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EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

Steve
Richard
Olin
MPJ

March 27, 1991

MEMORANDUM FOR DISTRIBUTION

FROM: FCCSET DIRECTORATE

SUBJECT: WEEKLY FCCSET CALENDAR

Attached for your information is the latest edition of the schedule of events for the Federal Coordinating Council for Science, Engineering, and Technology Committee meetings.

Attachment

as of March 27, 1991

FCCSET COMMITTEE MEETINGS FOR MARCH-JULY 1991

MARCH

- 28 Noon Committee on Industry and Technology, COMAT Working Group on Planning, National Institute of Standards and Technology (NIST), Department of Commerce, Gaithersburg, MD, Materials Building (#223), Room B307 (until 5:00 pm)
- 28 2:00 pm Committee on Earth and Environmental Sciences, Working Group on Mitigation and Adaptation Research Strategies (MARS), Auditors Bldg., 14th & Independence Ave., SW (until 5:00 pm)
- 28 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)

APRIL

- 1 1:00 pm Committee on Interagency Radiation Research and Policy Coordination, Science Panel Meeting, 1019 Nineteenth St., NW, Suite 700 (until 4:00 pm)
- 8 9:00 am Committee on Interagency Radiation Research and Policy Coordination, Public Education Subpanel Meeting, 1019 Nineteenth St., NW, Suite 700 (until 5:00 pm)
- 8 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00 pm)
- 11 10:00 am Committee on Food, Agricultural, and Forestry Research, USDA, 12th & Jefferson Drive, SW, Room, 104-A (until noon)
- 11 2:00 pm Committee on Life Sciences and Health, Room 729-G, Hubert Humphrey Building, 200 Independence Ave., SW (until 4:00 pm)
- 12 10:00 am CIRRPC/HHS Agency Visit (until Noon)
- 12 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, NASA Headquarters, 400 Maryland Ave., SW, Room to be announced (until 4:00 pm)

- 16 11:00 Committee on Industry and Technology, Department of Commerce, 14th & E Sts., NW, Room 5843 (until 2:00 pm)
- 18 Noon Committee on Interagency Radiation Research and Policy Coordination, Science Panel Executive Committee, 1019 Nineteenth St., NW, Suite 700
- 18 2:00 pm Committee on Interagency Radiation Research and Policy Coordination, Executive Committee, 1019 Nineteenth St., NW, Suite 700
- 19 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)
- 22 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00)

MAY

- 6 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St, NW, Room 537 (until 2:00 pm)
- 9 9:30 am Committee on Interagency Radiation Research and Policy Coordination, CIRRPC Policy Meeting, 1019 Nineteenth St., NW, Suite 700 (until noon) (TENTATIVE DATE)
- 20 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00 pm)
- 28-31 Committee on Interagency Radiation Research and Policy Coordination, Public Education Subpanel Workshop, Emmitsburg, Maryland

JUNE

- 3 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00 pm)
- 17 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00 pm)

JULY

- 1 1:00 pm CIT Steering Group on Materials, National Science Foundation, 1800 G St., NW, Room 537 (until 2:00 pm)

**** This FCCSET calendar is published weekly. Please note that the meeting information is often changed. It is advised that you confirm information on meetings of interest. If you become aware of any changes, please phone the FCCSET office at 395-5101.**

OFFICE OF CABINET AFFAIRS STAFFING MEMORANDUM

Date: 4-3-91

Due by: 4:00 Friday, April 5

Subject: Annual Report of the National Critical Technologies Panel

From: Holly Williamson

	ACTION	CONCUR	FYI		ACTION	CONCUR	FYI
HOLIDAY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	FITZHENRY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DANZANSKY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MCMUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ADAIR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PORTER	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BUCHHOLZ	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SCHALL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CASSE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SECHLER	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
EVANS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WETHINGTON	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
FARRAR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WILLIAMSON	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HEIMBACH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JACKSON	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

I am not planning to send to any Departments. Please review & provide comments to me by 4:00 on Friday, April 5. Thanks.

(Note: Todd has the entire report)

WHITE HOUSE STAFFING MEMORANDUM

DATE: 3/22/91 ACTION/CONCURRENCE/COMMENT DUE BY: 4/5/91

SUBJECT: ANNUAL REPORT OF THE NATIONAL CRITICAL TECHNOLOGIES PANEL

	ACTION	FYI		ACTION	FYI
VICE PRESIDENT	<input type="checkbox"/>	<input type="checkbox"/>	MCCLURE	<input type="checkbox"/>	<input type="checkbox"/>
SUNUNU	<input type="checkbox"/>	<input type="checkbox"/>	NEWMAN	<input type="checkbox"/>	<input type="checkbox"/>
SCOWCROFT <i>Concur</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	PORTER	<input checked="" type="checkbox"/>	<input type="checkbox"/>
DARMAN	<input checked="" type="checkbox"/>	<input type="checkbox"/>	ROGICH	<input type="checkbox"/>	<input type="checkbox"/>
BRADY	<input type="checkbox"/>	<input checked="" type="checkbox"/>	UNTERMAYER	<input type="checkbox"/>	<input type="checkbox"/>
CARD	<input type="checkbox"/>	<input type="checkbox"/>	BROMLEY <i>n/c</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
DEMAREST	<input type="checkbox"/>	<input type="checkbox"/>	CLERK	<input type="checkbox"/>	<input checked="" type="checkbox"/>
FITZWATER	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
GRAY	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
HOLIDAY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>

REMARKS:

Please forward your comments on the Annual Report directly to our office no later than Friday, April 5. Thank you.

RESPONSE:

PLEASE RETURN THE ANNUAL REPORT

PHILLIP D. BRADY
Assistant to the President
and Staff Secretary
Ext. 2702

To the Congress of the United States:

✓ In accordance with Title VI of the National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282), as amended by Section 841 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), I ~~am transmitting~~ the first biennial report of the National Critical Technologies Panel. **TRANSMIT HEREWITH**

The Panel, consisting of both public and private sector representatives, has dealt with a complex subject and produced a well-reasoned and balanced report. Their charge was to identify those technologies deemed critical to the satisfaction of national needs in both defense and economic competitiveness. The technologies recommended by the Panel meet those requirements very well.

Having identified the critical technologies, the Panel also points out that identification is only one step in the progress toward improved national security and economic competitiveness. As a nation we must emphasize the development and deployment of technologies as well, so that we can improve the speed with which ideas are converted into high-quality, cost-effective, viable products for military as well as commercial uses. This effort will require determination and diligence on the part of all Americans and especially those who are responsible for our science, technology, and industry. I believe that by working together toward a common goal we can continue to enhance our international stature in technology for which we are justly proud.

~~George Bush~~

The White House,
~~April 22, 1991~~

WHY IS THIS DATED ?

CLERK'S EDITS

FCCSET
COMMITTEES, SUBCOMMITTEES AND
WORKING GROUPS
WITH
FCCSET SECRETARIAT AND OSTP
POINTS OF CONTACT

revised JUNE 26, 1990

COMMITTEE ON EARTH AND ENVIRONMENTAL SCIENCES

FCCSET POC: Maryanne C. Bach

OSTP POC: Nancy Maynard/Bill Busch

Subcommittees

Atmospheric Research (Bill Busch)
Ground Water (Bill Busch)
Federal Oceanographic Fleet Coordinating Committee (Bill Busch)
International Decade for Natural Disaster Reduction (Bill Busch)

Working Groups

Global Change (Nancy Maynard/Bill Busch)
Mitigation and Adaptation Technologies for Global Change (Bill Busch)

COMMITTEE ON LIFE SCIENCE AND HEALTH

FCCSET POC: Maryanne Bach

OSTP POC: Dr. Wyngaarden

Subactivities

Biotechnology Science Coordinating Committee (Rachel Levinson)

Committee on Interagency Radiation Research
and Policy Coordination (Alicia Dustria)

*Decade of the Brain (Alicia Dustria)

Protection of Human Subjects (Alicia Dustria)

Other Suggested:

Neurological and Behavioral Science
Risk Assessment Research

*Proposed by Chair to be part of FCCSET

Other Suggested cont.

