													.70
Rdv. Process. Techs.						.35		.55													.90
ENVIRONMENT																					
Chemical Threats												4.80									4.80
Benef. Env. Mgt.		.70												4.00							4.70
Weather Modification	1.40 **																				1.40
Earthquake-Siting									6.75												6.75
Earthquake-Design										8.75											8.75
Earthquake-Policy											1.00										1.00
Societal Response											1.50										1.50
PRODUCTIVITY																					
Serv. rod. & in.-prodv. Relns		**	1.00																		1.00
Telecommunications	.50	1.30																			1.80
Service Del. Techs.			1.00																		1.00
Prod. Measurement				.60																	.60
Population		2.50																			2.50
Distrib. & Equity		2.35			.30		.35													.25	3.20
Syste. Analysis				.10	.20	.40															.70
Sdv. Info. Process.						3.20		1.00													4.20
INTERGOV. S&T & ADJ																					
Local Government															2.85						2.85
State Government																1.80					1.80
S&T Resources																	.35				.35
Industrial Prgs.																			1.00		1.00
EXPLORATORY RES.& T.A.																				1.00	1.00
Exploratory Research																					(1.50) *
Technology Assmnt																					
TOTALS	1.90	6.80	2.00	1.70	.50	4.45	2.80	2.95	6.75	8.75	2.50	4.80	4.00	4.00	2.85	1.80	.35		1.00	1.50	61.40
	1.90			21.20					30.80						6.00					1.50	

* Technology Assessment transferred to STIA in FY 1978. ($1.5 M)

** Present RANN activities identified for transfer to IBR; responsibility for projects will be transferred to basic research directorates.

Table B-1

This table shows the total operating plan for FY 1978.
NOTE: $54.50 NOA
1.70 SSET Carryover
1.71 Miscellaneous FY 1977 Commitments
$57.91

12/28/77

ASRA/RANN CROSSWALK

FY 1978 CURRENT PLAN (NOA and Prior Year Funds)

(Dollars in Millions)

ASRA / RANN	INTEGRATED BASIC RESEARCH	APPLIED RESEARCH: Public Policy & Reg.	Public Serv. Deliv.	Indus. & Consmr Mkts.	Indiv. & Group Process	Phys. & Math. Applcns	Biol. & Ecol. Applcns	Envir. & Geophys Applcns	PROBLEM-FOCUSED RESEARCH APPLCTNS: Earthquake Siting	Earthquake Design	Earthquake Policy	Chemical Threats	Biol. Sources	Comm. Water	INTERGOVERNMENTAL SCIENCE & RDI: Intergovernmental: Local Gov't	State Gov't	SET Resrcs	SSET	Indust. Program	PROBLEM ANALYSIS	TOTALS
RESOURCES							.75	.90					2.36							.25	1.90
Resource Systems																					2.36
Innov. Biosynthesis							1.50														1.50
Nonconvntnl Food													1.50								1.50
Biomass Utilization				.80																	.80
Mineral Mkt Behavior						.50		.20													.70
Resource Dev. & Cons.						.35		.55													.90
Adv. Process Techs.																					
ENVIRONMENT																					3.53
Chemical Threats												3.53									3.32
Reasnl Env. Mgt.		.70												2.60							1.40
Weather Modification	1.40**																				6.86
Earthquake									6.86												8.75
Earthquake-Siting										8.75											1.00
Earthquake-Design											1.00										1.50
Earthquake-Policy											1.50										
Societal Response																					
PRODUCTIVITY																					.50
Public Sector			.50																		1.55
Serv. Prod. & Intergov. Relns	.50**	1.05																			1.15
Telecommunications			1.15																		1.30
Service Del. Techs.				.30																	2.50
Prod. Measurement		2.53			.30		.35													.25	2.70
Regulation		1.70			.20	.40															.60
Distrib. & Equity						3.20		.70													3.90
Systems Analysis																					
Adv. Indus. Process.																					
INTERGOV. SCI & RDI															2.85						2.85
Intergov. Local Government																1.88		1.70			3.58
State Government																	.35				.35
S&T Resources																			1.00		1.00
Industrial Prog.																					
EXPLORATORY RES. & T.A.																				1.00	1.00
Exploratory Research																					(1.50) *
Technology Assmnt																					
TOTALS	1.90	5.98	1.65	1.10	.50	4.45	2.60	2.35	6.86	8.75	2.50	3.53	3.86	2.60	2.85	1.88	.35	1.70	1.00	1.50	57.91
	1.90			18.63							28.10						7.78			1.50	

* Technology Assessment transferred to STIA in FY 1978. ($1.5 M)

** Present RANN activities identified for transfer to IBR; responsibility for projects will be transferred to basic research directorates

Table B-2

This table shows the NOA for FY 1978 current plan.

NOTE: $54.5 M
1.5 M Transfer of T.A. to STIA
$56.0 M
.1 M Pay raise
6.9 M Proposed deferral
$63.0 M TOTAL APPROPRIATION

12/28/77

ASRC/RANN CHUSSALK

FY 1978 CURRENT PLAN (NOA only)

(Dollars in Millions)

ASRC / RANN	INTEGRATED BASIC RESEARCH	APPLIED RESEARCH: Public Policy & Reg.	Public Serv. Deliv.	Indus. & Consmr Mkts.	Indiv. & Group Process	Phys. & Math. Applcns	Biol. & Ecol. Applcns	Envir. & Geophys Applcns	PROBLEM-FOCUSED RESEARCH APPLCNS: Earthquake: Siting	Earthquake: Design	Earthquake: Policy	Chemical Threats	Biol. Sources	Comm. Water	INTERGOVERNMENTAL SCIENCE & RDT: Intergovernmental: Local Gov't	State Gov't	S&T Resrcs	SSET	Indust. Program	PROBLEM ANALYSIS	TOTALS
RESOURCE																					
Resource Systems							.75	.90												.25	1.90
Innov. Biosynthesis													2.10								2.10
Nonconventional Food Sources Utilization							1.50						1.50								3.00
Mineral Mkt Behavr				.80																	.80
Resource Dev. & Cons.						.50		.20													.70
Adv. Process. Techs.						.35		.65													1.00
ENVIRONMENT																					
Chemical Threats Regnl Inv. Mgt.		.70										3.10		2.60							6.40
Weather Modification	1.40**																				1.40
EARTHQUAKE HAZARDS REDUCTION									6.75												6.75
Earthquake-Siting										8.75											8.75
Earthquake-Design											1.00										1.00
Earthquake-Policy											1.50										1.50
Societal Response																					
PRODUCTIVITY																					
Serv. Prod. & Interrgn. Relns			.50																		.50
Telecommunications	.50**	1.00																			1.50
Services Tel. Techs.			1.00																		1.00
Prod. Measurement				.30																	.30
Regulation		1.90																			1.90
Distrib. & Equity		1.70			.30		.35													25	2.60
Systems Analysis					.20	.40															.60
Sy. Indus. Process.						3.20		.70													3.90
INTERGOV. SCI & RDT																					
Local Government															2.85						2.85
State Government																1.80					1.80
S&T Resources																	.35				.35
Industrial Prog.																			1.00		1.00
EXPLORATORY RES. & T.A.																				1.00	1.00
Exploratory Research																					1.50)*
Technology Asmnt																					
TOTALS	1.90	5.30	1.50	1.10	.50	4.45	2.60	2.35	6.75	8.75	2.50	3.10	3.60	2.60	2.85	1.80	.35		1.00	1.50	54.50
	1.90	17.80							27.30						6.00					1.50	

* Technology Assessment transferred to STIA in FY 1978. ($1.5 M)

** Present RANN activities identified for transfer to IBR; responsibility for projects will be transferred to basic research directorates.

Table B-3

This table shows the composition of the proposed deferral into FY 1979.

12/28/77

ASRA/RANN CROSSWALK

FY 1978 DEFERRALS

(Dollars in Millions)

ASRA / RANN	INTEGRATED BASIC RESEARCH	APPLIED RESEARCH: Public Policy & Reg.	Public Serv. Deliv.	Indus. & Consmr Mats.	Indiv. & Group Process	Phys. & Math. Applcns	Biol. & Ecol. Applcns	Envir. & Geophys Applcns	PROBLEM-FOCUSED RESEARCH APPLCTNS: Earthquake Siting	Earthquake Design	Earthquake Policy	Chemical Threats	Biol. Sources	Comm. Water	INTERGOVERNMENTAL SCIENCE & RDT: Intergovernmental Local Gov't	Intergovernmental State Gov't	Intergovernmental S&T Resrcs	SSET	Indust. Program	PROBLEM ANALYSIS	TOTALS
RESOURCES								.30					.20								.50
Resource Systems																					
Innov. Biosynthesis							.20														.20
Nonconvntnl Food													.20								.20
Biomass Utilization				20																	
Mineral Mkt Behavr																					
Resource Dev. & Cons.																					
Adv. Process Techs.																					
ENVIRONMENT												1.70									1.70
Chemical Threats														1.40							1.40
Renal Env. Mgt.																					
Weather Modification																					
Earthquake-Siting																					
Earthquake-Design																					
Earthquake-Policy																					
Societal Response																					
PRODUCTIVITY																					.50
Serv. Prod. & Intergov. Relns			.50																		.30
Telecommunications		.30																			.30
Service Del. Techs.																					.60
Prod. Measurement		.60		.30																	.10
Regulation																					.30
Distrib. & Equity		.60																			
Systems Analysis				.10				.30													
Sty. Indus. Process.																					
INTERGOV. SCI & RDT																					
Local Government																					
State Government																					
Natl Resources																					
Industrial Prgs.																					
EXPLORATORY RES. & T. A.																					
Exploratory Research																					
Technology Asmnt																					
TOTALS		1.50	.50	.60			.20	.60				1.70	.40	1.40							6.90
		3.40							3.50												

Table B-4

28-096 O - 78 - 13

This table shows the components of the Scheuer Amendment funds, including the portion in the proposed deferral.

ASRA/RANN CROSSWALK

12/28/77

FY 1978 ESTIMATED OBLIGATIONS (SCHEUER AMENDMENT RELATED)

(Dollars in Millions)

ASRA / RANN	INTEGRATED BASIC RESEARCH	APPLIED RESEARCH: Public Policy & Reg.	Public Serv. Deliv.	Indus.& Consmr Mkts.	Indiv.& Group Process	Phys.& Math. Applcns	Biol.& Ecol. Applcns	Envir.& Geophys Applcns	PROBLEM-FOCUSED RESEARCH APPLCNS: Earthquake Siting	Earthquake Design	Earthquake Policy	Chemical Threats	Biol. Sources	Comm. Water	INTERGOVERNMENTAL SCIENCE & RDT: Local Gov't	State Gov't	SST Resrcs	SSET	Indust. Program	TECH. ASMNT	FY1978 Deferrals	TOTAL
RESOURCES																						
Resource Systems																						
Innov. Biosynthesis																						
Conventnl Food																						
Biomass Utilization																						
Mineral Mkt Behavr																						
Resource Dev.& Cons.																						
Env.Process.Techs.																						
ENVIRONMENT																						
Chemical Threats																						
Mgmnt Env. Mgt.		.70												.70							.40	1.80
Weather Modification																						
Earthquake-Siting																						
Earthquake-Design											1.00											1.00
Earthquake-Policy											1.50											1.50
Societal Response																						
PRODUCTIVITY																						
Serv.Prod. & Intergov. Relns	**		.50																		.50	1.00
Telecommunications	.50	1.00																			.30	1.80
Service Del. Techs.			1.00																			1.00
Prod. Measurement				.30																	.30	.60
Regulation		1.90																			.60	2.50
Distrib.& Equity		1.70			.30		.35														.60	2.35
Systems Analysis																						
Indv. Indus. Process																						
INTERGOV. SCI & RDT																						
Local Government															.70							.70
State Government																.90						.90
SST Resources																						
Industrial Progs.																						
EXPLORATORY RES.& T.A.																						
Exploratory Research																						
Technology Asmnt																				50*		50
FY 1978 DEFERRALS		1.50	.50	.30										.40							2.70	
TOTALS	.50	6.80	2.00	.60	.30		.35				2.50			1.10	.70	.90				.50		16.2

* Technology Assessment transferred to STIA in FY 1978 ($ .5 M of the $1.5 M applies)

** Present RANN activities identified for transfer to IBR; responsibility for projects will be transferred to basic research directorates.

Table B-5

APPENDIX C

Selected FY '77 RANN Research Awards

of Interest to

State and Local Governments

State and Local Government Financial Management

- Assessing Municipal Financial Conditions and Improving Financial Management Practices
  International City Management Association (ICMA)

- Identification and Analysis of Current State Government Accounting and Financial Reporting - Practices
  Council of State Governments

- Urban Government Information Needs in Intergovernmental Fiscal Relations
  Public Technology, Inc.

- Inventory of Current Research on State and Local Finance and Financial Management
  Municipal Finance Officers Association

- Cost Savings to State and Local Governments in the Selling of New Bonds
  University of Oregon

Police and Public Safety Management

- Seismic Safety Design for Police and Fire Stations
  American Institute of Architects

- Study of the Consequences and Policy Implications of Increased Unionization of Court Personnel
  The Futures Group

- Evaluating the Organization of Service Delivery: Police
  University of Indiana

- Symposium on Police/Firefighter Compulsory Arbitration
  New York State Police Employment Relations Board

- Evaluating the Organization of Service Delivery: Fire
  Research Triangle Institute

- Design of Schedules for Fire Services Manpower
  Research Triangle Institute

- Fire Alarm Assignment System
  National Fire Protection Association

- Measurement of the Effectiveness of Municipal Fire Protection Services
  The Urban Institute

- Assessment of the Effectiveness of Fire Inspection Practices
  The Urban Institute

Urban Water and Wastewater Management

- Utilization of Urban Water Runoff Techniques
  American Society of Civil Engineers

- Water Pollution and the Urban Economy
  Argonne National Laboratory/University of Chicago

- Water Quality and Health Significance of Bacterial Indicators of Pollution
  Drexel University

- Control of Heavy Metal Content of Municipal Wastewater Sludges
  Gurnham and Associates, Inc.

- High Energy Electron Irradiation of Municipal Wastewater Liquid Residuals
  M.I.T.