International Research
Computational Biology
Plant Biology
Social Sciences
Ecology/Environmental Biology
Support for Basic Biological Research
Global Ecological Health

COMMITTEE ON FOOD, AGRICULTURAL AND FORESTRY RESEARCH

FCCSET POC: Maryanne Bach
OSTP POC: James Wyngaarden

Subcommittees:

TBD

COMMITTEE ON INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY

FCCSET POC: Hugh Stringer
OSTP POC: Sara Bowden

Subcommittees:

Title V Report (Sara Bowden)
International Science and Technology Cooperation (Sara Bowden)
Science and Technology Cooperation with Developing Countries (Sara Bowden)
International Cooperation in Big Science (Kathy Yuracko)
Technology and Competitiveness (Sara Bowden)
International Environment (Sara Bowden)

COMMITTEE ON TECHNOLOGY AND INDUSTRY

FCCSET POC: Hugh Stringer
OSTP POC: TBD

Subcommittees:

Materials (Robert Post/Perry Lindstrom)

Working Groups:

High Temperature Superconductivity
Structural Ceramics
Versailles Advanced Materials Study
Interagency Materials
Nondestructive Inspection/Evaluation
Automated Materials Processing
Composites
Electronic Materials

Others TBD (Possibly Regulation, Technology Transfer, Intellectual Property Rights)

COMMITTEE ON EDUCATION AND HUMAN RESOURCES

FCCSET POC: Charles Dickens
OSTP POC: Katherine Yuracko

Working Groups:

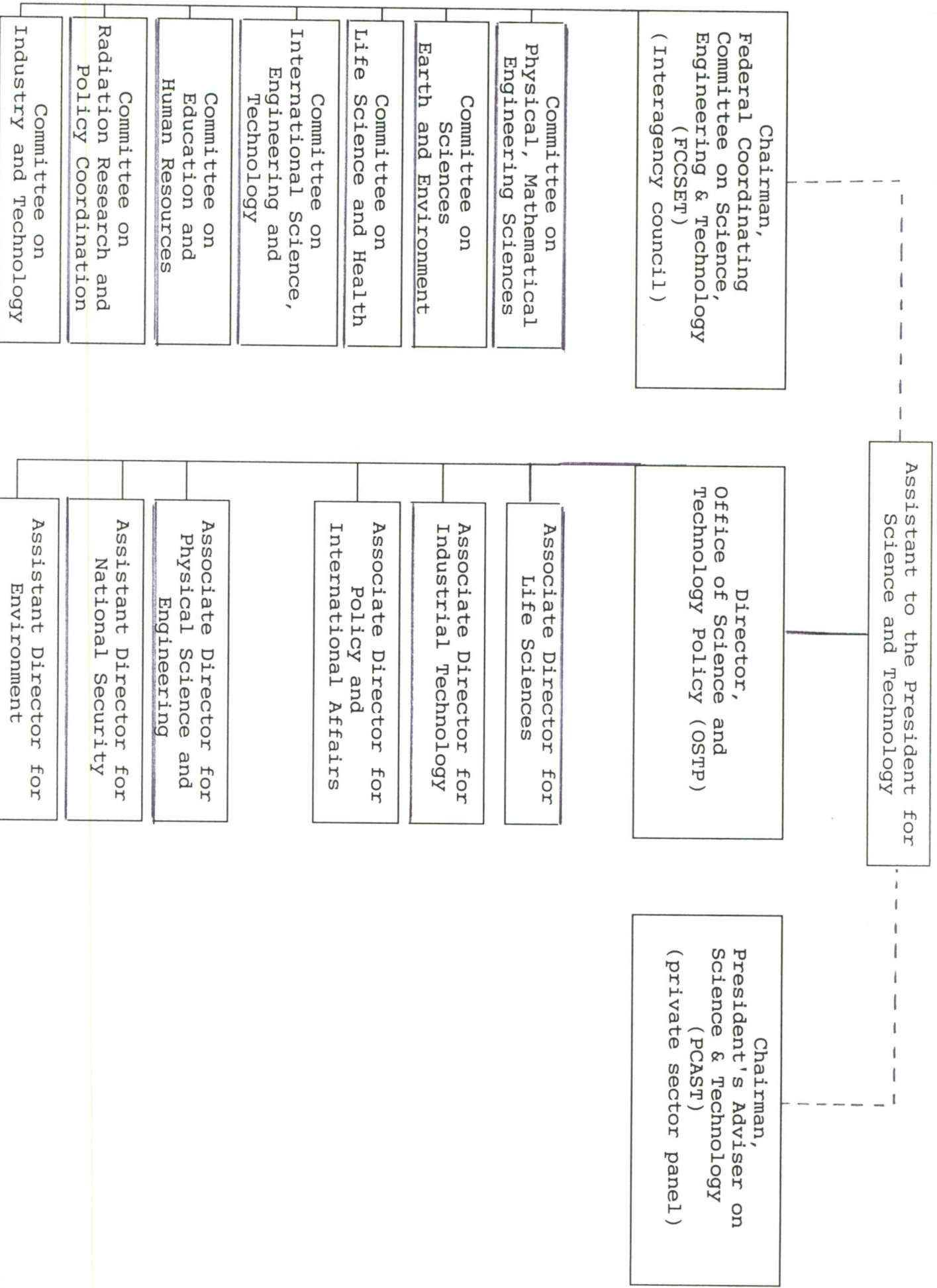
FY 1992 EHR Budget Proposal (Kathy Yuracko)

COMMITTEE ON PHYSICAL, MATHEMATICAL, AND ENGINEERING SCIENCES

FCCSET POC: Charles Dickens
OSTP POC: Eugene Wong

Working Groups:

High Performance Computing Initiative (Eugene Wong)
Access and Representation (Karl Erb)
Structure/Support of Science (Karl Erb)



Assistant to the President for Science and Technology

Director, Office of Science and Technology Policy (OSTP)

Chairman, President's Adviser on Science & Technology (PCAST) (private sector panel)

Associate Director for Life Sciences

Associate Director for Industrial Technology

Associate Director for Policy and International Affairs

Associate Director for Physical Science and Engineering

Assistant Director for National Security

Assistant Director for Environment

Chairman, Federal Coordinating Committee on Science, Engineering & Technology (FCCSET) (Interagency council)

Committee on Physical, Mathematical & Engineering Sciences

Committee on Earth and Environment

Committee on Life Science and Health

Committee on International Science, Engineering and Technology

Committee on Education and Human Resources

Committee on Radiation Research and Policy Coordination

Committee on Industry and Technology

PROPOSED AGENDA FOR S&T WORKING GROUP

- o Review Pending Legislation on Technology Policy
 - o American Technology Preeminence Act
 - o High Performance Computing Initiative
 - o Prospective Critical Technologies Legislation

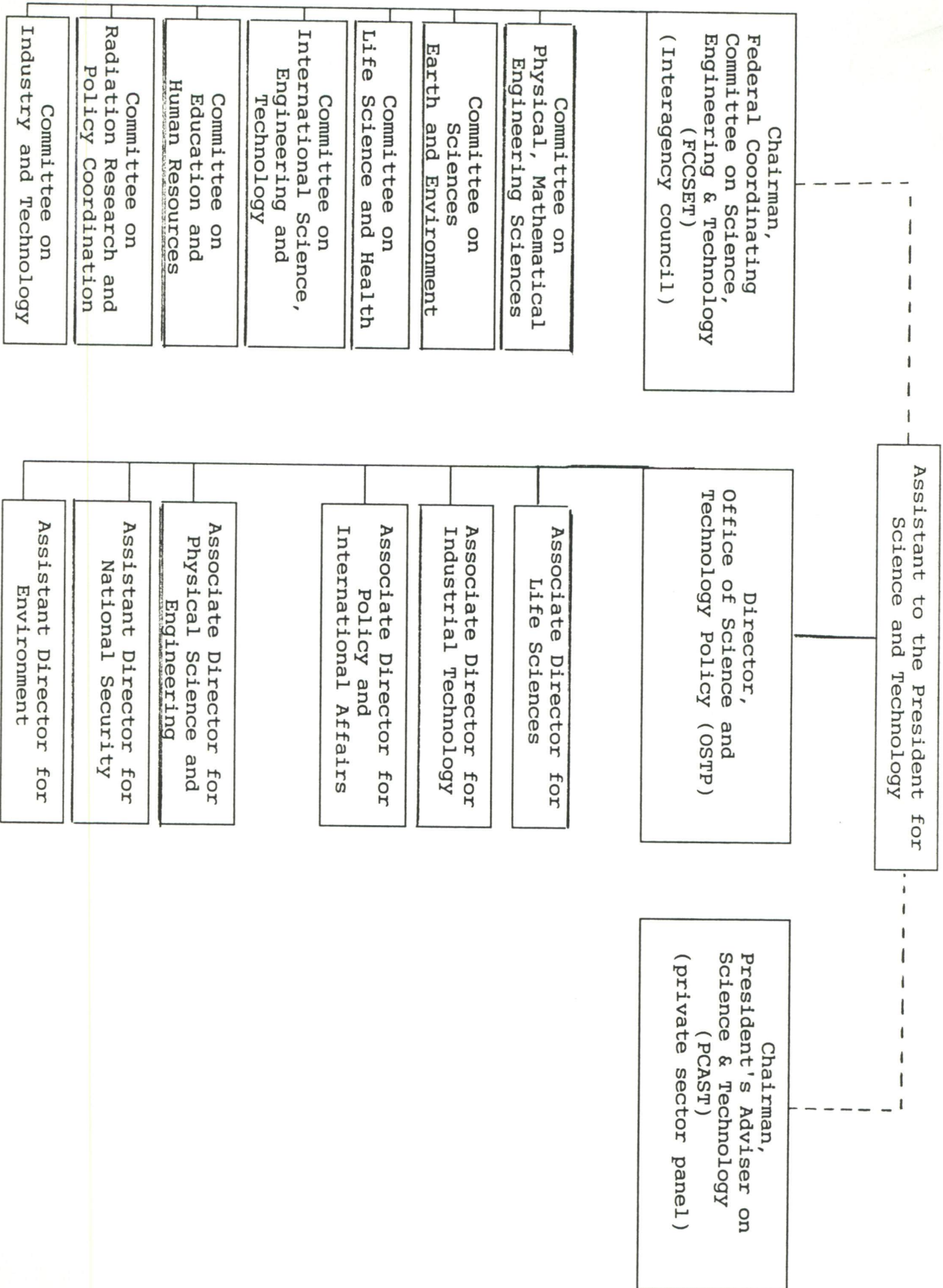
- o Develop Guidelines Regarding Industry/Government Cost Sharing and Joint R&D
 - o Initial focus: electric car consortium in the National Energy Strategy

- o Develop Plan for the National Critical Technologies Institute

- o Develop position on Uruguay Round disciplines on Government support for R&D (perhaps better suited as TPRG issue)

EPC APPROACH TO S&T ISSUES

- o Goal: bring S&T policy issues affecting competitiveness into the EPC orbit.
- o Vehicle: activate the Science & Technology EPC Working Group chaired by Dr. Bromley.
- o Rely on the mid-1990 understanding with Bromley that significant S&T policy issues requiring decision go through the EPC or DPC.
- o Abandon the "comprehensive strategy" approach articulated in March 1989.
- o Instead, focus on specific, manageable issues.
- o Seek to establish credibility of the S&T Working Group as an available forum for future S&T issues.



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as of February 26, 1991

FCCSET COMMITTEE MEETINGS FOR FEBRUARY-MAY 1991

FEBRUARY

- 28 2:00 pm Committee on Physical, Mathematical, and Engineering Sciences, Working Group on Access and Representation, National Science Foundation, 1800 G St., NW, Room 1225 (until 4:00 pm)
- 28 3:00 pm Committee on Earth and Environmental Sciences, Subcommittee on Mitigation and Adaptation Research Strategies (MARS), Auditors Bldg., 14th and Independence Ave., SW (until 5:00 pm)

MARCH

- 1 10:00 am Committee on Life Sciences and Health, Biotechnology Research Subcommittee, Room 180, Old Executive Office Building (until 12:00 noon)
- 1 10:30 am Committee on International Science, Engineering and Technology, Subcommittee on Megascience, National Science Foundation, 1800 G St., NW, Room 520
- 1 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)
- 1 3:00 pm Committee on International Science, Engineering and Technology, U.S. Department of State, Room 6909
- 4 9:00 am Committee on Interagency Radiation Research and Policy Coordination, Recommendations on Radiological Protection Subpanel Meeting, 1019 Nineteenth St., NW, Suite 700 (until Noon)
- 4 1:00 pm Committee on Interagency Radiation Research and Policy Coordination, Science Panel Meeting, 1019 Nineteenth Street, N.W., Suite 700 (until 4:00 pm)
- 5 2:00 pm Committee on Physical, Mathematical, and Engineering Sciences, Executive Committee of Working Group on High Performance Computing and Communications, Department of Energy, 1000 Independence Ave., SW, Room 6A092 (until 4:00 pm)

- 7 1:00 pm Committee on Physical, Mathematical, and Engineering Sciences, Working Group on the Structure of Science Support in the U.S., U.S. Department of Agriculture, Administration Building, 14th St. and Independence Ave., NW, Room 116E (until 3:00 pm)
- 8 10:00 am Committee on Interagency Radiation Research and Policy Coordination, Use of BEIR V and UNSCEAR 1988 in Risk Assessment Subpanel Meeting, 1019 Nineteenth St., NW, Suite 700 (until 4:00 pm)
- 8 1:00 pm Committee on Industry and Technology, COMAT Meeting, New Executive Office Building, 725 17th St., NW, Room 5104 (until 5:00 pm)
- 8 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)
- 11 9:00 am Committee on Interagency Radiation Research and Policy Coordination, Public Education Subpanel Meeting, 1019 Nineteenth St., NW, Suite 700 (until 5:00 pm)
- 12 1:00 pm Committee on Physical, Mathematical, and Engineering Sciences, General Services Administration, 18th & F Sts., NW, Room 3210 (until 3:00 pm)
- 14 2:00 pm Risk Assessment Ad Hoc Working Group, Environmental Protection Agency, 401 M St., SW, Room 1103, West Tower (until 4:00 pm)
- 15 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)
- 19 11:00 am Committee on Industry and Technology, Department of Commerce, 14th & E Sts., NW, Room 5843 (until 2:00 pm)
- 21 Noon Committee on Interagency Radiation Research and Policy Coordination, Science Panel Executive Committee Meeting, 1019 Nineteenth St., NW, Suite 700
- 21 2:00 pm Committee on Interagency Radiation Research and Policy Coordination, Executive Committee Meeting, 1019 Nineteenth St., NW, Suite 700
- 22 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)
- 28 1:00 pm Committee on Industry and Technology, COMAT Subcommittee, Working Group on Planning, National Institutes of Standards and Technology (NIST), Gaithersburg, MD, Materials Building (#223), Room B307 (until 5:00 pm)

29 2:00 pm Committee on Education and Human Resources, FY 1991 Program Review Working Group, Dept. of Education, 555 New Jersey Ave., NW, Room 326 (until 4:00 pm)

APRIL

1 1:00 pm Committee on Interagency Radiation Research and Policy Coordination, Science Panel Meeting, 1019 Nineteenth St., NW, Suite 700 (until 4:00 pm)

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11 2:00 pm Committee on Life Sciences and Health, Room 729-G, Hubert Humphrey Building, 200 Independence Ave., SW (until 4:00 pm)

18 Noon Committee on Interagency Radiation Research and Policy Coordination, Science Panel Executive Committee, 1019 Nineteenth St., NW, Suite 700

18 2:00 pm Committee on Interagency Radiation Research and Policy Coordination, Executive Committee, 1019 Nineteenth St., NW, Suite 700

MAY

9 9:30 am Committee on Interagency Radiation Research and Policy Coordination, CIRRPC Policy Meeting, 1019 Nineteenth St., NW, Suite 700 (until noon) (TENTATIVE DATE)

28-31 Committee on Interagency Radiation Research and Policy Coordination, Public Education Subpanel Workshop, Emmitsburg, Maryland

** This FCCSET calendar is published weekly. Please note that the meeting information is often changed. It is advised that you confirm information on meetings of interest. If you become aware of any changes, please phone the FCCSET office at 395-5101.

OFFICE OF CABINET AFFAIRS STAFFING MEMORANDUM

Date: 3-20-91

Due by: 11:00 Friday, March 22

Subject: OMB Clearance: OSTP Progress Report

From: Holly Williamson

	ACTION	CONCUR	FYI		ACTION	CONCUR	FYI
HOLIDAY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FITZHENRY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
DANZANSKY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MCMUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ADAIR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PORTER	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BUCHHOLZ	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	SCHALL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CASSE	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	SECHLER	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
EVANS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WETHINGTON	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
FARRAR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WILLIAMSON	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HEIMBACH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JACKSON	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

I will submit no comment unless I hear otherwise from you by 11:00 on Friday, March 22. Thanks.