- Ferrate Ion Disinfection of Municipal Wastewater
  Northwestern University

- Designing an Urban Runoff Control Master Plan
  American Society of Civil Engineers

Earthquake Mitigation

- Community Response to Earthquake Threat in Southern California
  University of California, Los Angeles

- Seismic Safety Preparedness by Local Governments in California
  University of California, Santa Barbara

- Inflationary Changes in Construction Costs Created by Earthquake Damage: Implications for Government Policy
  Colorado State University

- Tall Buildings and Urban Habitat: Impact on the Urban Environment and Planning for Natural Disasters
  Lehigh University

Societal Response to Natural Disasters

- Disaster Knowledge and Beliefs and Emergency Planning
  University of Delaware

- Research Program on Natural Disaster Recovery Processes
  University of Massachusetts

- Community Response to Natural Hazard Warnings
  University of Minnesota

APPENDIX D

ATTENDANCE AT NSF-ISETAP BRIEFING
December 20, 1977

Averch, Harvey	NSF
Beals, Alan	National League of Cities
Bean, Alden	NSF
Burgher, Robert	APWA
Borthman, Jerry	Navy/Commerce Dept.
Blankenship, Vaughn	NSF
Brockman, Paul	NASA Hq.
Chinitz, David	Univ. of Pennsylvania
Conlin, Bruce	ASME
Cowle, Stan	Task Force
Fitts, Hartley	HUD
Flajser, Steve	Senate Commerce Commission
Fleischer, Robert	Greylock Center
Floyd, Picot	Task Force
Gasser, Jim	U.S. Conference of Mayors
Goldman, Bob	Task Force
Gunther, John	U.S. Conference of Mayors
Hamilton, Tara	National League of Cities
Havlick, Bob	Public Technology, Inc.
Hersman, Frank	Hillsborough County, Florida
Hoffman, Allan	Senate Commerce Committee
Horn, Charles	Task Force
Hoy, Nelson	Public Technology, Inc.
Keane, Mark	Int'l City Management Association
Kelly, Edward	NSF
Lanham, Clifford	Army/Fed. Lab. Consortium
Linenberger, Jim	NSF
Linhares, Al	DoT
Mack, Joanna	Nat. Conf. of State Legislatures
McNamara, Petty	Naval Underwater Systems Center
Miller, Trudi	NSF
Morin, Alex	NSF
Preston, Lynn	NSF
Rabin, Bob	NSF
Rancer, Mike	ICMA
Reiss, Bruce	NSF
Reuss, John	NCSL
Richtmann, Dave	NSF
Roessner, Dave	NSF
Sanderson, Jack	NSF
Schacht, Wendy	Congressional Research Service
Shapek, Raymond	ASPA/NSF
Slosky, Len	ISETAP Staff
Strange, Russell	NSF
Tedesco, Ted	Task Force
Thar, Bud	National Governors' Association
Thiel, Charles	NSF
Voss, Gordon	Task Force
Watt, Graham W.	Nat'l Training and Devel. Service
Weller, Bart	Nat. Conf. of State Legislatures
Wetmore, Bill	NSF
Wyckoff, James	DOC/NBS

THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY PROGRAM

A Short Summary of Work Activities
Proposed by Applicants

FIRST ROUND

New Hampshire

Governor Thomson will channel SSET funds through the Governor's Council on Energy, where a policy advisory mechanism has been designed to assimilate a high degree of scientific and technological information. The intent is to use the Council experience as a basis for planning a more comprehensive system that will include as actors the Governor's Science Advisor, the Office of Comprehensive Planning and line department personnel. One work task will be an inventory of critical state issues that require S/T input.

Applicant	Program Manager
Norman VanderNoot, Director Governor's Council on Energy 3 Capitol Street Concord, NH 03301 603/271-2711	John H. Sununu Governor's Advisor Science & Technology 3 Capitol Street Concord, NH 03301 603/271-2711

Iowa

In April 1977, Governor Ray appointed a Science Advisory Council. Its twelve members are drawn from the "hard" sciences, and all but three are university professors. The purpose of the Council, in the words of the executive order under which it functions, is to "respond to state government and make available vital scientific and technological information." The group is divided into three panels under the general headings of energy, environment, and resources. SSET funds will be used to examine alternative operating modes for the Council as well as to survey research needs as perceived by state agency personnel and by the Governor.

Robert F. Tyson, Director
Office for Planning & Programming
523 East 12th Street
Des Moines, IA 50319
515/281-5888

Robert W. Hanson
Liaison Officer
Governor's Science Advisory Council
University of North Iowa
Cedar Falls, IA 50613
319/273-2021

Michigan

Governor Milliken is one of several Governors who has not hesitated to call upon the scientific community when confronted with policy questions that demand a high degree of technical expertise. He has relied upon his science advisor, Dr. William Taylor, to organize a task force to review the technical and environmental implications of project SEAFARER, to organize and interpret scientific advice on the crisis caused by accidential spillage of fire retardant chemicals into cattle feed that was shipped to several beef-raising areas of Michigan, and to conduct a task force inquiry into the implications of proposed nuclear waste disposal sites in the State. Groundwork has been laid for a Science and Technology Commission, and SSET funds will be used for an evaluation of the ways that Council effectiveness may be assured. Michigan's past experience has produced a number of valuable lessons that could be important to other States.

Gordon Alexander
Administrative Officer
Office of the Governor
State Capitol
Lansing, MI 48901
517/373-7956

Dr. William Taylor
Governor's Office
State Capitol
Lansing, MI 48901
517/355-5107

Kansas

The Kansas Division of Planning and Research provides public policy analysis to the Governor on a broad range of subjects. As part of its effort to secure rapid access to data that bears upon major public issues, the Division has created the Kansas Policy Database System, a computer-based rapid-retrieval system that permits users both to recall raw information and to apply a number

of interpretive statistical procedures. Data is filed under nineteen functional categories, as agriculture, social services, wildlife, and transportation. Governor Bennett has proposed to use SSET monies to further develop the system, which is now operational but incomplete.

Dr. H. Edward Flentje, Director
Division of State Planning & Research
109 West 9th Street, Suite 501
Topeka, KS 66612
(913) 296-3496

A. Victor Ferreros
Assistant Director for Data Analysis
Planning & Research Division
109 West 9th Street, Suite 501
Topeka, KS 66612
(913) 296-3496

New Mexico

From the application: "During the recent past, the State of New Mexico has experienced uneven results in its ability to successfully identify and apply science and technology to the formulation of policy which will significantly affect the future of this State and its inhabitants. The successes have encouraged the Governor to want to examine the development of a mechanism which will more regularly support the myriad of policy-making activities which could benefit from such scientific and technological inputs. The State Planning Office has been selected by him as the agency most appropriate to oversee the proposed activity and promote the desired results.

The State Planning Office will review the State's successes of the past, other experiences in sister States, current processes for policy making, and methods for identifying and organizing scientific and technical resources. A synthesis will be prepared, and a mechanism likely to succeed will be recommended for implementation."

Leila Andrews
State Planning Office
Greer Bldg
505 Don Gasper
Santa Fe, NM 85703
(505) 827-2073

Nelson Hanover
Economics & Technology, Inc.
101 Trenton Street
Boston, MA 02108
(617) 423-3780

Colorado

More than most other States, Colorado has tried to link state government to research sources in order to insure that both policy and operations are based upon the latest technology. While progress has been uneven, the Governor's Science and Technology Advisory Council, a forty-plus member group of physical and social scientists that operate through task forces, has been active during the past six months in a number of policy areas. The SSET study will be based upon interviews with selected department heads and the observation of several important state commissions and policy-making bodies. An in-depth probe to discover the need for scientific and technical information will also yeild an assessment of the existing procedures that have been devised to fulfill the need. This will be followed by an analysis of the potential for procedural and structural improvement, including alternatives to the Council currently in place. Governor Lamm has designated the Institute for Advanced Urban Studies at the University of Colorado to conduct the study, although the project will be closely supervised by key aides in his office.

James Monaghan
Assistant to the Governor
for Natural Resources
Governor's Office
State Capitol Bldg.
Denver, CO 80203
(303) 892-2471

Dr. Floyd Mann
1945 Kohler Drive
Boulder, CO 90303
(303) 492-7748

California

California state government supports an impressive array of research activity at the line-agency level. The Office of Planning and Research, a component of the Governor's Office, has a statutory mandate to coordinate all research directed to growth and development and to the preservation of environmental quality. This office will deploy SSET funds within a larger, on-going program to inventory existing resources, explore alternative methods of coordination, and strengthen the process by which research output is made accessible to policy makers. The primary objective is "a central facility to provide the Governor with a central point of access to scientific and technological information available to state government." While priority attention is being given to internal problems, such as the fact that agencies are seldom aware of research being conducted in other departments, reference was also made to the need for better access to external institutions, including the university system.

Bill Press, Director
Office of Planning and Research
1400 Tenth Street, Room 156
Sacramento, CA 95814
(916) 322-2318

Bill Kahrl, Director of Research
Office of Planning and Research
1400 Tenth Street, Room 256
Sacramento, CA 95814
(916) 322-3784

Alabama

Alabama boasts a Public Research and Development Program jointly supported by five public research universities. In addition to expertise represented in the R&D program, the Governor has had access to scientific and technical advisory services through the Alabama Development Office. It appears that both of these arrangements could be used more regularly and effectively as components

of the policy-development process. Hence, as an adjunct to the executive reorganization proposed earlier this year by Governor Wallace, an effort will be made with SSET funds to explore improvements that would make scientific resources available to the State's top policy makers on a more systematic, reliable, and responsive basis. The project will be supervised by the Executive Office of the Governor.

Grady Perdue
Executive Assistant to the
Governor
Office of the Governor
State Capitol
Montgomery, AL 36104
(205) 832-6866

John Cain, Director
Public R&D Program
Auburn University
Auburn, AL 36830
(205) 826-4731

South Carolina

Governor Edwards has asked to use SSET monies to study the potential for a research and development complex oriented toward state policy problems. South Carolina has tried several science and technology advisory mechanisms in the past and without noteworthy success. In part, the current study will explore the reasons for past failures in an effort to avoid similar mistakes in any future program that might be implemented. The Community Development Office within the Department of Administration will supervise the analysis, with survey work and field investigation to be conducted by a private consulting firm. The expectation is that research centers established in other States may provide some guidance that will permit a major undertaking in South Carolina along lines that the Research Triangle has developed in North Carolina.

Joe Wickel, Director
Office of Community Development
309 Edgar A. Brown Bldg
Columbia, SC 29201
(605) 224-3661

Hawaii

Hawaii has an active and widely recognized Center for Science Policy and Technology Assessment through which nearly five million dollars have been channeled by the state legislature since 1975. The Center's permanent staff is small; it acts as a research broker and catalyst, drawing upon the resources of state agencies, the University of Hawaii, and private industry to secure scientific and technical resources that are directly relevant to such current policy problems as geothermal development, aquaculture, and marine minerals. Remarkably, the Center is just one of several institutionalized mechanisms whereby science and technology is introduced to Hawaii's policy-making processes.SSET funds will be used to re-examine the relationship among these institutions, explore the potential for link up with other States and with the federal government, investigate the need for better communication with the legislature, and analyze the need for greater dissemination of scientific information to the public.

Hideto Kono, Director
Department of Planning & Economic Development
State of Hawaii
PO Box 2359
Honolulu, HI 96804
(808) 548-3033

Dr. Eugene M. Grabbe, Project Mgr.
Center for Science Policy
Department of Planning & Economic Development
PO Box 2359
Honolulu, HI 96804
(808) 548-4195

Arizona

Arizona SSET funds will be used by the Office of Economic Planning and Development, a unit of the Governor's Office, to form a new set of procedures for gathering scientific assistance from both internal sources and from the academic and private sectors. Several previous efforts, including legislation creating a Scientific and Technological Planning and Advisory Council, have proven unsuccessful. During the last two years, however, the energy crisis has provoked a new interest in technological support for policy making. The governor

cited land use, growth, health, housing, energy, and environmental planning among the "increasingly complex issues" that require improved communication between government and the science, engineering, and technology community.

Brent W. Brown, Executive Director
Office of Economic Planning & Development
1700 West Washington Street
Room 505
Phoenix, AZ 85007
(602) 271-5371

Dave Hamernick
Governor's Office of Economic Planning and Development
1700 West Washington Street
Fourth Floor
Phoenix, AZ 85007
(602) 271-5004

Idaho

Idaho proposes to develop a new science and technology mechanism rather than to improve an existing system. The Idaho application cites the fairly widespread conviction that science, engineering, and technology activities in both the private and public sectors are too remote from the policy arena. While state policy makers must wrestle on a day-to-day basis with problems whose resolution demands state-of-the-art technology, those with scientific knowledge are often inaccessible. The SSET study will examine the extent and nature of this phenomenon in Idaho state government, and present a set of recommendations to the Governor. The analysis will be done by the Bureau of State Planning and Community Affairs with assistance from the University of Idaho.

Shirl C. Boyce, Jr., Chief
Bureau of State Planning
Division of Budget, Policy Planning & Coordination
State House
Boise, ID 83720
(208) 384-3900

Paul Cunningham
Bureau of State Planning
Division of Budget, Policy Planning & Coordination
State House
Boise, ID 83720
(208) 384-3900

Oklahoma

The Oklahoma Division of Planning and Management Analysis has proposed a tightly knit work program that will involve two universities and the Department of Economic and Community Affairs. Part I of the SSET study will focus upon the nature and depth of need for scientific, technological, and engineering information among agency policy makers and at the gubernatorial level. Part II will be an inventory of resources available both from within the State and from out-of-state sources. Part III, which will involve several state officials, will consider the possible mechanisms for linking available resources to needs, and will contain a set of recommendations to the Governor. It should be noted that Governor Boren has already used a variety of techniques and processes for securing scientific advice. A central question to be resolved in the SSET study is whether the present arrangements could be improved through institutionalization.

Tom Bryan
Office of the Governor
PMA Division, Room 5A
State Capitol
Oklahoma City, OK 73105
(405) 521-3994

Connecticut

Last year the Connecticut General Assembly created the Connecticut Academy of Science and Engineering (CASE), whose mission is to provide "guidance to the people and the government of the state of Connecticut, upon request, in the application of science and engineering to the economic and social welfare" and to "initiate reports to the people and the government of the state of Connecticut when advances in science and engineering raise implications upon public policy." The academy is designed to serve both the executive and the legislative branches,

and SSET funds will be expended jointly to identify research priorities, to develop procedures for utilizing Academy resources, and to carry out some experimental assignments for both the legislative leadership and the Governor. Additionally, the potential for collaboration with federal R&D agencies, including the Office of the President's Science Advisor, will be explored.