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

6 pgs
SPECIAL

March 19, 1991

LEGISLATIVE REFERRAL MEMORANDUM

TO: Legislative Liaison Officer

Department of Agriculture-Marvin Shapiro-382-1516
Department of Commerce-Michael Levitt-377-3151
Department of Defense-Sam Brick-697-1305
Department of Education-John Kristy-401-2670
Department of Energy-Bob Rabben-586-6718
Department of Health and Human Services-Frances White-
245-7760
Department of Housing and Urban Development-Edward
Murphy-755-7093
Department of Interior-Pam Somers-343-6706
Department of Justice-Paul McNulty-514-4606
Department of Labor-Bob Shapiro-523-8201
Department of Transportation-Tom Herlihy-366-4687
Department of Veterans Affairs-Raoul Carroll-233-3832
National Science Foundation-Charles Herz-357-9435
Environmental Protection Agency-Christopher Hoff-
382-5414
National Aeronautics and Space Administration-Lynn
Heninger-453-1948
Smithsonian Institution-Margaret Gaynor-357-2962

SUBJECT: Draft Office of Science and Technology Policy progress report. A list of members of the FCCSET Committee on Education and Human Resources is also attached for your information.

The Office of Management and Budget requests the views of your agency on the above subject before advising on its relationship to the program of the President, in accordance with OMB Circular A-19. A response to this request for your views is needed no later than noon on Friday, March 22, 1991. Questions should be referred to Jack Fellows (202-395-3935).

Janet R. Forsgren
Janet Rice Forsgren for
Assistant Director for
Legislative Reference

Enclosure

cc: Rae Nelson, OPD
Doreen Torgerson, OPD
Holly Williamson, OCA
Tom Scully
Barry White

Bob Grady
Norine Noonan
Joe Hezir
John Morrall
Dan Chenok
Kathy Burchard
Janet Forsgren

FCCSET COMMITTEE ON EDUCATION AND HUMAN RESOURCES

<u>Name</u>	<u>Telephone</u>	<u>FAX</u>
Admiral James Watkins, DOE, Chairman	202-586-6210	202-586-9988
Dr. Ted Sanders, Education, Vice-Chairman	202-401-1000	202-401-3093
Dr. Luther Williams, NSF, Vice-Chairman	202-357-7557	202-357-9813
Mr. John Schrote, Interior	202-208-6182	202-208-5048
Dr. Charles E. Hess, USDA	202-447-5923	202-755-7842
Mr. Roberts T. Jones, Labor	202-523-6050	202-523-6827
Mr. John C. Weicher, HUD	202-708-1600	202-619-8000
Ms. Kate Moore, Transportation	202-366-9191	202-366-6031
Ms. Nancy Mason, Commerce	202-377-1091	202-377-4498
Mr. Erich W. Bretthauer, EPA	202-382-7676	202-475-9761
Ms. Ann I. Bay, Smithsonian	202-357-2425	202-357-2116
Mr. William G. Myers, III, Justice	202-514-3116	202-514-4699
Dr. Frederick K. Goodwin, HHS/ADAMHA	301-443-4797	301-443-0284
Mrs. Margaret Finarelli, NASA	202-453-8310	202-755-3741
Dr. Ted G. Berlincourt, DOD	703-697-3228	703-697-3762
Mr. D'Wayne Gray, Veterans Affairs	202-233-2455	202-233-5584
Mr. Charles E. M. Kolb, OPD	6515	2878
Mr. Joseph Hezir, OMB	3404	4817
Mr. Barry White, OMB	4532	3910
Ms. Peggy Dufour, DOE, Executive Secretary	202-586-7970	202-586-9988

DRAFT**March 19, 1991****Dear Madam Chair:**

I am pleased to send you this progress report describing efforts, developed under OSTP leadership, to accomplish the following: (A) The establishment and restructuring of offices of education in mission agencies to support science and mathematics education and to make the agencies fully responsive to the plan of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) Committee on Education and Human Resources (CEHR); and (B) OSTP activities, working with the National Science Foundation, the Department of Education, and Federal mission agencies, to coordinate agency efforts to improve mathematics, science, and engineering education, particularly in the area of developing laboratory-education partnerships. I am also pleased to report on progress of Federal agencies with research and development activities toward establishment of education offices at each Federal laboratory under its control.

FCCSET COMMITTEE ON EDUCATION AND HUMAN RESOURCES

The White House Office of Science and Technology Policy (OSTP), through the Federal Coordinating Council for Science, Engineering, and Technology, established the Committee on Education and Human Resources in the spring of 1990. The Committee played a central role in preparing the Presidential Initiative on mathematics and science education included in The President's FY 1992 Budget.

The CEHR is chaired by Secretary of Energy James Watkins, with the Deputy Secretary of Education, Ted Sanders, and the Assistant Director for Education and Human Resources of the National Science Foundation (NSF), Luther Williams, serving as vice chairmen. The Committee includes sixteen departments and independent agencies, each represented by a senior policy-level official, generally at the Assistant Secretary level. The CEHR has representation from all Federal agencies with significant responsibilities in the area of science, mathematics, engineering, and technological education, including those with jurisdiction over the education of scientists, mathematicians, and engineers, as well as those with responsibilities for technician training and science literacy for the general public. The Committee also includes those agencies that are major users of scientific and engineering personnel.

SENATE REQUEST (A): MISSION AGENCY EDUCATION OFFICES

This progress report is submitted in response to the Senate Appropriation Committee's request, as set forth in its Report No. 101-474 to accompany H.R. 5158. The request appears on page 114 of the Committee Report:

The Committee directs the OSTP to guide the mission agencies in establishing and restructuring their offices of education to support science and mathematics education and to make the agencies fully responsive to the FCCSET Education Committee's plan. Also, OSTP shall ensure that each agency's office of education has programs directed at student and teacher segments from K through graduate school.

Summary of Departmental and Agency Actions

Each of these departments and agencies has programs related to mathematics and science education. Descriptions of these programs are provided in the enclosed report, By the Year 2000, First in the World, which was prepared by the Committee on Education and Human Resources. The report includes a separate chapter for each of these departments and independent agency, beginning on page 67 and continuing through page 301. (Although it is not a member of the CEHR, the report includes information about programs of the Barry M. Goldwater Scholarship and Excellence in Education Foundation, which awards undergraduate scholarships for study in the fields of mathematics and the natural sciences.)

The names of the departmental and agency officials who are contacts for mathematics and science education programs are included with the descriptive materials for each agency. In a number of the departments and agencies, there are several offices that share in these responsibilities, and more than one contact is provided where appropriate to facilitate inquiries from educators and the public. Most agencies have programs that span the educational spectrum from kindergarten through graduate school.

SENATE REQUEST (B): LABORATORY-EDUCATION PARTNERSHIPS

This progress report is submitted in response to the Senate Appropriation Committee's request, as set forth in its Report No. 101-474 to accompany H.R. 5158. The request appears on page 115 of the Committee Report:

The Committee strongly encourages efforts within the Federal Government to strengthen the educational activities of Federal research laboratories. Further, the Committee believes that the OSTP should require all Federal agencies with research and

development activities to establish education offices at each particular Federal laboratory under its control. The goal of such an effort is to improve internal Federal agency science, mathematics and engineering education programs, as well as foster education partnerships between various Federal labs and schools and academic institutions which are located near them. The Committee notes there is a need to coordinate and disseminate information on these programs among the various Federal mission agencies, as well as between the National Science Foundation [NSF] and the Department of Education. Therefore, the Committee directs OSTP to work with the NSF, the Department of Education, and Federal mission agencies to coordinate agency efforts to improve math, science, and engineering education, particularly in the area of developing laboratory education partnerships. The OSTP shall report the status of this effort and the agencies' funding needs for this activity to the Committee by March 15, 1991.

Summary of Departmental and Agency Actions

A number of these departments and agencies have research and development activities that are conducted through in-house and/or sponsored Federal laboratories. Many of the laboratories, particularly the larger ones, have established education offices or have designed certain staff to carry out this function. Furthermore, a number of partnerships between the departments and agencies and their laboratories have been established to bring their resources, especially the expertise of their scientists and engineers, to bear on efforts to improve mathematics, science, and engineering education. Funds to initiate or continue partnership activities are included in each department's and agency's FY 1992 budget request under the President's Initiative.

The CEHR report, By the Year 2000, First in the World, provides descriptions of a number of these partnerships. Mathematics and science education activities conducted by Federal laboratories, including examples of specific partnership agreements for some departments and agencies, are described in the respective chapters for the following departments and agencies:

Department of Agriculture (pages 75-79);

Department of Commerce/National Institute of Standards and Technology (pages 84-85) and National Oceanic and Atmospheric Administration (pages 88-92);

Department of Defense (pages 95-109);

Department of Energy (pages 132-146);

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Department of Health and Human Services (pages 153-161);
Department of Housing and Urban Development (pages 161-169);
Department of the Interior (pages 175-181);
Department of Transportation (pages 222-230);
Environmental Protection Agency (pages 255-259);
National Aeronautics and Space Administration (pages 266-271); and
Smithsonian Institution (pages 292-297).

OSTP has worked with the Department of Education, the National Science Foundation, and the mission departments and agencies to further interagency cooperation with the goal of improving mathematics and science education. These activities are summarized in the chapters on the Department of Education (page 118) and the National Science Foundation (page 280).

Under the leadership of OSTP, and with the assistance of the FCCSET Committee on Education and Human Resources, departments and agencies will continue to strengthen their activities related to mathematics and science education. OSTP intends to continue to foster the advances being made in terms of partnerships and in tapping the resources of the Federal laboratories to help improve mathematics and science education. We much appreciate the support for these efforts provided by you and your colleagues and look forward to working with you as we work on this vitally important topic.

Sincerely,

D. Allan Bromley
Director

Enclosure

The Honorable Barbara A. Mikulski
Chair, Subcommittee on Veterans Affairs,
Housing and Urban Development, and
Independent Agencies
Committee on Appropriations
U.S. Senate
Washington, DC 20510



Office of Management and Budget
Energy and Science Division

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Total number of pages including this page: 17

Message: For your information:

- House & Senate FY 91 Rept. Lang on OSTP c. notations
- EO. & current list of PCAST members
- Summary of US-EC consultative group on S&T

I hope this is helpful.

House Report 100-556
5/19/81

NATIONAL SPACE COUNCIL

1990 appropriation..... \$863,000
Estimate, 1991..... 1,363,000
Recommended in bill..... 1,000,000
Decrease below estimate..... -363,000

The National Space Council was established by Public Law 100-685, the National Aeronautics and Space Administration Authorization Act of 1989. The Council provides advice and assistance to the President on national space policy and strategy. The Vice President is the President's principal advisor on national space policy and serves as the Council Chairman. Other Council members include: the Secretaries of State, Treasury, Defense, Commerce, and Transportation, the Directors of the Offices of Management and Budget and the Central Intelligence Agency, the Administrator of the National Aeronautics and Space Administration, the Chief of Staff to the President, the Assistant to the President for National Security Affairs, and the Assistant to the President for Science and Technology.

The budget request for fiscal year 1991 is \$1,363,000 and 7 full-time equivalents for the National Space Council. The bill provides for \$1,000,000, the same level as provided for in the fiscal year 1990 appropriation before the Gramm-Rudman-Hollings sequestration and section 517 reductions. This amount is \$363,000 below the request. The bill language also continues a proviso requiring reimbursement to other agencies for at least one-half of the cost of detailed individuals.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

1990 appropriation..... \$2,829,000
Estimate, 1991..... 3,300,000
Recommended in bill..... 3,300,000

The Office of Science and Technology Policy (OSTP) was created by the National Science and Technology Policy, Organization, and Priorities Act of 1976. OSTP provides advice to the President concerning policies on science and technology and supports other organizations within the Executive Office of the President. In addition to being the source of science and technology analysis, the Office coordinates research and development programs for the Federal Government.

The Committee recommends the Administration's request of \$3,330,000 and 43 fulltime equivalents for the Office of Science and Technology Policy in fiscal year 1991. The bill language also continues a proviso requiring reimbursement to other agencies for at least one-half of the cost of detailed individuals.

Last year, the Committee took action to designate the Office of Science and Technology Policy as the lead agency to coordinate activities pertaining to the "Decade of the Brain." The Committee understands that OSTP is developing an interagency program and budget for government-sponsored research relating to the diseases and disorders of the brain and nervous system. The Committee commends OSTP for undertaking this activity and urges the Office to complete its plan as quickly as possible. The Committee hopes that this effort leads to a coordinated and comprehensive approach

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by the Federal government to harness our knowledge about brain physiology and function during the "Decade of the Brain."

FEDERAL EMERGENCY MANAGEMENT AGENCY

1990 appropriation..... \$1,796,320,000
Estimate, 1991..... \$19,273,000
Recommended in bill..... \$66,781,000
Decrease below estimate..... -182,460,000

The Federal Emergency Management Agency (FEMA) was created by reorganization plan no. 3 of 1978. The Agency carries a wide range of program responsibilities for emergency planning and preparedness, disaster response and recovery, and hazard mitigation under the following authorities:

- Under the Federal Civil Defense Act of 1950, as amended, responsibility for administering a national program for population protection preparedness and response in emergency conditions.
- Under the Earthquake Hazards Reduction Act of 1977, programs designed to identify and reduce earthquake vulnerabilities and consequences.
- Under Executive Order 12148, responsibility for oversight of the national dam safety program.
- In accordance with provisions of the Nuclear Regulatory Commission 1980 Appropriations Act and other statutes, Executive Order 12657, and by Presidential directive, responsibility for offsite emergency preparedness for fixed nuclear facilities.
- Under the National Security Act of 1974, as amended, and the Defense Production Act of 1950, as amended, programs to provide for continuity of government as well as emergency resources assessment, management, and recovery.
- Under the Federal Fire Prevention and Control Act of 1974, programs to reduce national fire loss, including training and education.
- Under the National Flood Insurance Act of 1968, as amended, and the Flood Disaster Protection Act of 1973, administration of a national program to provide flood insurance and to encourage better flood plain management.
- Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, programs to provide assistance to individuals and State and local governments in Presidentially-declared major disaster or emergency areas.
- Under the Inspector General Act of 1978, as amended, agency-wide audit and investigative functions to identify and correct management and administrative deficiencies which create conditions for existing or potential instances of fraud, waste and mismanagement.
- Under the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, and Executive Order 12316, responsibility for specific emergency response activities.
- Under Title III of the Stewart B. McKinney Homeless Assistance Act, a program to provide food and shelter to the homeless through a National Board chaired by FEMA and composed of representatives of various charities.

Senate Report 100-474 FY 1991

Until this policy is established, the Committee believes it would be inappropriate to fund this new initiative.

The Committee directs the Council to prepare a strategic plan for the environment, including how it will improve coordination with the myriad of Federal agencies involved in environmental protection. This report is due to the Committee by January 4, 1991.

The Committee is encouraged by improvements in the Council's ability to produce its annual environmental quality report in a timely manner. The Committee wishes to underscore its concern that this report be issued expeditiously each year in a manner that is useful to the Congress. The Committee urges CEQ to incorporate into this report its strategic plan for the environment.

The Committee has not included bill language requested by the administration to increase representation expenses from \$600 to \$2,000.

NATIONAL SPACE COUNCIL

Appropriations, 1990	\$983,000
Budget estimate, 1991	1,263,000
House allowance	1,000,000
Committee recommendation	1,263,000

PROGRAM DESCRIPTION

The National Space Council was reestablished by section 501 of Public Law 100-685. Its primary function is to provide advice and assistance to the President on national space policy and strategy. The Council has been directed by the President to review U.S. Government space policy, including long-range goals, and develop a strategy for national space activities. The Council will also develop recommendations for the President on space policy and space-related issues and will encourage cooperation and exchange among the civil, national security, and commercial space sectors. In addition, it will monitor and coordinate implementation of the President's national space policy by executive departments and agencies, and will resolve differences concerning major space and space-related policy issues. The Council is composed of the Vice President as Chairman, the Secretaries of State, Treasury, Defense, Commerce, Transportation, and Energy, the Director of the Office of Management and Budget, the Chief of Staff to the President, the Assistant to the President for National Security Affairs, the Assistant to the President for Science and Technology, the Director of Central Intelligence, and the Administrator of the National Aeronautics and Space Administration.