Horace Brown
Office of Policy and Management
340 Capitol Avenue
Hartford, CT 06115
(203) 566-4872

Dr. Lee Azaroff, President
Connecticut Academy of Science & Engineering
3 Lewis Street
Hartford, CT 06103
(203) 486-4623 (afternoons only)

North Carolina

Liaison between North Carolina state government and the scienctific and technical community has been extensive. The Research Triangle Institute, formed as a consortium to assist state government, is widely known as a successful science and technology center. Nevertheless, the North Carolina proposal states: "At this time, there is no effective mechanism for scientific, engineering, or technological input into the Governor's policy development process." Governor Hunt has asked the Division of Policy Development to study several options that might be used to establish and sustain an advisory function. Recommendations are based in part upon a survey of both scientists and policy makers, who will be asked to reveal their perceptions both of critical issues and of the best procedures to put a full range of scientific and technological expertise at the disposal of the Governor.

Arnold Zogry, Assistant Secretary
Office of Policy Development
Department of Administration
116 West Jones Street
Raleigh, NC 27603
(919) 733-4131

Gene Namkoong
Department of Administration
116 West Jones Street
Raleigh, NC 27603
(919) 733-4131

Louisiana

Louisiana has submitted a joint legislative-executive proposal designed to improve the capacity of the Governor's Office of Science, Technology, and Environmental Policy. The SSET study will generate a needs' assessment and a directory of technical resources available from the public, private, and university sectors both inside and outside Louisiana, together with a plan to modernize the computer-based science and technology reference service in the Legislative Council Research Library. More effective science and technology utilization is not a new objective in Louisiana government; the State has just completed a three-year experiment involving technology transfer, out of which grew nearly three million dollars in projects. The use of satellite imagery for natural resources management, particularly in the coastal zone, has been a major S/T application in Louisiana.

Charles F. D'Agostino, Director
NASA/NSTL
Governor's Office of Science Technology
& Environmental Policy
P. O. Box 44095
Baton Rouge, LA 70804
(504) 389-2849

Texas

Texas has submitted a proposal for joint funding through the Energy Advisory Council, which is currently supplying scientific and technological information to policy makers in both the legislative and the executive branches. The objective of the project will be to improve the performance of the Council by increasing its leverage over the agendas of Texas research institutions.

In this respect the Texas strategy is somewhat unique, for Texas suggests that it is not state government's capacity to assimilate scientific and technical information that inhibits progress, but rather that the research community is not responsive to public policy concerns.

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Lt. Governor
State Capitol
Austin, TX 78711
(512) 475-3535

Milton L. Holloway, Executive Director
Energy Advisory Council
7703 North Lamar Blvd.
Austin, TX 78752
(512) 475-5588

Virginia

Virginia's Department of Intergovernmental Affairs will conduct a planning study considering several models of science and technology in state policy making. Among them: the policy development or integrated model that folds S/T into conventional management processes; the clearinghouse model; the research model; and the brokerage model. These, along with other approaches, will be reviewed against the State's past experience with an ad hoc array of advisory techniques that have arisen in response to specific problems without attention to overall design. Virginia's application shows an awareness of the complexity of the technology utilization process, and the SSET study will examine in some depth the question of how to identify useful scientific and technological development within the overwhelming volume of research product that flows from public and private institutions. The study will culminate in a schedule of research priorities and a set of recommendations for structural change that will go to the Governor.

Charles A. Christophersen, Director
Department of Intergovernmental Affairs
205 North 4th Street
Richmond, VA 23219
(804) 786-4407

Utah

Utah's SSET study will be conducted as a joint project of the Governor and the legislature and will form part of a response to requests from both branches for more emphasis upon scientific advisory services. The State Advisory Council on Science and Technology was created by legislation in 1973, and the State Science Advisor serves as its executive secretary. While the Council has not been inactive, the Science Advisor has only recently been made a full-time employee, and the potential impact of energy-related development in Utah has dramatized the importance of scientific information in both legislative and executive policy making. SSET funds will underwrite an effort to update the current system, particularly to increase capacity for "proactive" output.

James Edwin Kee
State Planning Coordinator
118 State Capitol
Salt Lake City, UT 84114
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Dr. Donald Neilson
Science Advisor
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Pennsylvania

The Pennsylvania Executive Office already has a number of units created to deal with matters of science and technology as they affect the well-being of the State. These include the Governor's Science Advisor, the Governor's Science Advisory Committee, the Pennsylvania Science and Engineering Foundation, the Pennsylvania Technical Assistance Program, the Governor's Energy Council, the Governor's Energy Council Advisory Committee, and the Bureau of Scientific and Technological Development. Each of these reports directly to the Governor with no formal means of coordinating efforts. Governor Shapp proposes to use the SSET funds to support a study by the Office of State Planning and Development

to review past activities, evaluate the extent to which they have influenced policy, and inventory the range of topics considered to assess their relevance and priority in relation to state needs. The final report will make recommendations concerning the need for a more formal mechanism for integrating and coordinating the individual operations of these various agencies.

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Harrisburg, PA 17120
(717) 787-2500

Louise Dufour
Room 506, Finance Building
Commonwealth of Pennsylvania
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Illinois

Illinois proposes to use SSET funds to develop a process which can provide the Governor with unbiased advice on issues with scientific or technological components, particularly those which involve more than one agency. The Governor's Program and Policy Staff, the Illinois Institute on Environmental Quality and the Governor's Science and Technology Task Force will work together to identify key scientific resources throughout the State and develop a means for integrating them with the existing policy-making process. Particular attention will be given to an analysis of the failure of past efforts to establish a science and technology mechanism and to recommending ways to forecast future problems.

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Chicago, IL 60606
(312) 793-2870

Noel Ebrahim
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(312) 793-3757

SECOND ROUND

Alaska

Because of its unique physical, climatic, and biological setting, Alaska is particularly sensitive to the need for scientific and technical expertise in the natural resources management field. The Alaskan Division of the American Academy of Sciences recently held a state-wide conference on the topic of science information exchange, and the legislature has under consideration a bill that would establish an Office of Appropriate Technology within the Division of Policy Development and Planning (DPDP). Funds available through the SSET program will be used to bring together the results of these and similar activities, with a view toward the need for a "system" that would make most effective use of the resources available. DPDP has already explored many of the most common problems encountered at the state level, including fragmentation of University research, lack of centralized data management, and underutilization of studies and reports already done because of inadequate facilities for location and retrieval of key information.

Applicant

Ms. Frances Ulmer
Director
Division of Policy Development
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Pouch AD
Juneau, AK 99811
(907) 465-3512

Project Manager

Bill Luria
Office of the Governor
Policy Development & Planning
Pouch AD
Junueau, AK 99811
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Rhode Island

Rhode Island has a well-structured process for policy development at the gubernatorial level. SSET funds will be used to focus new attention upon the status of scientific and technical information within that process. A survey of the most often needed types of information will be conducted, and the availability of untapped resources to satisfy unmet needs will be analyzed. Several alternative models will be assessed, and one will be chosen to complement institutions and processes already in place. The Policy Division of the Governor's Office will be the performing agency.

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Providence, RI 02903
(401) 277-2071

Glenn Kumekawa
Associate Professor
Community Planning & Area Development
University of Rhode Island
Kingston, RI 02881
(401) 792-2158

Montana

Montana must face difficult choices about the mode and pace of energy-related mineral extraction, choices that are laden with very complex scientific and technical issues. In response to this stituation, the state has developed a sophisticated and largely successful procedure for collecting information and advice in the energy area, and for assuring that policy-makers have effective access to needed scientific resources. Experience with the energy issue has dramatized the need for scientific and technical expertise in other policy areas, as water resource management, state building codes, and environmental regulation. Montana will use SSET funds to explore these needs. Drawing upon

the knowledge gained from dealing with energy policy, several mechanisms for supplying S/T resources in other areas will be tested. The study will be conducted by the Office of the Lieutenant Governor.

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Helena, MT 59601
(406) 449-3084

Robert Hall
Executive Assistant
Office of Lt. Governor
State Capitol Station
Helena, MT 59601
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West Virginia

The West Virginia SSET project will involve both the legislature and the executive branch. A central theme of the West Virginia proposal is the need for rapid and accurate retrieval of relevant scientific information as policy issues arise during the day-to-day course of legislative and executive business. SSET planning will be done in the Fuel and Energy Division of the Office of Economic and Community Development, where a Technical Liaison Representative and a Technical Reference Library will be housed. An inventory of S/T resources and an analysis of policy issues will be conducted by the West Virginia College of Engineering.

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West Virginia Fuel & Energy
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Charleston, WV 25311
(304) 348-8860

Dr. B. L. Atchley
Dean, West Virginia University
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Wisconsin

Wisconsin has a well-deserved reputation for information and personnel exchange between its universities and state agencies. University faculty have often taken leaves of absence to serve as state administrators, and the general familiarity with university expertise is high among state executive and legislative officials. Thus the objectives of SSET represent no new departure for Wisconsin policy-makers. Nevertheless, the program does furnish an opportunity to perform an objective evaluation of traditional practice and procedure, and to identify areas where improved performance would be both possible and desirable. The study will be conducted by the University Center for the Study of Public Policy, acting jointly with the Office of State Planning.

Craig Adams, Acting Director
Office of State Planning & Energy
Room B-130
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Madison, WI 53702
(608) 266-1033

Carlisle P. Runge
Center for the Study of Public Policy and Administration
University of Wisconsin-Madison
322 North Hall
Madison, WI 53706
(608) 262-3581

Arkansas

Arkansas has proposed a joint legislative/executive work program centering on the various ways to establish a liaison or "broker service" between the technical community and the two branches of state government. A two-day state conference will be held in order to expose policy-makers to a needs-priorities schedule to be developed by the Office of Management and Planning. To the extent possible, selected alternatives will be tested on specific issues as they arise during the study period.

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Director
Governor's Office of Management and Planning
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Little Rock, Arkansas 72201
(501) 371-2611

Bill Onopa
Governor's Office of Planning and Management
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Little Rock, AR 72201
(501) 371-2611

Oregon

The Oregon SSET planning study, to be conducted within the Office of the Governor, will consist of a straightforward nine-step process. Beginning with a review of past efforts in Oregon and other states, the study team will proceed to inventory existing resources and compare them with an inventory of the principal policy issues thought to deserve extraordinary attention from the scientific and technical community. Several alternative methods of matching resources with needs will be tried out on actual cases during the coming year, and final recommendations will be based in large part upon that trial experience.

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Don Jones, Assistant to the Governor
Intergovernmental Relations Division
Executive Department
240 Cottage Street, SE
Salem, OR 97310
(503) 378-3732

Maine

Maine will conduct a joint executive/legislative study through an interdisciplinary team made up of representatives of the State Planning Office, the Office of Legislative Assistance, and the University of Maine. The team will interview legislative leaders and state agency directors in order to identify active issues that have a significant scientific and technical component, then explore the sources of information that are currently used by the interviewees. Based upon an analysis of shortcomings in the existing "system," the team will consider the results achieved in other states and recommend tentative solutions.

These will be presented to agency personnel and legislators in a series of "re-interviews," designed to narrow the number of alternatives before final recommendations are made to the Governor and the Legislature.

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(207) 289-3261

Charles S. Colgan
State Planning Office
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Vermont

Vermont's SSET proposal is based upon the conviction that adopting technological innovations in state government could greatly increase the productivity of the work force. A private consultant will be retained to perform the actual study under supervision by the State Planning Office and the Governor's Commission on Productivity in Government. Work tasks will include analysis of barriers to the use of new technologies in state departments, a study of job descriptions to determine the adequacy of technical background requirements, and a set of case studies illustrating why available technology has or has not been implemented. The final report will be transmitted to the Governor for implementation.

John Simson
Director, State Planning Office
Pavilion Office Building
Montpelier, VT 05602
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New York

New York's SSET activities will be based squarely upon energy policy as the top-priority scientific/technical issue currently facing the state. New York has an active state Energy Office, and also an Energy Research and Development Authority, a public benefit corporation that engages in research, development, and demonstration projects. The linkages between scientific and technical expertise represented by the Authority and general energy policy deliberations elsewhere in state government are the central concern of the SSET study. Governor Carey has designated the State Energy Office as the applicant and performing agency.

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Acting Commissioner
New York State Energy Office
Annex Bldg.2, Empire State Plaza
Albany, NY 12223
(518) 474-3348

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New York State Energy Office
Annex Bldg. 2
Empire State Plaza
Albany, NY 12223
(518) 474-7690

Nevada

Nevada will use SSET funds to lay a foundation for the state science advisor function. The advisory position was first established in 1973 by executive order, but has been dormant because of lack of financial support. This year the legislature formalized the program by providing access to University personnel through an expanded sabbatical leave arrangement. Nevertheless, the first "science resource person" was not to have been available until July, 1978. Under the SSET proposal, this timetable will be advanced by six months, and the initial work task will be plan development so that alternative advisory mechanisms and procedures can be thoroughly evaluated in the light of state needs before the final decision is made about the mode in which the science advisor will operate.

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Bruce D. Arkell
State Planning Coordinator
Capitol Bldg, Room 45
Capitol Complex
Carson City, NV 89701
(702) 885-4865

Delaware

Delaware has submitted a joint executive/legislative application. In addition to a general appreciation of the relevance that technology has to current state policy problems, Delaware's proposal reflects recent budgetary difficulties: "In order for the budget process to work properly, decisions must be based on accurate information concerning the benefits of proposed or existing programs, the costs associated with such programs and the long-range accomplishments to be achieved." Thus an assessment of the current technical knowledge base in state government will be coupled with a review of critical issues encountered over the past three years to determine where S/T could have made the most useful contributions to effective policy. Based upon those findings, selected mechanisms for improvement will be tested on actual cases arising during the winter and spring of 1978. The University of Delaware will be the performing organization, and will operate under the supervision of an advisory team with representatives from each branch.

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Office of Management
Budget and Planning
530 South DuPont Highway
Dover, DE 19901
(302) 678-4271

Dr. Gerard Mangone
Director of Center for the Study of
Marine Policy
University of Delaware
Newark, DE 19711
(302) 738-1212

Florida

One of the most important issues in Florida continues to be the impact of rapid urban and suburban development upon the natural systems, such as groundwater aquifers and a unique wildlife habitat. Growth management problems are often highly technical, and state officials are largely aware of the importance of sound scientific information as a basis for decisions that may have a long-term effect upon Florida's future. The Office of State Planning will use A-95 data, an inventory of projects underway in the University system, and elements of the state comprehensive plan to analyze both the demand for and the supply of scientific counsel within the current policy development process.

R. G. Whittle, Jr., Director
Division of State Planning
660 Apalachee Parkway
Tallahassee, FL 32304
(904) 488-1115

Ohio

The Ohio Governor's Office will create and chair a State Technology Applications Advisory Committee, consisting of state officials, to identify major state problems that seem to require more extensive advisory input from the scientific and technical community. Concurrent with advisory group discussion, the Ohio Academy of Science, collaborating with the Ohio Engineers Foundation, will survey existing resources and explore alternative science advisory structures that have been adopted in other states. Recommendations will flow from a series of five or six regional meetings, where representatives of the area scientific and technical community will gather to review preliminary staff findings and suggest amendments or improvements.