COMMITTEE RECOMMENDATION

The Committee recommends \$1,263,000 for the National Space Council. This amount is the same as the administration's request, \$983,000 more than the House allowance, and \$380,000 more than the fiscal year 1990 appropriation.

The Committee expects by January 31, 1991, a progress report on the Council's review of the Nation's space policy, its strategy for national space activities, specific recommendations to the President

on space policy and related issues, and the status of its efforts to coordinate the implementation of space policy by the executive departments and agencies.

The Committee is concerned about the ability of the United States to service polar-orbiting satellites launched from the west coast. Since this requirement may affect both civilian and national security payloads, the Committee directs the Council to prepare a report that outlines options, cost estimates, Agency roles, and recommendations for addressing this problem. The report should be submitted to the Committee by April 1, 1991.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Appropriations, 1990	\$2,523,000
Budget estimate, 1991	2,300,000
House allowance	2,300,000
Committee recommendation	2,500,000

PROGRAM DESCRIPTION

The Office of Science and Technology Policy [OSTP] was created by the National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282) and provides advice to the President concerning policies in science and technology and on the utilization of science and technology in addressing important national problems. OSTP also supports other organizations within the Executive Office of the President with regard to issues involving science and technology considerations; reviews and analyzes the research and development budgets and programs of the Federal Government, in concert with the Office of Management and Budget; coordinates research and development programs of the Federal Government; and fulfills other obligations, duties, functions, and activities mandated by the National Science and Technology Policy, Organization, and Priorities Act of 1976.

OSTP chairs and provides both administrative and fiscal support for the President's Council of Advisors on Science and Technology [PCAST]

COMMITTEE RECOMMENDATION

The Committee recommends \$2,560,000 for the Office of Science and Technology Policy [OSTP]. This amount is \$260,000 more than the administration's request and the House allowance, and an increase of \$731,000 above the fiscal year 1990 appropriation.

The Committee directs the OSTP to report by January 31, 1991, its recommendations for simplifying and institutionalizing the responsibilities (currently shared with CEQ) for focusing and coordinating the R&D agencies' global climate change programs.

The Committee directs the OSTP with NSF to report as part of its 1992 budget request its recommendations for stimulating specific civilian R&D sectors, ranked by priority within the overall Federal budget request, that will make real contributions to the Nation's economic competitiveness. For supercomputers and biotechnology, which the OSTP has identified as high-priority sectors, the report should describe the administration's approach to help

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strengthen U.S. economic interests in both areas, and how efforts in both areas will enhance U.S. civilian research capabilities. Also, the OSTP shall identify the top 20 civilian science projects in the Federal budget, ranked according to the administration's priority, and show their life-cycle cost projections.

The Committee is deeply concerned about the tremendous need for funds for the modernization and rehabilitation of the Nation's academic research facilities. The 1988 Bromley-Packard report, done at the request of the OSTP, estimated that the current backlog of facilities modernization needs, just for those institutions of higher education dealing with the National Science Foundation, was a staggering \$10,000,000,000, and that a \$500,000,000 a year Federal investment, matched by an equal amount from non-Federal sources, was need to reduce this shortfall over the next decade. Unfortunately, this 1986 report, whose results have since been confirmed by additional studies by the National Science Foundation, has not led to the development of a Federal strategy on academic research facilities. Only the National Science Foundation, with a modest \$20,000,000 a year program, has attempted to address this glaring deficiency in higher education. As a result, the Committee directs OSTP to develop a policy on academic research facilities modernization that includes all Federal research and development agencies and a 5-year funding projection of the Federal contributions to this effort. This interagency policy should be submitted to the Committee by April 1, 1991, and its funding profile should be clearly identified in the fiscal year 1992 budget submission for all agencies.

The Committee applauds the establishment of the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) interagency Committee on Science Education and Human Resources. The Committee requests that this FCCSET committee prepare and submit a strategy document with its 1992 budget request that will describe how the President intends the Nation will achieve the objective that by the year 2000, U.S. students will be first in the world in science and mathematics achievements. The Committee expects that the report will be modeled after the strategy document prepared by the FCCSET Committee on Earth Sciences, and it shall include measurable objectives supporting the national goals.

In addition, it shall include a multilevel priority-setting framework that will focus, integrate, and where necessary, reassign agency roles and responsibilities, along with the requisite program development and budget proposals. The Committee requests that this report specifically include milestones and assessment methods that will be used to chart the Nation's progress in meeting the objectives. The OSTP should provide a draft report to the Committee by November 30, 1990.

The Committee directs the OSTP to guide the mission agencies in establishing and restructuring their offices of education to support science and mathematics education and to make the agencies fully responsive to the FCCSET Education Committee's plan. Also, OSTP shall ensure that each agency's office of education has programs directed at student and teacher segments from K through graduate school.

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The Committee strongly encourages efforts within the Federal Government to strengthen the educational activities of Federal research laboratories. Further, the Committee believes that the OSTP should require all Federal agencies with research and development activities to establish education offices at each particular Federal laboratory under its control. The goal of such an effort is to improve internal Federal agency science, mathematics and engineering education programs, as well as foster education partnerships between various Federal labs and schools and academic institutions which are located near them. The Committee notes there is a need to coordinate and disseminate information on these programs among the various Federal mission agencies, as well as between the National Science Foundation (NSF) and the Department of Education. Therefore, the Committee directs OSTP to work with the NSF, the Department of Education, and Federal mission agencies to coordinate agency efforts to improve math, science, and engineering education, particularly in the area of developing laboratory education partnerships. The OSTP shall report the status of this effort and the agencies' funding needs for this activity to the Committee by March 15, 1991.

Last year the Congress authorized funds for OSTP to establish the national critical technologies panel, and a Critical Technologies Institute, a federally funded research and development center under the OSTP, to support it. The Congress took this step in the belief that there was a need for the Federal Government to help focus the Nation's efforts in developing precompetitive technologies to support our knowledge-based economy, without picking winners and losers in the marketplace. The Committee notes its strong support for this investment, and directs the OSTP to move forward in establishing the Critical Technologies Institute, and to report to the Committee on its efforts in this area by February 1, 1991.

The Committee is aware that a recent study by the National Academy of Sciences Council strongly endorsed the U.S. Global Change Research Program (USGCRP). At the same time, the Academy's review raised concerns about the program which are shared by the Committee. The Committee directs the OSTP to respond to the review by February 1, 1991, with an emphasis on providing stronger program management to: (a) use extramural advisory expert panels for defining and evaluating the USGCRP's various programs and the products they are designed to develop; (b) focus agencies to produce research results specifically agreed upon by the USGCRP interagency committee; (c) assure greater interagency cooperation; (d) broaden involvement at the project level by the academic community, local, and State governments, and other nations; and (e) schedule and report interim assessments of the USGCRP in public forums.

Despite the Committee's strong support for the current global climate research program, the Committee believes that additional global climate policy action needs to take place. In that light, the Committee directs the OSTP to submit to it a report by March 1, 1991, that addresses several key issues. First, what the OSTP considers to be the maximum concentration of greenhouse gases which is acceptable, and the date by which those concentrations will be reached and stabilized. Second, what is the U.S. contribution to the

concentration of greenhouse gases, and what specific policy measures does the administration intend to propose that would reduce levels of emissions consistent with the levels of concentration's levels which they expect to occur. Third, what is the administration's decisionmaking process on the greenhouse issue, what are the steps which the administration has already taken to reduce emissions and what quantifiable reductions have taken place, and how is responsibility for the control of greenhouse gases divided among Federal agencies. Finally, what is the administration's plan, if any, for achieving an international consensus on the proper strategy for coping with the potential of the greenhouse effect, and what is the timetable, if any, for implementation of that strategy.

POWER OF LEASER INITIATIVE FOUNDATION

Appropriations, 1990	
Budget estimate, 1991	
House allowance	\$4,000,000
Committee recommendation	

PROGRAM DESCRIPTION

The Foundation is a Government, nonprofit corporation within the Executive Office of the President, which will receive grants from the private sector and departments and agencies in the Federal Government for the purpose of integrating community service into the work and life of each individual in the country. The Foundation is to accomplish this by such means as set forth in S. 1430, including: encouraging Americans and American institutions to volunteer their time and services to community service projects; identify successful community service projects and disseminate information on them to other communities; and to discover and encourage individuals that serve as a strong example of commitment to serving others.

COMMITTEE RECOMMENDATION

The Committee recommends an appropriation of \$5,000,000. The Committee has included bill language that requires the President to report to the Congress within 6 months of the date of enactment on the use of these funds.

FEDERAL EMERGENCY MANAGEMENT AGENCY

Appropriations, 1990	\$1,799,529,000
Budget estimate, 1991	819,272,000
House allowance	668,787,000
Committee recommendation	\$46,788,000

GENERAL DESCRIPTION

FEMA is responsible for coordinating Federal efforts to anticipate, prepare for and respond to a spectrum of major civil emergencies. The Agency also works to assure the effectiveness of the National Civil Defense Program and the availability of civil defense systems and resources in coping with all manmade and natural disasters; consolidates the programs aimed at preventing and

mitigating the effects of potential disasters with the programs designed to deal with the disasters once they occur; coordinates and plans for the emergency deployment of resources that are used on a routine basis by Federal agencies; and helps to coordinate preparedness programs with State and local governments, private industry, and voluntary organizations.

FEMA's budget submission describes several principal activities, including:

Civil defense.--This activity provides for the development of plans and functional emergency capabilities to mitigate, prepare for, respond to, and recover from attack and natural disasters, including technological hazards. It has financial and technical assistance programs which support State and local organizations requirements, and operating costs. Federal civil defense objectives support are integrated with State and local emergency operational requirements, thereby enhancing overall emergency preparedness for all hazards. Under the administration's new civil defense policy, this activity places emphasis on ensuring a basic emergency response infrastructure with potential for rapid enhancement of capabilities when necessary (the surge concept). Included in this activity are preparedness programs that address functions including planning, warning, communications, direction and control, shelter, movement of people, and provision of food and medical resources. This activity also provides for development of training materials and training programs, and for research and development activities that provide the technical basis for national planning for such activities as population protection.

National Earthquake Program and other hazards.--This activity provides for the enhancement of Federal, State, and local governments' capability to prepare for, respond to, and mitigate potential impact of disasters and emergencies. Programs include the following: National Earthquake Program, which provides for technical and financial assistance to State and local governments to develop and implement hazard reduction programs, development and adoption of improved seismic design and construction standards, public education and information transfer, and Federal response planning; hurricane, which provides technical and financial assistance for the development of population preparedness and property protection; dam safety, which provides for coordination and monitoring of activities to enhance the safety of Federal and non-Federal dams, including provision of technical assistance on design, construction, maintenance, and operation of safe dams; and hazard mitigation assistance, which funds planning efforts to reduce potential hazards. FEMA is also designated as lead Agency for the National Earthquake Hazards Reduction Program and is responsible for planning, coordinating, and recommending goals and priorities for the multi-agency program.

Radiological emergency preparedness.--This activity is focused on improvement of Federal, State, and local planning for emergencies in areas surrounding nuclear power reactors and enhanced capabilities to cope with radiological accidents at fixed nuclear facilities, including commercial nuclear powerplants, and nuclear materials license holders. The activity provides assistance to State and

THE WHITE HOUSE

Office of the Press Secretary
(Knoxville, Tennessee)

For Immediate Release

February 2, 1990

The President today announced the appointment of the President's Council of Advisers on Science and Technology (PCAST), comprised of 12 distinguished scientists and engineers. This panel will provide high-level advice directly to the President on a wide range of important issues concerning science and technology.

PCAST will be the first Presidential scientific advisory group in many years to report directly to the President. Its establishment is a measure of the Bush Administration's high esteem for science and a recognition that advances in science and technology contribute in a major way to increased economic competitiveness. It also reflects the President's desire to strengthen Federal science and technology policy, enhance Federal research and development activities, and encourage private sector involvement in research and development.

The United States scientific community leads the world in creating new knowledge. Through PCAST, the President is seeking to provide the best obtainable private sector advice to Executive Branch decision-making in science and technology.

PCAST will be chaired by Dr. D. Allan Bromley, Assistant to the President for Science and Technology. A list of the members and their affiliations is attached, along with a fact sheet on science and technology accomplishments in the Bush Administration.

PCAST was established January 19, 1990, by Executive Order 12700. Its members will be sworn in later today by the Vice President at the White House.

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NORMAN E. BORLAUG

Nobel Laureate Borlaug, of Texas, is currently leader of the Sasakawa-Global-2000 agricultural program in sub-Saharan Africa, Distinguished Professor of International Agriculture at Texas A&M University, and a Senior Consultant to CIMMYT. He was Director of the Wheat Research and Production Program of the International Maize and Wheat Improvement Center, Mexico, from 1964 until his retirement in 1979.

Dr. Borlaug's career began in 1935 in the U.S. Forest Service, and he subsequently worked as an instructor in plant pathology at the University of Minnesota in 1941, where he received his Ph.D. From 1942 through 1944 he was a microbiologist with the E. I. DuPont de Nemours & Co.. He also served as research scientist in charge of wheat improvement with the Cooperative Mexican Agricultural Program, Mexican Ministry of Agriculture and the Rockefeller Foundation, 1944-60, and later, as Associate Director of the Foundation assigned to the Inter-American Food Crop Program, 1960-63.

D. ALLAN BROMLEY, CHAIRMAN

D. Allan Bromley, of Connecticut, is Assistant to the President for Science and Technology and Director of the Office of Science and Technology Policy (OSTP).

Dr. Bromley carried out pioneering studies on both the structure and dynamics of nuclei and is considered the father of modern heavy ion science. He has played major roles in the development of accelerators, of detection systems, and in computer based data acquisition and analysis systems. He is currently on leave from his position as Henry Ford II Professor of Physics at Yale University, where he was founder and Director of the A.W. Wright Nuclear Structure Laboratory.

Dr. Bromley has been a leader in the national and international science and science policy communities for more than 20 years, serving as a member of the White House Science Council throughout the Reagan Administration and as a member of the National Science Board in 1988-89. He received the President's National Medal of Science in 1988 and the Presidential Medal of the New York Academy of Sciences in 1989. He has served as President of the American Association for the Advancement of Science and of the International Union of Pure and Applied Physics.

Dr. Bromley received the B.Sc. degree in 1948 at Queen's University, Canada, the M.Sc. degree from Queen's University in 1950, and the Ph.D. degree in nuclear physics from the University of Rochester in 1952. He has since been awarded 10 honorary doctorates.

SOLOMON J. BUCHSBAUM

Solomon J. Buchsbaum, of New Jersey, has been Senior Vice President, Technology Systems, at AT&T Bell Laboratories since 1979. His early career included work at the MIT Research Laboratory of Electronics. He received his Ph.D. in physics from MIT in 1957. He joined Bell Laboratories in 1958 as a member of the technical staff and later became department head and director of the Electronics Research Laboratory. In 1968, he was named Vice President for Research at the Sandia Laboratories and served in a number of different capacities. He returned to Bell Laboratories in 1971 as an Executive Director. In 1976 he became Vice President, Network Planning and Customer Systems.

Dr. Buchsbaum is a member of the National Academy of Sciences and of the National Academy of Engineering. He was the recipient of the President's National Medal of Science in 1986.

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CHARLES L. DRAKE

Charles L. Drake, of Vermont, has been the Albert Bradley Professor of Earth Sciences at Dartmouth since 1984 and Professor of Geology since 1969. Dr. Drake's professional career began at Columbia University in 1953. He joined the staff at Dartmouth in 1958 after receiving his Ph.D. in geology from Columbia University where he has continued his career, including service as Professor and Chairman of the Department, 1967-69; as Dean of Graduate Studies and as Associate Dean of the Science Department, 1978-81.

Dr. Drake is a recipient of the G. P. Woollard Award, Geophysical Division of the Geological Society of America.

RALPH E. GOMORY

Ralph E. Gomory, of New York, is President of the Sloan Foundation and, until his recent retirement, was Senior Vice President for Science and Technology, IBM Corporation. He received his Ph.D. in mathematics from Princeton in 1954.

Dr. Gomory's professional experience includes teaching and research at Princeton from 1957-59. In 1959, he joined the Research Division of IBM and was named Director of the Mathematical Sciences Department in 1965. In 1970 he became IBM Director of Research and held that position until 1985, becoming IBM Vice President in 1973, Senior Vice President in 1985, and IBM Senior Vice President for Science and Technology in 1986. He has been awarded a number of honorary degrees and prizes, including the John von Neumann Theory Prize in 1984 and the National Medal of Science in 1988.