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Program Coordination Section
Governor's Office
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(614) 466-7461

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Program Analyst, Governor's Office
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Nebraska

A principal product of Nebraska's SSET project will be a "state science policy," drawn to reflect research priorities that are consistent with the state's current problems. The policy will be hammered out before a small advisory committee, presented for public comment to a statewide conference on science and technology, and transmitted to the Governor for final approval. Nebraska is particularly anxious to increase the level of federally-supported research that bears upon its particular needs, and believes that a well-constructed science policy will furnish an effective framework within which to influence federal agencies. The study will be conducted by the Office of Planning and Programming, with the University of Nebraska as a cooperating agency.

Jerry Kromberg
Office of Planning & Programming
Box 94601, State Capitol
Lincoln, NE 68509
(402) 471-2414

Massachusetts

Massachusetts proposes to study the development of a Poli-Tech-Net force, chaired by the Secretary of Environmental Affairs. Half of this study would focus on a single issue, water management, and half would augment the conclusions reached in this policy area in order to design a government wide policy

support system. Citizen participation, geographical decentralization and water consumption will be the principal element in the study which will test techniques for feedback balloting to facilitate citizen involvement.

Dr. Evelyn F. Murphy
Secretary of Environmental Affairs
Commonwealth of Massachusetts
100 Cambridge Street
Boston, MA 02202
(617) 727-7700

Richard E. Kendall, Commissioner
Department of Environmental Management
State Office Building
100 Cambridge Street
Boston, MA 02202
(617) 727-3163

Missouri

The Missouri Office of Budget and Planning intends to develop a process for using available scientific and technological resources to improve policy development and coordination in the Governor's office. After the major areas for application have been assessed and existing information sources have been identified, a series of working conferences will be held for state personnel to examine possible approaches and discuss the financial and institutional constraints.

Gary Passmore, Director
Division of Budget & Planning
Missouri Office of Administration
Jefferson City, MO 65101
(314) 751-2438

Mike Boxberger, Chief
Research & Information
Office of Administration
Division of Budget & Planning
Box 809, Capitol Bldg.
Jefferson City, MO 65101
(314) 751-2073

South Dakota

The study in South Dakota will center on the Policy Development and Review Process of the executive branch, which seeks annually to identify new areas of concern and to revise established directives. The objective is to

develop an on-going work management plan for the regular use of scientific and technological expertise, particularly that of the higher education network. Consideration will be given to the establishment of a Policy Coordination Council, to identify legislative themes and evaluate the annual process, and to the creation of a "Technology Trust," through which issues could be channeled to the appropriate resource.

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State Capitol
Pierre, SD 57501
(605) 224-3661

Scott McGregor
State Planning Bureau
State Capitol
Pierre, SD 57501
(605) 224-3661

Minnesota

Minnesota will use a specific problem -- the control and disposal of hazardous and toxic substances -- as a case study in the relationships between scientific expertise and state policy-making. After an initial analysis of the issue, an inventory of relevant activity currently under way in the executive branch will be conducted. This will be followed by an attempt to assess the attitude of line managers toward available S/T resources. The result will be a set of recommendations describing how state officials could make better use of scientists and engineers when designing programs and policies.

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(612) 296-4932

A. Edward Hunter
Deputy Director
State Planning Agency
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St. Paul, MN 55101
(612) 296-4932

Georgia

Georgia will use its SSET funds to explore the feasibility of and need for a "high technology development center" whose roles would include (a) advising policy-makers, (b) planning a mechanism to attract high technology industry to the state, and (c) strengthening the ties between industry, government and the universities. The study will be conducted under supervision of the Vice President for Research at the Georgia Institute of Technology.

Gordon Harrison
Governor's Office/IGR
270 Washington Street, SW
Atlanta, GA 30334
(404) 656-5767

North Dakota

North Dakota presently faces a major change in its economic structure, as historic dependence upon agriculture is displaced in part by development of the state's massive lignite deposits. Scientific and technical expertise previously committed to agriculture must now be balanced with new kinds of capacity -- to deal with environmental pressures, water resource management problems, and the regulation of energy facilities siting. Sub-cabinet "coordinating bodies" created by the legislature and the governor will be the mechanism North Dakota officials will call upon to define more carefully the priorities for S/T utilization that meets these problems. Priorities will be compared with a profile of research capacity in existing governmental and university institutions, and from this comparison will come recommendations to the governor outlining the kinds of improvement that seem to match most closely the state's needs. Responsibility for the SSET project has been given to the Governor's Energy and

Natural Resources Coordinator, although his study will span all of state government and will focus most heavily upon policy issues that involve more than one department or agency.

Charles F. Metzger
Energy and Natural Resources
Coordinator
Governor's Office
State Capitol Building
Bismarck, ND 58505
(701) 224-2200

Kentucky

Kentucky intends to study the linkage between technology and state policy processes by focusing upon specific issues that are currently matters of public concern. The extent to which state officials are aware of advanced fire protection and prevention technology, and the degree to which such technology is incorporated into state fire regulations, is one issue from which the Office for Policy and Management expects to generalize about the broader question of technical information and how it is supplied to policy-makers as important state decisions are made. The results of the Kentucky analysis may have several implications, including some evidence about the need for ongoing staff training in those areas of state policy where changing technology continuously outdates previous practices.

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209 Capitol Annex
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REPRESENTATIVE APPROACHES

State Science, Engineering,and Technology Program

The following are summaries of the applications submitted by four states. These are offered with the warning that even though state projects can be classified in general categories, the actual projects are quite different and none can be considered as typical or representative.

Arizona

Arizona SSET funds will be used by the Office of Economic Planning and Development, a unit of the Governor's Office, to form a new set of procedures for gathering scientific assistance from both internal sources and from the academic and private sectors. Several previous efforts, including legislation creating a Scientific and Technological Planning and Advisory Council, have proven unsuccessful. During the last two years, however, the energy crisis has provoked a new interest in technological support for policy making. The governor cited land use, growth, health, housing, energy, and environmental planning among the "increasingly complex issues" that require improved communication between government and the science, engineering, and technology community.

Wisconsin

Wisconsin has a well-deserved reputation for information and personnel exchange between its universities and state agencies. University faculty have often taken leaves of absence to serve as state administrators, and the general familiarity with university expertise is high among state executive and legislative officials. Thus the objectives of SSET represent no new departure for Wisconsin policy-makers. Nevertheless, the program does furnish an opportunity to perform an objective evaluation of traditional practice and procedure, and to identify areas where improved performance would be both possible and desirable. The study will be conducted by the University Center for the Study of Public Policy, acting jointly with the Office of State Planning.

New York

New York's SSET activities will be based squarely upon energy policy as the top-priority scientific/technical issue currently facing the state. New York has an active state Energy Office, and also an Energy Research and Development Authority, a public benefit corporation that engages in research, development, and demonstration projects. The linkages between scientific and technical expertise represented by the Authority and general energy policy deliberations elsewhere in state government are the central concern of the SSET study. Governor Carey has designated the State Energy Office as the applicant and performing agency.

Alaska

Because of its unique physical, climatic, and biological setting, Alaska is particularly sensitive to the need for scientific and technical expertise

in the natural resources management field. The Alaskan Division of the American Academy of Sciences recently held a state-wide conference on the topic of science information exchange, and the legislature has under consideration a bill that would establish an Office of Appropriate Technology within the Division of Policy Development and Planning (DPDP). Funds available through the SSET program will be used to bring together the results of these and similar activities, with a view toward the need for a "system" that would make most effective use of the resources available. DPDP has already explored many of the most common problems encourtered at the state level, including fragmentation of University research, lack of centralized data management, and underutilization of studies and reports already done because of inadequate facilities for location and retrieval of key information.

National Governors' Association

William G. Milliken
Governor of Michigan
Chairman

Stephen B. Farber
Director

March 27, 1978

Dr. Richard C. Atkinson
Director
National Science Foundation
1800 G Street, N. W.
Washington, D. C. 20550

Dear Dr. Atkinson:

On behalf of the National Conference of State Legislatures and the National Governors' Association, we would like to urge you to include funds for an implementation phase of the State Science, Engineering and Technology Program in the Foundation's budget planning process now underway for fiscal years 1980-82.

As you know, the Foundation requested $2.5 million for its FY 79 budget for support of a limited implementation phase for the SSET program. However, this request was eliminated from the NSF budget by the Office of Management and Budget and was not part of the Administration's budget as submitted to the Congress. We are asking Congress to both authorize and appropriate funds for an implementation phase for the program for FY 79. The results of our efforts will not be known for some time and are uncertain. The House Science and Technology Committee did not include any FY 79 funds for the SSET implementation phase in the NSF authorization bill.

Both NCSL and NGA have adopted official policy positions strongly endorsing the SSET implementation phase. As of February 28, 1978, the last date for accepting SSET applications, 49 states and 43 legislatures had submitted applications. We believe this extremely high level of participation, the quality of the proposals and the fact that the required state match exceeds the minimum is strong evidence that this program is of great importance to the states and the Foundation, despite the fact that the planning funds available to the states were very modest.

We are firmly convinced that without additional federal funds, most states will complete their planning studies but will not be able to act upon their studies' recommendations. About half of these state plans will be finished by December of this year. Our failure to secure implementation funds for FY 79, so that states can continue their studies without a potentially detrimental time lapse, has serious implications for the future viability of this important program.

The National Conference of State Legislatures and the National Governors' Association believe the SSET program will significantly strengthen state governments' ability to use science and technology resources to resolve complex public policy issues and improve management capabilities. We appreciate the support of the Foundation in this area and urge you to provide for the continuation of this program in NSF's FY 80-82 budget.

Sincerely,

William G. Milliken

William G. Milliken
Chairman, National Governors' Association

Fred E. Anderson

Fred E. Anderson
Chairman, National Conference of
State Legislatures

POLICY POSITION OF THE NATIONAL GOVERNORS' ASSOCIATION

WINTER MEETING

1978

SCIENCE AND TECHNOLOGY

STATE AND LOCAL GOVERNMENTS ARE CONFRONTED BY AN EVER INCREASING NUMBER OF PROBLEMS THAT ARE COMPLICATED BY SCIENTIFIC AND TECHNOLOGICAL CONSIDERATIONS. MANY OF THESE PROBLEMS ARE BROUGHT ABOUT AS A RESULT OF FEDERAL PROGRAMS AND REGULATIONS IMPOSED UPON THE STATES.

AT THE SAME TIME, THE FEDERAL GOVERNMENT SUPPORTS A MULTI-BILLION DOLLAR RESEARCH AND DEVELOPMENT BUDGET WHICH DOES NOT EFFECTIVELY MEET STATE AND LOCAL NEEDS. ALTHOUGH MANY GOVERNMENT-FINANCED DISCOVERIES IN SCIENCE AND TECHNOLOGY HAVE BEEN ADAPTED FOR PRACTICAL USE, THIS APPLICATION HAS OFTEN BEEN MERELY COINCIDENTAL BECAUSE FEDERAL RESEARCH AND DEVELOPMENT GENERALLY IS NOT UNDERTAKEN TO ADDRESS SPECIFIC AREAS OF CONCERN AS DEFINED BY STATE AND LOCAL GOVERNMENTS.

IF THE GENERAL PUBLIC IS TO DERIVE MAXIMUM BENEFIT FROM THE CIVILIAN-ORIENTED RESEARCH AND DEVELOPMENT BUDGET SUPPORTED AT GREAT TAXPAYER EXPENSE, ITS INVESTMENT MUST BE RECONSIDERED TO EMBRACE THIS BROADER RANGE OF SCIENTIFIC AND TECHNICAL PROBLEMS.

IN ORDER TO ACHIEVE THIS GREATER RETURN FOR STATE GOVERNMENTS AND THEIR CITIZENS, A STRONGER LONG-TERM RELATIONSHIP WITH THE EXISTING FEDERAL SCIENCE AND TECHNOLOGY ESTABLISHMENT MUST BE FORGED. THE CREATION OF THE INTERGOVERNMENTAL SCIENCE, ENGINEERING AND TECHNOLOGY ADVISORY PANEL (ISETAP) UNDER THE CHAIRMANSHIP OF THE DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY PROVIDES THE MECHANISM FOR DIRECT COMMUNICATION WITH THE FEDERAL GOVERNMENT. THE DEGREE TO WHICH ISETAP REALIZES ITS POTENTIAL IS DEPENDENT UPON THE BREADTH OF INTERPRETATION WITH WHICH THE PANEL ADDRESSES ITS CHARGE.

IN ORDER TO MEET STATE RESPONSIBILITIES, STATE CAPABILITIES MUST BE IMPROVED TO ENCOMPASS A GREATER RECOGNITION OF THE IMPORTANCE OF THE SCIENTIFIC AND TECHNO-

LOGICAL ELEMENTS IN STATE POLICY ISSUES. THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY (SSET) PROGRAM WAS CREATED BY THE CONGRESS, WITH THE SUPPORT OF THE NATIONAL GOVERNORS' ASSOCIATION, TO ASSIST STATE EXECUTIVES AND LEGISLATORS IN DEVELOPING THIS CAPACITY.

THE NATIONAL GOVERNORS' ASSOCIATION HAS ENDORSED, AND VIRTUALLY ALL OF ITS MEMBERS ARE PARTICIPATING IN, THE PLANNING PHASE OF THE SSET PROGRAM. IT HAS BEEN WELCOMED AS A COOPERATIVE EFFORT TO BUILD WITHIN THE STATES A GREATER CAPACITY FOR RESOLVING POLICY ISSUES THAT HAVE SIGNIFICANT SCIENTIFIC OR TECHNOLOGICAL CONTENT.

HOWEVER, CAPACITY-BUILDING IS A GRADUAL AND LABORIOUS PROCESS. NEW INSTITUTIONS CREATED THOUGHTLESSLY SELDOM SURVIVE, AND OLD INSTITUTIONS YIELD SLOWLY TO PRESSURES FOR CHANGE. PROGRAMS LIKE SSET MUST BE SUSTAINED AT REASONABLE LEVELS AND FOR A REASONABLE TIME IF THEY ARE TO SUCCEED.

WE ARE THEREFORE DISMAYED BY THE UNEXPECTED DELETION OF FEDERAL SUPPORT FOR SSET FROM THE 1979 EXECUTIVE BUDGET. SSET OBJECTIVES CANNOT BE ACHIEVED UNLESS PLANNING STUDIES CURRENTLY UNDERWAY ARE SECURED BY A COMMITMENT TO IMPLEMENTATION.

THE NATIONAL GOVERNORS' ASSOCIATION URGES CONGRESS TO RESTORE SSET FUNDING FOR FISCAL YEAR 1979 AT A LEVEL OF $100,000 PER STATE FOR THE EXECUTIVE BRANCH, WITH AN EQUAL APPORTIONMENT FOR EACH STATE LEGISLATURE. IN ORDER TO ENSURE THE LONG-TERM COMMITMENT REQUIRED FOR MEANINGFUL IMPLEMENTATION, WE FURTHER URGE CONSIDERATION FOR A FIVE-YEAR AUTHORIZATION ACT.

Mr. HELMINSKI. Before concluding my statement, I would like to state that the public interest groups in their fervor for supporting effective applied research programs, are not in any way asking that the basic research effort of the NSF be diminished. We recognize the importance of, and endorse a strong basic research program. Without it, the pursuit of knowledge and academic excellence, and the quality of our academic institutions would surely be lost.

Our concern is that applied problem-solving research be recognized as necessary and beneficial activity within the NSF, and adequate funds be appropriated to assure the development of an effective program.

I might add that in designing a research program within ASRA, caution has to be exhibited, such that the applied research effort is not merely a marketing arm of the basic research arm within the Foundation, and not a push-oriented program, but one where research is applied in the problem-solving role.

I thank you, Mr. Chairman.

Senator KENNEDY. I suppose really the legitimate kind of question is not whether the National Science Foundation should begin to sort of help the States get started in this area, but whether they could really be expected to run a program, whether the other agencies ought to assume that kind of responsibility.

What is the Government's position, such as the Commerce Department?

Mr. HELMINSKI. We have discussed that with the National Science Foundation, and with State officials, and other agencies, and it has been the focus of a discussion of the ISETAP Panel for over a year.

It is our general opinion, in a full-blown implementation, that there may be a possibility of another agency running that type of a program, one that had a majority of programs dealing with State and local governments.

Also, there is the advantage of keeping the program within ASRA, where applied research is emphasized. Another consideration is that NSF is not a mission-oriented research agency and therefore can manage a program such as SSET without emphasizing a particular area. We have not come out with a clear answer. There are advantages to possibly spinning it off to the Commerce Department in their State and local division, or keeping it at the National Science Foundation, so it is more closely alined with the ASRA program—we have not come up with a clear decision.

Senator KENNEDY. Granted it is a very small amount of money, what are some of the more effective State programs now?

Mr. HELMINSKI. In addition to Massachusetts, which has a program in the State legislature, started with prior funding from NSF and the SSET other States that have successfully implemented programs in the past are New York, Minnesota, California, Illinois, Pennsylvania, Maryland, and Alaska.

Senator KENNEDY. Pennsylvania.

Mr. HELMINSKI. Pennsylvania has a network—Tennessee.

Senator KENNEDY. What are some of the things that they have been doing?

Mr. HELMINSKI. One interesting aspect of the Pennsylvania effort is the attempt to establish an S/T resource network with the universities. Seven universities are involved in the program to work with

the State legislature, and the executive branch of the State government.

The program is designed so as to utilize university resources for work on State problems.

In the State of Michigan, a close link has been established with Michigan State. In fact, the science advisor is the head of the civil engineering department at Michigan State University. His role over the past year has been very critical to some very important policy issues in that State. The resources of Michigan State University have been used at the Governor's request, and assisted his office in dealing with very significant problems.

In Hawaii, a State technology center has been established. This center has undertaken studies to investigate industrial expansion, the mining of manganese nodules off the coast of Hawaii, the development of an energy policy, and many other aspects of development in the State of Hawaii.

Senator KENNEDY. Doctor Atkinson, what is your reaction, and what should be expected?

Dr. ATKINSON. I am proud of the activities of the intergovernmental agencies program. It is not just National Science Foundation initiative; it has been working with public interest groups like the one Doctor Helminski represents. It has been working with a small amount of dollars, and has been quite productive. I would like to see it continue.

Your question as to whether the National Science Foundation is the right place depends upon the nature of future programs. The National Science Foundation should have an innovative role and should support some activities.

It might be that some agency like the Commerce Department is appropriate. I assume, over the 5 years we are talking about, that the National Science Foundation might still be the cognizant agency, even though the program in time might be transferred to Commerce.

The issue of whether the next phase of the program should be moved ahead a year is special. The House and Senate Authorization Committees have some debate. The conference view was that we would fund a set of planning activities, then we would conduct an evaluation. We are going to be doing that in the course of the summer, and we will have recommendations available, I hope, late in the summer and early in the fall for input to the 1980 budget.

We are somewhat in disagreement as to whether we should try to move ahead for the 1979 budget, or whether we should wait for plans and then move ahead in the 1980 budget.

Mr. HELMINSKI. One of the problems with waiting, most of the States will have completed their plans by the end of next summer. They will complete their first evaluation by August 1978. There will be a year's gap waiting for funding of implementation.

Because of the lack of appropriation, even though the authorization existed, the program was implemented very slowly. If grants are out, and States are implementing their study grants, I do not think a penalty should be paid for the fact that good work is going on, and the program is slowly being implemented.

It will be a severe penalty if the authorization and appropriation waited until fiscal year 1980. In fact, we would probably lose the opportunity we now have.

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It is very interesting to note that even though only $25,000 was available with respect to States, there was enough of an initiative out there to get almost all the States participating.

Although the public interest groups were stimulating that interest in the first round of proposals, there were only 30 from the executive branch of the State government, and with very little awareness on their part.

I really would think that the investment made, the $2.5 million of last year, and investments to other State demonstration programs would really be lost if we do not have an authorization for 1979. I think it would disrupt a lot of planning, and it would really—I think that the States may lose interest. At least it would show a lack of appreciation of what is happening right now.

Senator KENNEDY. Do you think that if they had some continuation for a year, that would give them sufficient interest, and they would be willing to accept responsibility after that.

Mr. HELMINSKI. I think a year's appropriation and authorization leave next year's funding question unanswered. State governments would like to plan more effectively so they could make more effective contributions.

A lot of legislatures appropriate funds every 2 years, not every year. They have to plan ahead. They have to know what is coming down the line.

We would accept, and want a year's program for the purpose of continuity. Along with the universities, we would prefer long-term funding, not only for the SSET, but the ASRA budget, as well.

Senator KENNEDY. The real question, I think, is the nature of that continuity, and what the appropriate kind of agency is for continuation. There has been some impressive work that has been done that I am familiar with, and it is obviously helpful.

Mr. Helminski, your complete statement will be made a part of the record, and anything else that you wish to add.

Mr. HELMINSKI. Thank you very much.

[The prepared statement of Mr. Helminski follows:]

TESTIMONY OF EDWARD L. HELMINSKI, DIRECTOR, ENERGY AND NATURAL RESOURCES PROGRAM NATIONAL GOVERNORS' ASSOCIATION

SENATE SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH

APRIL 10, 1978

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE, MY NAME IS EDWARD L. HELMINSKI. I AM DIRECTOR OF THE ENERGY AND NATURAL RESOURCES PROGRAM AT THE NATIONAL GOVERNORS' ASSOCIATION. I APPRECIATE THE OPPORTUNITY TO ADDRESS YOU TODAYREGARDING THE 1979 AUTHORIZATION FOR THE NATIONAL SCIENCE FOUNDATION. MY STATEMENT IS PRESENTED NOT ONLY ON BEHALF OF THE NATION'S GOVERNORS, BUT REFLECTS THE CONCERNS OF OTHER MAJOR PUBLIC INTEREST ORGANIZATIONS REPRESENTING STATE AND LOCAL GOVERNMENTS, NAMELY THE NATIONAL CONFERENCE OF STATE LEGISLATURES AND THE U. S. CONFERENCE OF MAYORS. EACH GROUP DESIRED TO ADDRESS THE SUBCOMMITTEE INDEPENDENTLY, BUT RECOGNIZING THE PRESS OF THE CONGRESSIONAL SCHEDULE RELUCTANTLY ACCEPTED THE ARRANGEMENT OF HAVING ONE SPOKESMAN TODAY. BOTH GROUPS REQUEST THE CHAIRMAN'S PERMISSION TO SUBMIT A WRITTEN STATEMENT.

THE INTENT OF MY STATEMENT IS THREE-FOLD:

1. TO REQUEST THAT THE COMMITTEE AUTHORIZE IN FY 79 $42 MILLION OVER A FIVE-YEAR PERIOD FOR THE IMPLEMENTATION PHASE OF THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY PROGRAM.
2. TO SUPPORT A CONTINUED AND STRENGTHENED RESEARCH APPLICATIONS EFFORT WITHIN THE REORGANIZED APPLIED SCIENCE AND RESEARCH APPLICATION DIRECTORATE OF THE FOUNDATION.
3. TO REQUEST THE CHAIRMAN'S AND THE SUBCOMMITTEE'S SUPPORT FOR THE INSTITUTIONALIZATION OF EFFECTIVE INTERGOVERNMENTAL MECHANISMS WITHIN THE NSF, PARTICULARLY WITHIN THE APPLICATIONS DIRECTORATE TO ASSURE THAT THE PROGRAMS

ARE RESPONSIVE TO THE NEEDS OF STATE AND LOCAL GOVERNMENTS.

BEFORE PROCEEDING, I WOULD LIKE TO FIRST COMPLIMENT YOU, MR. CHAIRMAN, ON BEHALF OF THE GOVERNORS, LEGISLATORS AND ALL STATE AND LOCAL OFFICIALS AND THEIR ASSOCIATED ORGANIZATIONS FOR YOUR CONTINUED AND UNFAILING SUPPORT OF EFFORTS TO DEVELOP AND STRENGTHEN THE SCIENTIFIC AND TECHNOLOGICAL CAPACITY OF STATE AND LOCAL GOVERNMENTS. YOUR RECOGNITION OF THE COMPLEX PROBLEMS THAT FACE STATE AND LOCAL GOVERNMENTS AND THE RESPONSIBLITY OF THE FEDERAL AGENCIES TO ASSURE THAT THE VAST AMOUNT OF MONIES EXPENDED ON CIVILIAN R&D ARE MEETING STATE AND LOCAL NEEDS HAS BEEN THE IMPETUS BEHIND THE CONTINUED STRENGTHENING OF THE FOUNDATION'S INTERGOVERNMENTAL SCIENCE PROGRAM AND APPLIED RESEARCH ACTIVITIES.

THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY PROGRAM, AUTHORIZED IN FY 77 COULD NOT HAVE BEEN INITIATED WITHOUT YOUR STRONG SUPPORT. THE NATIONAL GOVERNORS' ASSOCIATION AND ALL THE ORGANIZATIONS REPRESENTING STATE AND LOCAL OFFICIALS ON BEHALF OF THEIR CONSTITUENTS ARE INDEBTED TO YOU AND LOOK FORWARD TO CONTINUED WORK WITH YOU AND THE SUBCOMMITTEE ON PROGRAMS THAT WILL ASSURE THE EVOLVEMENT OF A STRONG NATIONAL GOVERNMENT ABLE TO MEET THE COMPLEX PROBLEMS OF TODAY AND THE FUTURE THROUGH THE DEVELOPMENT OF AN EFFECTIVE PARTNERSHIP BETWEEN THE FEDERAL, STATE, AND LOCAL GOVERNMENTS, WHERE ALL HAVE THE CAPACITY TO IDENTIFY, DEFINE, AND COMMUNICATE THEIR R&D NEEDS.

SCIENCE IS A POWERFUL FORCE SHAPING THE QUALITY AND CHARACTER OF AMERICAN LIFE. NEW CONSUMER PRODUCTS THOUGHT IMPOSSIBLE A FEW YEARS AGO APPEAR IN THE MARKETPLACE AND ARE ACCEPTED WITH LITTLE THOUGHT TO THE ENORMOUS TECHNICAL PROGRESS THEY REPRESENT. ADVANCES IN MEDICAL KNOWLEDGE SINCE 1920 HAVE EXTENDED LIFE EXPECTANCY ANOTHER 18 YEARS. DISEASES ONCE CONSIDERED FATAL ARE TREATED ROUTINELY AND SUCCESSFULLY. THE C COMPUTER, THE LASTER, HIGH-SPEED TELECOMMUNICATIONS, SUPERSONIC TRANSPORTATIC THESE ARE BUT A FEW EXAMPLES OF THE TECHNOLOGICAL DELUGE THAT HAS ENGULFED OUR SOCIETY DURING POST-WAR DECADES.

THIS INCREASED INFLUENCE OF SCIENCE AND TECHNOLOGY POSES A UNIQUE CHALLENGE TO STATE AND LOCAL GOVERNMENTS. THE BULK OF RESEARCH SPENDING HAS OCCURED IN THE PRIVATE SECTOR AND IN THE FEDERAL GOVERNMENT: STATE AND LOCAL GOVERNMENTS HAVE NOT BEEN SUPPLIERS OF A NEW TECHNOLOGY. INDEED, THE FUNCTION OF THESE GOVERNMENTS AS PROVIDERS OF TRADITIONAL SERVICES HAS OFFERED LITTLE REASON TO DEVELOP A SCIENTIFIC CAPACITY. NEW TECHNOLOGY HAS BEEN INTRODUCED TO STATE AND LOCAL SERVICES AS INDEPENDENT VENDORS. IN RECENT YEARS, HOWEVER, THE RELATIONSHIP BETWEEN SCIENTIFIC KNOWLEDGE AND THE PERFORMANCE OF GOVERNMENTAL INSTITUTIONS HAS TAKEN ON A DIFFERENT MEANING. FOR EXAMPLE, GROWING AWARENESS OF MAN'S DESTRUCTIVE EFFECT UPON THE PHYSICAL ENVIRONMENT HAS INTRODUCED EXPANDED GOVERNMENTAL REGULATORY POWER. AS A RESULT OF THIS EXPANSION DECISIONS BY STATE AND LOCAL POLICY MAKERS HAVE A FAR-REACHING AND LONG-RANGE EFFECT UPON THE SOCIAL, ECONOMIC, AND PHYSICAL HEALTH OF THEIR CONSTITUENTS. NUCLEAR POWER DEVELOPMENT, AIR POLLUTION AND GROUNDWATER RESOURCE EXPLORTATION ARE NOW THE OBJECTS OF GOVERNMENT INTERVENTION.

THE KNOWLEDGE THAT ERRONEOUS OR ILL-ADVISED POLICIES CAN BRING DISASTROUS CONSEQUENCES HAS BROUGHT SOBERING, NEW OBLIGATIONS TO ELECTED OFFICIALS.

RECOGNIZING THAT AN EXPANDING SET OF PUBLIC POLICY ISSUES HAVE SCIENTIFIC AND TECHNICAL DIMENSIONS, IT IS CRITICAL NOW MORE THAN EVER THAT THE INITIATIVE THAT BEGAN WITH THE STUDY GRANTS UNDER THE SSET PROGRAM IN 1977 BE CARRIED THROUGH WITHOUT INTERRUPTION, INTO AN IMPLEMENTATION PHASE IN FY 79.

THE NATIONAL GOVERNORS' ASSOCIATION AND THE NATIONAL CONFERENCE OF STATE LEGISLATURES SUPPORTED BY THE OTHER STATE AND LOCAL ORGANIZATIONS REQUEST THAT THE COMMITTEE AUTHORIZE TO THE NATIONAL SCIENCE FOUNDATION $42 MILLION IN FY 79 FOR A FIVE-YEAR IMPLEMENTATION PHASE OF THE STATE SCIENCE AND ENGINEERING TECHNOLOGY PROGRAM. THIS FUNDING LEVEL IS DESIGNED TO PROVIDE EACH BRANCH OF STATE GOVERNMENT WITH A $100,000 MAXIMUM FOR THE FIRST TWO YEARS, $80,000 FOR THE THIRD AND FOURTH YEARS AND $60,000 FOR THE FIFTH AND FINAL YEAR.

THIS TYPE OF SEED MONEY PROGRAM WILL ALLOW THE STATES TO DEMONSTRATE THE EFFECTIVENESS OF AN INCREASED S/T CAPACITY TO THEIR CONSTITUENCIES AND ENHANCE THE POSSIBILITY OF A CONTINUED PROGRAM WITH STATE FUNDS.

THE INTERGOVERNMENTAL PROGRAM WITHIN NSF HAS PROVEN SUCH A SEED MONEY PROGRAM CAN BE SUCCESSFUL.

SEVERAL DEMONSTRATION S/T CAPACITY BUILDING PROJECTS SUPPORTED BY THE NSF OVER THE LAST SEVERAL YEARS HAVE RESULTED IN THE INSTITUTIONALIZING OF S/T MECHANISMS WITHIN BOTH THE LEGISLATIVE AND EXECUTIVE BRANCHES OF STATE GOVERNMENT.

IN HAWAII, NSF SEED MONEY WAS INSTRUMENTAL IN THE INSTITUTIONALIZING OF A CENTER FOR SCIENCE POLICY AND TECHNOLOGY ASSESSMENT. NOW ALMOST WHOLLY SUPPORTED BY THE STATE GOVERNMENT. THE GOVERNOR OF MICHIGAN HAS REQUESTED $50,000 OF STATE MONEY THIS YEAR TO CONTINUE A PROGRAM STARTED AND PROVEN EFFECTIVE THROUGH THE USE OF NSF SEED MONEY. IN THE LEGISLATURES OF MINNESOTA, NEW YORK AND ILLINOIS, NSF DEMONSTRATION PROJECT SUPPORT PAVED THE WAY FOR CONTINUED STATE FUNDING.

SUPPORT FOR THE SSET IMPLEMENTATION PROGRAM IS BASED ON THE BELIEF THAT SIMULTANEOUS EFFORTS IN ALL THE STATES, COUPLED WITH A COOPERATIVE FEDERAL POSTURE, WOULD PROVIDE A MUTUALLY REINFORCING IMPETUS TO ESTABLISH EFFECTIVE NATIONWIDE S/T CAPACITY.

DESPITE THE MEAGER AMOUNT OF MONEY AVAILABLE TO EACH STATE UNDER THE PRESENT SSET STUDY GRANT PROGRAM, ($25,000 PER BRANCH PER STATE) 49 EXECUTIVE BRANCHES AND 42 STATE LEGISLATURES ARE INVOLVED IN THE PROGRAM. (I HAVE PROVIDED THE SUBCOMMITTTEE WITH DOCUMENTS OUTLINING THE VARIOUS STATE ACTIVITIES UNDER THE PROGRAM.) THE STATES HAVE CONTRIBUTED OVER AND ABOVE THE REQUIRED MATCH IN ORDER TO CARRY OUT THEIR STUDIES.

MOST ALL WILL HAVE COMPLETED THEIR PLANS BY LATE SUMMER AND WILL BE READY TO BEGIN IMPLEMENTATION. IF SEED FUNDING IS NOT AVAILABLE IN FY 79, THE MOMENTUM NOW IN THE STATES WILL BE LOST.

WE WILL HAVE MISSED AN EXCELLENT OPPORTUNITY TO ASSURE THAT OUR NATION'S POLICYMAKERS HAVE THE CAPACITY TO ACT EFFECTIVELY ON COMPLEX PUBLIC POLICY ISSUES.

THE SSET PROGRAM IS ONLY ONE OF THE SEVERAL PROGRAMS WITHIN THE NEWLY REORGANIZED APPLIED RESEARCH AND SCIENCE APPLICATIONS DIRECTORATE OF THE NSF THAT IS OF CONCERN TO STATE AND LOCAL INTERESTS.

THE PUBLIC INTEREST GROUPS HAVE CLOSELY MONITORED THE REORGANIZATION OF RANN INTO THE ASRA DIRECTORATE, AND THOUGH GENERALLY APPROVING OF THE REORGANIZATION, REMAIN CONCERNED ABOUT THE ROLE OF APPLIED RESEARCH BEFITTING STATE AND LOCAL GOVERNMENT. WITHIN THE NSF, DR. ATKINSON, THE DIRECTOR OF THE NSF, AND DR. SANDERSON, THE ASSISTANT DIRECTOR FOR ASRA, HAVE TO THEIR CREDIT, MET WITH THE EXECUTIVE DIRECTOR OF THE VARIOUS STATE AND LOCAL GROUPS TO EXPLAIN THE OBJECTIVES OF ASRA AND HAVE STATED THEIR INTENT TO ASSURE THAT EXISTING EFFORTS WITH STATE AND LOCAL GOVERNMENTS WILL BE STRENGTHENED. OUR INPUT HAS BEEN SOLICITED AND WELCOMED.

ON BEHALF OF THE INTEREST GROUPS, I WOULD LIKE TO EXPRESS SOME OF OUR CONCERNS AND ALSO OFFER FOR YOUR CONSIDERATION SEVERAL RECOMMENDATIONS THAT IF IMPLEMENTED COULD ASSIST THE NSF IN MAKING ASRA MORE RESPONSIVE TO THE NEEDS OF STATE AND LOCAL GOVERNMENT.

THOUGH ASRA IS INTENDED TO MAINTAIN AND STRENGTHEN THE PAST ACITVITIES OF RANN, NOT MUCH PROGRESS WILL BE MADE UNTIL THE NSF RECOGNIZES THE IMPORTANCE OF THE ROLE APPLIED PROBLEM SOLVING RESEARCH PLAYS. FROM OUR VANTAGE POINT, THIS RECOGNITION WILL NOT BE ACCOMPLISHED UNTIL STATE AND LOCAL OFFICIALS HAVE REPRESENTATION ON THE NSF BOARD OF DIRECTORS AND THEREFORE HAVE A VOICE IN

ESTABLISHING NSF PROGRAMS AND PRIORITIES.

IN ADDITION TO MEMBERSHIP ON THE BOARD, STATE AND LOCAL GOVERNMENT REPRESENTATIVES MUST BE DIRECTLY INVOLVED, THROUGH INSTITIONALIZED MECHANISMS, IN THE PLANNING AND EVALUATION OF ASRA PROGRAMS. THE INTERGOVERNMENTAL SCIENCE, ENGINEERING AND TECHNOLOGY ADVISORY PANEL'S TASK FORCE ON SCIENCE AND TECHNOLOGY OF THE OSTP CHAIRED BY MR. TED TEDESCO, HAS MADE SIMILAR OBSERVATIONS AND RECOMMENDATIONS. I WOULD ASK THE CHAIRMAN'S PERMISSION TO SUBMIT THE TASK FORCE'S REPORT FOR THE RECORD.

ALL THE MAJOR PUBLIC INTEREST GROUPS ARE REPRESENTED ON THIS TASK FORCE AND ENDORSE THE STATED RECOMMENDATIONS.

BEFORE CONCLUDING MY STATEMENT, I WOULD LIKE TO STATE THAT THE PUBLIC INTEREST GROUPS IN THEIR FERVOR FOR SUPPORTING EFFECTIVE APPLIED RESEARCH PROGRAMS, ARE NOT IN ANY WAY ASKING THAT THE BASIC RESEARCH EFFORT OF THE NSF BE DIMINISHED. WE RECOGNIZE THE IMPORTANCE OF AND ENDORSE A STRONG BASIC RESEARCH PROGRAM. WITHOUT IT, OUR PURSUIT OF KNOWLEDGE AND ACADEMIC EXCELLENCE AND THE QUALITY OF ACADEMIC INSTITUTIONS WOULD SURELY BE LOST.

OUR CONCERN IS THAT APPLIED PROBLEM SOLVING RESEARCH BE RECOGNIZED AS NECESSARY AND BENEFICIAL ACTIVITY WITHIN THE NSF AND ADEQUATE FUNDS BE APPROPRIATED TO ASSURE THE DEVELOPMENT OF AN EFFECTIVE PROGRAM.

THANK YOU, MR. CHAIRMAN.

POLICY POSITION OF THE NATIONAL GOVERNORS' ASSOCIATION

WINTER MEETING

1978

SCIENCE AND TECHNOLOGY

STATE AND LOCAL GOVERNMENTS ARE CONFRONTED BY AN EVER INCREASING NUMBER OF PROBLEMS THAT ARE COMPLICATED BY SCIENTIFIC AND TECHNOLOGICAL CONSIDERATIONS. MANY OF THESE PROBLEMS ARE BROUGHT ABOUT AS A RESULT OF FEDERAL PROGRAMS AND REGULATIONS IMPOSED UPON THE STATES.

AT THE SAME TIME, THE FEDERAL GOVERNMENT SUPPORTS A MULTI-BILLION DOLLAR RESEARCH AND DEVELOPMENT BUDGET WHICH DOES NOT EFFECTIVELY MEET STATE AND LOCAL NEEDS. ALTHOUGH MANY GOVERNMENT-FINANCED DISCOVERIES IN SCIENCE AND TECHNOLOGY HAVE BEEN ADAPTED FOR PRACTICAL USE, THIS APPLICATION HAS OFTEN BEEN MERELY COINCIDENTAL BECAUSE FEDERAL RESEARCH AND DEVELOPMENT GENERALLY IS NOT UNDERTAKEN TO ADDRESS SPECIFIC AREAS OF CONCERN AS DEFINED BY STATE AND LOCAL GOVERNMENTS.

IF THE GENERAL PUBLIC IS TO DERIVE MAXIMUM BENEFIT FROM THE CIVILIAN-ORIENTED RESEARCH AND DEVELOPMENT BUDGET SUPPORTED AT GREAT TAXPAYER EXPENSE, ITS INVESTMENT MUST BE RECONSIDERED TO EMBRACE THIS BROADER RANGE OF SCIENTIFIC AND TECHNICAL PROBLEMS.

IN ORDER TO ACHIEVE THIS GREATER RETURN FOR STATE GOVERNMENTS AND THEIR CITIZENS, A STRONGER LONG-TERM RELATIONSHIP WITH THE EXISTING FEDERAL SCIENCE AND TECHNOLOGY ESTABLISHMENT MUST BE FORGED. THE CREATION OF THE INTERGOVERNMENTAL SCIENCE, ENGINEERING AND TECHNOLOGY ADVISORY PANEL (ISETAP) UNDER THE CHAIRMANSHIP OF THE DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY PROVIDES THE MECHANISM FOR DIRECT COMMUNICATION WITH THE FEDERAL GOVERNMENT. THE DEGREE TO WHICH ISETAP REALIZES ITS POTENTIAL IS DEPENDENT UPON THE BREADTH OF INTERPRETATION WITH WHICH THE PANEL ADDRESSES ITS CHARGE.

IN ORDER TO MEET STATE RESPONSIBILITIES, STATE CAPABILITIES MUST BE IMPROVED TO ENCOMPASS A GREATER RECOGNITION OF THE IMPORTANCE OF THE SCIENTIFIC AND TECHNO-

LOGICAL ELEMENTS IN STATE POLICY ISSUES. THE STATE SCIENCE, ENGINEERING AND TECHNOLOGY (SSET) PROGRAM WAS CREATED BY THE CONGRESS, WITH THE SUPPORT OF THE NATIONAL GOVERNORS' ASSOCIATION, TO ASSIST STATE EXECUTIVES AND LEGISLATORS IN DEVELOPING THIS CAPACITY.

THE NATIONAL GOVERNORS' ASSOCIATION HAS ENDORSED, AND VIRTUALLY ALL OF ITS MEMBERS ARE PARTICIPATING IN, THE PLANNING PHASE OF THE SSET PROGRAM. IT HAS BEEN WELCOMED AS A COOPERATIVE EFFORT TO BUILD WITHIN THE STATES A GREATER CAPACITY FOR RESOLVING POLICY ISSUES THAT HAVE SIGNIFICANT SCIENTIFIC OR TECHNOLOGICAL CONTENT.

HOWEVER, CAPACITY-BUILDING IS A GRADUAL AND LABORIOUS PROCESS. NEW INSTITUTIONS CREATED THOUGHTLESSLY SELDOM SURVIVE, AND OLD INSTITUTIONS YIELD SLOWLY TO PRESSURES FOR CHANGE. PROGRAMS LIKE SSET MUST BE SUSTAINED AT REASONABLE LEVELS AND FOR A REASONABLE TIME IF THEY ARE TO SUCCEED.

WE ARE THEREFORE DISMAYED BY THE UNEXPECTED DELETION OF FEDERAL SUPPORT FOR SSET FROM THE 1979 EXECUTIVE BUDGET. SSET OBJECTIVES CANNOT BE ACHIEVED UNLESS PLANNING STUDIES CURRENTLY UNDERWAY ARE SECURED BY A COMMITMENT TO IMPLEMENTATION.

THE NATIONAL GOVERNORS' ASSOCIATION URGES CONGRESS TO RESTORE SSET FUNDING FOR FISCAL YEAR 1979 AT A LEVEL OF $100,000 PER STATE FOR THE EXECUTIVE BRANCH, WITH AN EQUAL APPORTIONMENT FOR EACH STATE LEGISLATURE. IN ORDER TO ENSURE THE LONG-TERM COMMITMENT REQUIRED FOR MEANINGFUL IMPLEMENTATION, WE FURTHER URGE CONSIDERATION FOR A FIVE-YEAR AUTHORIZATION ACT.

Senator KENNEDY. Let me just ask this, Dr. Atkinson. I am going to submit some questions. It would be interesting if you could review, maybe just briefly, your auditing provisions that have been developed in the National Science Foundation in trying to get a handle on some of the programs and projects which have been funded, to be sure they conform with what the applications indicate they should.

Dr. ATKINSON. Senator Kennedy, the Audit and Oversight Office is a new office in the Foundation. I would rather submit the material for the record. It is a major thrust for us.

Senator KENNEDY. OK.

Dr. ATKINSON. We think it will help greatly in insuring that policies are properly carried out. It also should reduce a lot of paperwork, both inside the Foundation and with the university communities, but I prefer to submit a more detailed statement for the record.

Senator KENNEDY. We ought to get that.

Just given the nature of the kinds of programs you are supporting, it is always easy, as some of my colleagues do, to sharpshoot on particular circumstances. I always felt they were pretty cheap shots, quite frankly, but I know the important fact is to try to develop the kinds of mechanisms so we can review those various factors and insure their basic and fundamental integrity.

And I will submit some other questions to you.

[The material referring to the Office of Audit and Oversight and answers to questions submitted follow:]

OFFICE OF AUDIT AND OVERSIGHT

The Office of Audit and Oversight was established October 15, 1977, mostly from existing staff units. Its functions are:

(1) post hoc sampling of proposal actions and post-award administration to evaluate documentation and adherence to stated procedures. It is anticipated that roughly ten percent of the actions would be audited and that a subsample of these may require an in-depth audit;

(2) assessment of overall system performance and recommendations for improved and simplified procedures;

(3) investigation of charges of improper actions by NSF staff and monitoring of the decision reconsideration system;

(4) financial audits;

(5) monitoring and coordination of procedures for scientific oversight undertaken by disciplinary advisory panels; and

(6) evaluation and program audit.

This Office will continue to provide internal audits; coordination with other agencies, principally DHEW and DOD, which do most of the Federal financial auditing at colleges and universities; and audits of the National Centers and some other institutions. The principal new function is the review, using a sample of the cases, of our procedures from receipt of a proposal through the peer review and decisionmaking process and post award administration. The intercomparison of the techniques and approaches to program management of programs throughout the Foundation will allow us to maintain high standards of performance and to facilitate the adaption of new techniques developed in one program to other programs. The further development of the Foundation's Management Information System with its extensive integrated files of data will both aid and be aided by the work of the new Office.

Question 1: I am pleased to note that the NSF authorization request for Fiscal Year 1979 includes for the first time in several years funds for construction of an oceanographic research vessel. I believe very strongly, however, that construction of oceanographic research vessels should proceed on the basis of a comprehensive long-range plan, based on an assessment of foreseeable future needs. I understand that UNOLS (University National Oceanographic Laboratory System) has been working on such a plan in cooperation with NSF. What is the status of that plan? When will it be completed? Will the plan be available to Congress before submission and consideration of the NSF Fiscal Year 1980 budget?

Answer: The UNOLS Advisory Council has completed a plan entitled, "On the Orderly Replacement of the Academic Research Fleet." This plan is a culmination of a year of effort by members of the Advisory Council. It draws to some extent on a previous UNOLS fleet planning effort initiated in October 1974, but is essentially a new report. In brief, this report assesses the present condition of the fleet and addresses the replacements and changes in composition which are necessary if this fleet is to meet the needs of academic oceanographic research in the future. The report is presently being prepared for distribution to the UNOLS members and will be presented for discussion and approval at the annual UNOLS meeting on May 18 and 19, 1978. Our expectation is that it will be endorsed by the UNOLS membership at that time and thus will be widely circulated well before the NSF FY 1980 budget is submitted to Congress. The report will be directed to all agencies concerned with support and use of the academic research fleet.

Question 2: There appears to be a persistent and increasingly serious problem in funding the operating costs of oceanographic research vessels in the academic fleet. Would you please provide an analysis of this problem, and your comments on the seriousness of the problem and potential solutions.

Answer: It is true that funding of the academic fleet has been a problem in recent years. For example, in 1978, there may be a shortfall of more than $2.0 Million or as much as 10% of the amount initially requested for full operation of the 29-ship fleet. There are a number of reasons for the funding problem, the dominant one being the continued decline in funding for academic fleet operations during the last decade by ONR. Although during the same period funding from several other agencies increased, even in the aggregate those increases have not been sufficient to offset the decline in ONR funding.

Funding shortfalls are dealt with by operator institutions in several ways. Projected schedules for the budget year are cut back to achieve some reduction in costs. Funding from non-Federal sources is sought, including state, local and industrial sources. These adjustments are made with varying degrees of success and at best will only partially offset the overall shortfalls for the total fleet. Hence, the average number of days utilized per ship for the year will be lower, resulting in higher daily rates.

In 1978 the funding problem was exacerbated by the abrupt and almost complete discontinuance of fleet use and the concomitant support for Bureau of Land Management activities. This posed a particularly severe hardship for a number of institutions which had reserved substantial blocks of shiptime in calendar year 1978 for BLM.

NSF and the US Geological Survey (USGS) are presently negotiating an Interagency Agreement whereby NSF will assist that agency in obtaining shiptime on academic fleet ships. This arrangement will assure some increase in fleet funding in the current fiscal year and a greater increase next year. Although it is not viewed as a total solution to the current problem, it is a positive step in that direction.

NSF's own support of fleet ships has kept pace with inflation over the past 5-7 years and continues to provide 65-70% of the total support required. It is sufficient to meet the ship-time requirements of NSF supported research projects and, therefore, is not likely to increase as a proportion of the total, unless our ocean research programs expand markedly.

In summary, the problem facing the academic fleet is one of sufficient utilization as well as sufficient funding. UNOLS and the principal funding agencies need to encourage increased demand for shiptime from sources, such as USGS, which are able to pay for the use of these important research resources.

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Question 3: Similarly, there appears to be a growing problem in obtaining funds necessary to provide modern, sophisticated equipment necessary to make the optimum use of the academic research fleet. Would you please provide an analysis of the seriousness of this problem, and what steps can be taken to alleviate it?

Answer: The Foundation's Office for Oceanographic Facilities and Support (OFS) is conducting a study of oceanographic equipment among research institutions, assessing current inventory, state-of-the-art of existing equipment, future needs and management problems. Mid-study, it appears that equipment is generally available and adequate if not ideal for current needs. But problems are mounting. For the academic fleet, there has been an overall decline in Federal support for oceanographic equipment. While OFS funding has remained relatively constant, other sources such as ONR have withdrawn support, resulting in increased pressure on OFS. NSF research grants continue to fund equipment for single investigators. But as the field of oceanography has developed, increasing cost and complexity of some types of equipment have made shared use by several investigators the only practical scheme for acquisition This in turn increases the demand for OFS funds.

Over and above the problem of finding support in this highly competitive climate for more costly equipment, the oceanographic institutions face the additional problem of high loss rate of items used at sea. Formerly only a problem for the individual investigator who lost his gear, this now has become an institutional management issue owing to increased shared use of equipment. OFS support is provided with the stipulation that equipment be shared and has encouraged various arrangements for pooled equipment at the institutions. Although this approach encourages maximum utilization of costly gear, it shifts maintenance costs and responsibity from the individual investigator to the institution, posing a different set of management problems. It is expected, therefore, that the OFS study will result in recommendations which focus on both management and funding needs for the future.

National Conference of State Legislatures

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President
Fred E. Anderson
President of the Senate
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Executive Director
Earl S. Mackey

April 11, 1978

The Honorable Edward M. Kennedy
United States Senate
431 Russell Senate Office Bldg.
Washington, D.C. 20510

Dear Senator Kennedy:

I was disappointed to learn that because of pressing time constraints I would not have the opportunity to appear personally before your Subcommittee on Health and Scientific Research to discuss the importance of adding funds to the National Science Foundation's FY 1979 budget authorization to support an implementation phase of the State Science, Engineering, and Technology Program.

Please find enclosed a copy of the testimony I had intended to deliver. I would appreciate it if it could be made a part of the hearing record and copies of it circulated to the other members of your Subcommittee.

State legislatures participating in the SSET Program are very concerned about the consequences of a lapse in funding for the program. The National Conference of State Legislatures endorses the SSET Program and appreciates your strong and positive leadership in this important effort.

Sincerely,

Gordon O. Voss

Representative Gordon O. Voss
Minnesota House of Representatives
Chairman,
NCSL Committee on Science and Technology

GOV/dmg

Enclosure

STATEMENT OF REPRESENTATIVE GORDON O. VOSS, MINNESOTA
CHAIRMAN, NATIONAL CONFERENCE OF STATE LEGISLATURES' SCIENCE AND TECHNOLOGY COMMITTEE
TO THE
SENATE COMMITTEE ON HUMAN RESOURCES
SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH
FOR HEARINGS ON THE NATIONAL SCIENCE FOUNDATION AUTHORIZATION FOR FISCAL YEAR 1979

Mr. Chairman, members of the Subcommittee, my name is Gordon O. Voss. I hold a Ph.D. in Mechanical Engineering from the University of Minnesota and since 1972 I have been a member of the Minnesota House of Representatives. In Minnesota I serve as chairman of the Legislative Coordinating Commission's Subcommittee on Science and Technology. Since December 1976, with the assistance of the National Science Foundation, the Minnesota Legislature has been developing a science and technology staff capability to provide Minnesota legislators with information about often complex scientific and technical ramifications of critical state problems. In addition, I have been actively involved in the Foundation's State Science, Engineering, and Technology (SSET) Program as Chairman of the National Conference of State Legislatures' Science and Technology Committee.

It is in my capacity as Committee Chairman that I appear before you today to request that you authorize funds in the National Science Foundation's FY 1979 budget in the amount of $42 million for a five-year implementation phase for the Foundation's State Science, Engineering, and Technology Program. This proposed funding level is based on making available to each State executive and legislative branch that has completed a management plan based upon its study grant undertaken through the State Science, Engineering, and Technology Program a maximum of $100,000 for the first two years, $80,000 for the third and fourth years, and $60,000 for the fifth and final year.

Mr. Chairman, as you know, Congress authorized, but failed to appropriate, $3 million in FY 1977 to the National Science Foundation to initiate the State Science, Engineering, and Technology Program. Of this amount, $2.5 million was made available to state executives and legislatures to study ways of developing or improving their capabilities to use science and technology resources in their policymaking processes. Despite the meager amount of money available to each state under the SSET Program ($25,000 per branch per state), the Program has been enthusiastically received by the states. Currently, 49 state executives and 43 state legislatures are participating in the SSET Program.

Before discussing why this Subcommittee should authorize and recommend appropriation of these funds, allow me to review briefly the legislative history of the SSET Program. Perhaps the first major recognition by the Congress that many state issues involved complex science and technology components and that a healthy intergovernmental system required strengthening the states' capabilities to deal effectively with these issues was S.32 (National Science Policy and Priorities Act of 1972) introduced in the 92nd Congress by the chairman of this subcommittee, Senator Kennedy. Though it failed to secure passage that session, it gained support in both Congress and the states and was reintroduced in the 94th Congress as the National Policy, Organization, and Priorities for Science, Engineering, and Technology Act of 1976.

Section 503 of that Act authorized the National Science Foundation to make grants available directly to state governments for the purpose of "establishing and strengthening the Office of State Science, Engineering, and Technology within the executive and legislative branches of the State government." This Act became Public Law 94-282. However, in the bill's final version, the provisions for the State and Regional Science and Technology Program (Title V) were deleted.

The genesis of the current State Science, Engineering, and Technology Program is found in the National Science Foundation Authorization Act of 1977 which authorized but did not appropriate funds (Conference Report on H.R. 12566). The FY 1977 NSF budget authorization directed the Foundation to develop the State Science, Engineering, and Technology Program. In addition, while Congress indicated support for the program, it stipulated that further funds for the program should await the completion of the states' study grants and an evaluation of those plans.

It is our understanding that the National Science Foundation's evaluation of the states' performance in this Program will be ready by late August of 1978. While we appreciate the Congress' concern that further funding for the SSET Program await these evaluations of the study plans produced under the program, we think there are compelling reasons for providing implementation funds in the Foundation's FY 1979 budget.

In general, these reasons can be summarized as follows:

1. As evidenced by the large number of applications and the high quality of the proposals, state legislatures are seriously concerned about the most effective use of science and technology resources in their policy making processes.

2. Many of the state legislative study plans will be ready for implementation in FY 1979.

3. Most state legislatures will have their long, substantive sessions beginning in January 1979. The study plans will have identified important issues to which science and technology resources could be applied if implementation funds were available. Given the nature of state legislatures' time frames for issues, the 1979 sessions are crucial to the effective handling of issues identified through the grants.

4. It must be recognized that regardless of the recognition and support developed within state legislatures during the SSET study grant phase for the benefits of gaining better access to science and technolgoy resources, the majority of state legislatures will not appropriate funds to implement the study plans for reasons that I will address later.

5. It is generally recognized that support for a SSET implementation program is in the best interests of the Federal government. The SSET Program offers the potential for significant improvements in the capacity of the states to participate more effectively in the development, implementation and delivery of Federal domestic policies and programs.

The 1978 legislative study completion dates, the crucial S&T issues that will confront legislatures very soon, future legislative session timing, and a real possibility that legislatures will lose momentum in building their capabilities all make it imperative that Congressional action on SSET affect NSF's FY 1979 budget.

Allow me to expand these themes. About three-quarters of the state legislatures that have submitted applications will be completing their planning grants in October/November of this year. As part of their plans most legislatures are identifying critical issues containing S&T elements that they are confronting or will confront in the very near future. Many legislatures will need additional assistance during their 1979 sessions, which will be their next substantive sessions, in order to handle these issues effectively. The 14 legislatures that meet biennially will not meet again until 1981. For those legislatures that meet yearly, 1979 will be their "long" session in which they, not the governors, will set the agenda. Losing a year between completing their plans and implementing them will cause legislatures to lose the momentum generated by the planning phase now underway. If the legislative impetus is lost, the SSET planning grants will become another pointless exercise performed by the states through a federally funded program.

The question that logically arises is "If a legislative capability to deal with S&T questions is a critical and recognized need, why aren't the legislatures funding it themselves?" The answer to that question is in state legislatures' traditional attitudes towards spending money on themselves. Not only are their budgets constrained fiscally, but they are constrained politically. While legislatures can appropriate funds for new state agency programs without protest, any new programs for themselves lead to accusations of "feathering their nest." In 1975 total state legislative branch expenditures were 26% of the total expenditures for general control of state government. That percentage has remained constant over the past two odd-numbered years and has actually decreased since the 1960's.

Another obstacle that legislatures face is the conflict between the short terms of elected officials and the amount of time needed to build an effective, long-term capacity. Legislators find it hard to justify spending money on a capability that may not show immediate results, particularly when it is often easier to seek outside assistance on a crisis-to-crisis basis.

These institutional constraints conflict with legislatures' awareness of the science and technology elements of many issues. As legislatures, in part through the SSET Program, become increasingly conscious of these issues, conflict will increase.

In addition to the SSET Program, two other factors have made legislatures focus more on the S&T components of state problems and their capacity to deal with them. One is the increase in S&T issues confronting legislatures; the other is the number of legislatures reassserting their policy making powers. More and more legislatures are looking at such issues as alternative fuels, energy sources, and waste management. Legislative awareness of the technically-related effects of seemingly non-technical issues such as economic development is increasing as well. During the next decade, legislatures will have to consider a much greater number of these and similar issues - land use/growth policy, natural hazards management, medical and health care, air and water quality, information privacy, to name a few.

As legislatures have ventured beyond their traditional subject areas they have experienced tremendous growth of their oversight capabilities as a means of strengthening their policy making powers. Sunset, review of state administrative rules and regulations, program evaluation, audit, and reappropriation of federal funds are the oversight methods that have usually been adopted either by themselves or in combination. In less than two years at least 23 states have passed sunset laws since Colorado adopted the first law in its 1976 session. Though review procedures vary widely from advisory only powers to full committee repeal

powers, there are presently 34 states with some form of regulation review. By the 1970's program evaluation and auditing procedures were established in 32 legislatures as a way to improve government management and efficiency. As of 1977, 35 legislatures had some provisions for reviewing federal funds coming into their states. These range from almost automatic appropriation to intensive program review and priority-setting processes.

Juding by legislative requests for information and workshops on these oversight methods, the oversight capabilities of state legislatures will become even stronger shortly.

Not only are legislatures faced with S&T issues within their states, but they are involved in carrying out federal programs often delegated to the states with little or no consultation. Since the mid-1960's over 30 laws with scientific and technical elements have been passed by Congress that delegate implementation responsibility to the states. These include the Resource Conservation and Recovery Act, the Energy Policy and Conservation Act, the Coastal Zone Management Act, and the Clean Air Act. The attached list of examples shows the range of areas. Delegation of program implementation to the states is being accelerated by the "New Federalism" and the present federal emphasis on decentralization.

In order for the states to fulfill these responsibilities they need a science and technology policy management capability. This has been defined as the capability to critique, assess, and evaluate proposals including the formulation of alternatives. The SSET Program has helped legislatures design such a capability but, as was mentioned earlier, it includes no funds for implementing plans.

Congress, as the initiator of many programs with state responsibility provisions, should help provide states with the expertise and capability they need to carry out those responsibilities effectively.

To quote from a 1972 Federal interagency report on the relationship of the Federal government to state and local utilization of science and technology:

> If the capacity of state and local government to produce and evaluate scientific knowledge is indispensible to the solution of national problems, then a federal investment in that capacity is justified.
>
> (from Committee on Intergovernmental Science Relations to the Federal Council for Science and Technology, Public Technology: A Tool for Solving National Problems)

Thank you, Mr. Chairman

Submitted: April 11, 1978

Attachment 1

Examples of Federal Laws Delegating
Implementation Responsibilities to the States

Federal Coal Mine Safety Act Amendments of 1965

National Traffic and Motor Vehicle Safety Act of 1966

Highway Safety Act of 1966

Federal Metal and Nonmetallic Mine Safety Act

Natural Gas Pipeline Safety Act of 1968

Radiation Control for Health and Safety Act of 1969

Federal Railroad Safety Act of 1970

Occupational Safety and Health Act of 1970

Energy Policy and Conservation Act (EPCA)

Energy Conservation and Production Act (ECPA)

Coastal Zone Management Act of 1972

Resource Conservation and Recovery Act

National Mass Transportation Assistance Act

Omnibus Crime Control and Safe Streets Act of 1968

Lead Based Paint Poisoning Prevention Amendments

Clean Air Act Amendments of 1970

Federal Environmental Pesticide Control Act of 1972

Noise Control Act of 1972

Federal Water Pollution Control Act Amendments of 1972

Marine Mammal Protection Act of 1972

Safe Drinking Water Act of 1974

Marine Protection Research and Sanctuaries Act of 1972

Emergency Highway Energy Conservation Act

Title XIX of Social Security Act (Medicaid)

National Health Planning and Resources Development Act

Health Maintenance Organization Act of 1973

Emergency Medical Service System Act of 1973

Juvenile Justice and Delinquency Prevention Act of 1974

Attachment 2

SUMMARY OF STATE LEGISLATIVE SSET APPLICATIONS

Thirty state legislatures had submitted SSET proposals to NSF by the October 30, 1977 second round deadline. Eight are joint legislative/executive applications; nine propose to improve an existing structure; and twenty-one will be developing a new system.

In their nine to twelve month studies most legislatures will:
- -survey and catalog existing sources of s & t information for the legislatures (universities, state agencies, etc.)
- -look at other states' legislative s & t programs and any past or present in-state programs
- -synthesize the information collected to determine the most feasible approaches
- -submit implementation recommendations and a plan to the legislative leadership. Most final reports for applications already or about to be approved will be completed by October/November 1978.

Within this general outline there are a wide range of approaches that reflect the diversity of legislative needs and structures. Some legislatures will concentrate on outside resources such as state universities (Maine, South Carolina, Oklahoma, West Virginia, and Utah); while others will assess possible in-house technical staff (Virginia and Nevada). Ways to deal with specific current legislative problems will be examined by Minnesota (waste disposal), Texas (energy), and Vermont (energy). Still other states will attempt to better coordinate existing information available to the legislature (California and Pennsylvania); or examine past, current and potential legislation with s & t elements (North Carolina, Arizona, Colorado and Nebraska).

The grant performers vary from legislative Council and scientific staff to individual consultants and university contractors. In Connecticut the executive and legislative branches will work with the state Academy of Science and Engineering. Several legislatures will appoint a special oversight committee for their studies. Massachusetts will involve at least half of the legislature's standing committees in its work plan.

NCSL staff estimate that at least seven more state legislatures will submit applications by the February 28, 1978 final deadline. Eight other legislatures have shown interest. If all fifteen legislatures apply, a total of forty-five state legislatures will participate in the SSET program. However, staff anticipate that a total of thirty-eight to forty legislative applications is a more likely estimate.

Comparative Summary of First Round SSTI Applications

(Revised November 14, 1977)

	APPLICANT	IMPROVE/DEVELOP	DURATION (Months)	PERFORMER	BUDGET ($000's)	OBJECTIVES AND TASKS: ADVISORY COMMITTEE	IMPLEMENTATION PLANS	NEEDS ASSESSMENT	RESOURCES ASSESSMENT	R&D AGENDA	ANALYZE PM SYSTEM	EVALUATE PRESENT SYSTEM	TEST MECHANISMS	PLAN MECHANISMS	REVIEW OTHER STATES	RESPONSE ALTERNATIVES	FUNDING ALTERNATIVES	BROKERING	LEGISLATIVE COORDINATION	ADVISORY STRUCTURE	SEMINARS OR WORKSHOPS	SURVEY LEGISLATORS	SURVEY STAFF	ACADEMIC COMPONENT	IDENTIFY INCENTIVES
California	B	I	12	I/SA	64	X			X			X	X	X											
Connecticut	J	D	12	C	75*	X	X	X					X	X		X	X	X	X						
Louisiana	J	I	12	E	98*			X	X	X					X			X	X	X	X				
Maryland	B	I	6	LC/SA/JC/CS	32				X			X		X	X	X		X				X			
Michigan	B	D	9		50			X				X		X		X						X			
Montana	B	D	9	I	39		X	X	X		X	X		X	X										
Oklahoma	B	D	9	I,C	39			X	X					X	X		X					X		X	
Oregon	B	D	12	I	38			X	X			X		X	X							X	X	X	
Pennsylvania	B	I	6	I	47	X	X					X		X		X	X							X	
Rhode Island	B	D	9	JC	38		X	X	X		X		X	X	X			X						X	
Texas	J	I	9	I	78*		X							X											X
Utah	J	I	12	SA	87*				X	X		X			X				X			X		X	
Virginia	B	D	12	I	44	X	X	X					X	X											

KEY

Applicant
- S: Senate
- H: House
- B: Senate/House
- J: Joint (Legislative/Executive)

Improve/Develop
- I: Improvement of existing mechanism
- D: Development of a new mechanism

Performer:
- I: Internal
- E: External
- SA: Science Advisor
- C: Contractor
- LC: Legislative Council
- JC: Joint Committee
- CS: Consultant

Budget:
*Indicates the total budget figure for a joint application.

Terminology:
- Advisory Committee: Indicates whether an advisory committee will be involved in the performance of the study.
- Analyze PM (Policy-making) System: The legislative aspects of the policy making system, and the role of science and technology information in the policy-making system, will be examined.
- Review other states: Legislative science & technology systems in other states will be reviewed, examined, or evaluated.
- Response alternatives: Alternative inquiry/response systems will be developed and examined.
- Brokering: Processes for "brokering" or "linking" outside resources to legislative S&T information needs will be developed and examined.
- Advisory Structure: The existing advisory structure will be examined, or alternative advisory systems developed and examined.
- Identify Incentives: Incentives for the effective delivery of S&T information will be identified.

Total of budgets for the 13 applications: $727,173

COMPARATIVE SUMMARY OF SECOND ROUND LEGISLATIVE SSET APPLICATIONS

January 1978

APPLICANT	IMPROVE/DEVELOP	DURATION (Months)	PERFORMER	BUDGET ($000's)	ADVISORY COMMITTEE	IMPLEMENTATION PLAN	NEEDS ASSESSMENT	RESOURCES ASSESSMENT	R&D AGENDA	ANALYZE PM SYSTEM	EVALUATE PRESENT SYSTEM	TEST MECHANISMS	PLAN MECHANISMS	REVIEW OTHER STATES	RESPONSE ALTERNATIVES	FUNDING ALTERNATIVES	BROKERING	LEGIS/EXEC COORDINATION	ADVISORY STRUCTURE	SEMINARS OR WORKSHOPS	SURVEY LEGISLATORS	STAFF	ACADEMIC COMPONENT	IDENTIFY INCENTIVES
ARIZONA	B	D	9	I	42				X					X	X										
ARKANSAS	J	D	12	LC/I	76*	X		X	X				X	X	X	X		X			X				
COLORADO	B	D	12	C	61			X						X								X			
DELAWARE	J	D	12	C	75*	X			X		X	X	X	X	X										
ILLINOIS	B	I	9	LC	42						X			X								X			
MAINE	J	D	12	C	100*	X		X	X			X		X	X							X			
MASSACHUSETTS	B	I	9	I	38	X		X	X			X			X				X	X	X				
MINNESOTA	B	I	9	LC/CS	38	X						X	X	X	X							X			
NEBRASKA	U	D	9	LC	41			X	X			X		X	X								X		
NEVADA	B	D	9	LC	41			X	X					X	X										
NEW MEXICO	B	D	9	LC	38					X	X				X										
NORTH CAROLINA	B	D	9	LC	38			X	X					X	X										
OHIO	B	D	12	LC	38								X											X	
SOUTH CAROLINA	B	D	8	LC	57			X			X			X	X						X				
SOUTH DAKOTA	B	D	12	LC/CS	38			X	X					X	X		X		X		X	X	X		
VERMONT	B	D	12	LC	38				X			X	X	X	X										
WEST VIRGINIA	J	D	12	C	75*		X		X					X	X										

OBJECTIVES AND TASKS

KEY

Applicant
- S: Senate
- H: House
- B: Senate/House
- J: Joint (Legislative/Executive)
- U: Unicameral

Improve/Develop
- I: Improvement of existing mechanism
- D: Development of a new mechanism

Performer:
- I: Internal
- E: External
- SA: Science Advisor
- C: Contractor
- LC: Legislative Council
- JC: Joint Committee
- CS: Consultant

Budget:
*Indicates the total budget figure for a joint application.

Terminology:
- Advisory Committee: Indicates whether an advisory committee will be involved in the performance of the study.
- Analyze PM (Policy-making) System: The legislative aspects of the policy making system, and the role of science and technology information in the policy-making system, will be examined.
- Review other states: Legislative science & technology systems in other states will be reviewed, examined, or evaluated.
- Response alternatives: Alternative inquiry/response systems will be developed and examined.
- Brokering: Processes for "brokering" or "linking" outside resources to legislative S&T information needs will be developed and examined.
- Advisory Structure: The existing advisory structure will be examined, or alternative advisory systems developed and examined.
- Identify incentives: Incentives for the effective delivery of S&T information will be identified.

Total of budgets for the 17 applications: $816,999

Attachment 3

A Resolution Adopted by the National Conference of State Legislature's Committee on Science & Technology

August 3, 1977

In order to improve the application of scientific and technological resources to the problems and issues confronting state governments, the National Conference of State Legislatures recommends:

1. That Congress and the National Science Foundation be commended for authorizing and implementing the State Science, Engineering, and Technology Program, which provides funds to state governments to identify ways of using scientific and technological resources to strengthen state policymaking.

2. That Congress appropriate sufficient funds to implement the plans produced by state legislatures through the State Science, Engineering, and Technology Program.

3. That intergovernmental science and technology communications continue to be developed and improved, that the Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP) be strengthened in its position within the Executive Office of the President, and that state legislative representation on key federal research and development advisory groups, especially ISETAP, be increased.

4. That the federal government, working with the established intergovernmental bodies and associations representing state and local government policymakers, establish an agenda of critical issues and problems facing the states and their localities that can be used in designing federal research and development programs.

5. That each federal agency involved in research and development or regulatory program implementation establish effective programs to make the results of these efforts available to state governments and that an interagency focal point be established to provide information on these programs.

It is further recommended that the several states:

1. Take action to apply science and technology resources to the legislative policymaking process by participating in the State Science, Engineering, and Technology Program, and

2. Communicate their specific needs for scientific and technical assistance to the appropriate federal agencies and NCSL Office of Science and Technology in order to facilitate the development of effective national research and development programs that meet state needs.

Senator KENNEDY. Thank you all very much.

The subcommittee stands in recess.

[Whereupon, at 1:40 p.m., the subcommittee adjourned, subject to the call of the Chair.]

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[illegible]