BERNADINE HEALY, VICE CHAIRMAN

Bernadine Healy, of Ohio, is Chairman of the Research Institute of The Cleveland Clinic Foundation, a position she assumed in 1985, and is a staff member of the Clinic's Department of Cardiology. Prior to that time, she was Deputy Director of the Office of Science and Technology Policy at the White House, and until that appointment had been a Professor at The Johns Hopkins University School of Medicine and Hospital. Dr. Healy received her medical degree from Harvard Medical School in 1970. Her medical career continued at Johns Hopkins from 1976 to 1984, where she was Professor of Cardiology and Medicine, Director of the Coronary Care Unit, and Assistant Dean for Postdoctoral Programs and Faculty Development.

Dr. Healy is a member of the Institute of Medicine of the National Academy of Sciences. She is the immediate Past President of the American Heart Association and a former President of the American Federation for Clinical Research.

PETER W. LIKINS

Peter W. Likins, of Pennsylvania, has been President of Lehigh University since 1982. His professional career began as a development engineer with the Jet Propulsion Laboratory, California Institute of Technology, in 1958. In 1964 he joined the faculty at the University of California, Los Angeles, where he became Professor of Engineering and later, Associate Dean. Dr. Likins received his Ph.D. in engineering mechanics from Stanford in 1965. In 1976 he became Professor and Dean of Columbia University, serving until 1980, when he became Provost of the University.

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THOMAS E. LOVEJOY

Thomas E. Lovejoy, of Virginia, is the Assistant Secretary for External Affairs, The Smithsonian Institution. His previous experience includes service as a research assistant at the University of Pennsylvania, 1971-74, after receiving his Ph.D. in biology from Yale University in 1971; as Executive Assistant to the Science Director and as Assistant to the Vice President for Resources and Planning of the Academy of Natural Sciences, 1972-73; as the Vice President for Science of the World Wildlife Fund-U.S., 1973-87; and as Executive Vice President, 1985-89.

Dr. Lovejoy is President of the Society for Conservation Biology.

WALTER E. MASSEY

Walter E. Massey, of Illinois, has been the Vice President of the University of Chicago for Research and for Argonne National Laboratory since 1984. He has also been Professor of Physics at the University since 1979.

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Director, NSF*

Dr. Massey previously served as a physics instructor at Morehouse College, 1958-59; and after receiving his Ph.D. in physics from Washington University in 1966, as a staff physicist with the Argonne National Laboratory until 1968; as Assistant Professor of Physics, University of Illinois, Urbana, 1968-70; Associate Professor of Physics and Dean of the College, Brown University, 1975-79. He is Vice President, and President-elect, of the American Physical Society and is the Past President and Chairman of the American Association for the Advancement of Science.

JOHN P. MCTAGUE

John P. McTague, of Michigan, is Vice President-Research, Ford Motor Company, and has served in that position since 1986.

In 1983 Dr. McTague was appointed Deputy Director of the Office of Science and Technology Policy, becoming Acting Science Advisor to the President and Acting Director of OSTP in 1986. Prior to that, he was Chairman of the National Synchrotron Light Source Department, Brookhaven National Laboratory, 1982-83. He was Professor of Chemistry and a member of the Institute of Geophysics and Planetary Physics, University of California, Los Angeles, 1970-82. Dr. McTague began his professional career as a member of the Technical Staff, North American Aviation Science Center, on receiving his Ph.D. in physical chemistry from Boston University, and remained there until 1970. He is U.S. Chairman of the U.S. Japan Joint High Level Advisory Panel on Cooperation in Research and Development in Science and Technology.

DANIEL NATHANS

Nobel Laureate Nathans, of Maryland, is Professor of Molecular Biology and Genetics at The Johns Hopkins University Medical School and Senior Investigator of the Howard Hughes Medical Institute. He has been on the faculty of The Johns Hopkins University Medical School since 1962.

After receiving his Medical Degree from Washington University in 1954, he served as Medical Resident at the Columbia-Presbyterian Medical Center in New York, 1955, 1957-59; as Clinical Associate at the National Cancer Institute, 1955-57, and Guest Investigator in biochemistry at the Rockefeller University, 1959-62.

Dr. Nathans received the Nobel Prize in Physiology or Medicine in 1978 for his research with enzymes that cut DNA into specific pieces, one of the basic tools of genetic engineering.

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DAVID PACKARD

David Packard, of California, has been Chairman of the Board of the Hewlett-Packard Co. since 1972. Mr. Packard received his B.A. and B.S.E.E. degrees from Stanford University in 1934 and 1939, respectively.

His professional experience includes service as an engineer with the Vacuum Tube Engineering Department, GE Co., 1936-38; co-founder and partner, the Hewlett-Packard Co., 1939-47; President, 1947-64; and Chairman and Chief Executive Officer, 1964-69. Prior to his present position, Mr. Packard served as U.S. Deputy Secretary of Defense from 1969-71.

Mr. Packard received the Vannevar Bush Award of the National Science Board in 1987 and the President's National Medal of Technology and the Presidential Medal of Freedom in 1988.

HAROLD T. SHAPIRO

Harold T. Shapiro, of New Jersey, has been President of Princeton University since 1988.

Dr. Shapiro's previous academic experience has been with the University of Michigan, after receiving his Ph.D. in economics from Princeton in 1964, first as an Assistant Professor of Economics. His career progressed from Associate Professor, 1967-70; Professor, 1970-76; Chairman of the Department of Economics, 1974-77; Professor of Economics and Public Policy, 1977; Vice President for Academic Affairs, 1977-79.

Dr. Shapiro was President of the University of Michigan from 1980 until 1987. He has served as a member of many industrial, governmental and academic boards and commissions.

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Office of the Press Secretary
(Miami, Florida)

For Immediate Release

January 19, 1990

#12700

EXECUTIVE ORDER

- - - - -

PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY

By the authority vested in me as President by the Constitution and laws of the United States of America, and in order to establish, in accordance with the provisions of the Federal Advisory Committee Act, as amended (5 U.S.C. App. 2), an advisory committee on science and technology, it is hereby ordered as follows:

Section 1. Establishment. There is established the President's Council of Advisors on Science and Technology ("Council"). The Council shall be composed of not more than 15 members, one of whom shall be the Director of the Office of Science and Technology Policy, and 14 of whom shall be distinguished individuals from the private sector to be appointed by the President. The Director of the Office of Science and Technology Policy shall serve as Chairman of the Council. The Vice Chairman shall be appointed by the President from among the 14 private sector members. The Chairman shall report directly to the President.

Sec. 2. Functions. (a) The Council shall advise the President on matters involving all areas of science and technology.

(b) In the performance of its advisory duties the Council shall conduct a continuing review and assessment of developments in science and technology, and shall, through the Chairman, report thereon to the President whenever requested.

(c) The Chairman may, from time to time, invite experts to investigate and report to the Council on specific issues of national consequence.

Sec. 3. Administration. (a) The heads of Executive agencies shall, to the extent permitted by law, provide the Council and its panels such information with respect to scientific and technological matters as required for the purpose of carrying out its functions.

(b) Members of the Council shall serve without any compensation for their work on the Council. However, members appointed from among private citizens of the United States may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by law for persons serving intermittently in the Government service (5 U.S.C. 5701-5707).

(c) Any expenses of the Council shall be paid from the funds available for the expenses of the Office of Science and Technology Policy.

(d) The Office of Administration shall, on a reimbursable basis, provide such administrative services as may be required.

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Sec. 4. General. (a) Notwithstanding any other Executive order, the functions of the President under the Federal Advisory Committee Act, as amended, except that of reporting to the Congress, which are applicable to the Council, shall be performed by the Office of Administration in accord with the guidelines and procedures established by the Administrator of General Services.

(b) The Council shall terminate on June 30, 1991, unless sooner extended.

GEORGE BUSH

THE WHITE HOUSE,
January 19, 1990.

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health
Bethesda, Maryland 20892

December 3, 1990

TO: CISET Subcommittee on S&T Cooperation with
Industrialized Countries

FROM: Dr. Philip Schambra, Chairman

SUBJECT: Next Subcommittee Meeting, December 10, 1990

The first meeting of the U.S.-E.C. Joint Consultative Group on Science and Technology (JCG), has been scheduled for the week of February 18, 1991 in Washington, D.C. Dr. Bromley has requested that our Subcommittee provide recommendations concerning the agenda and preparations for this meeting and advice on the preferred scope of the JCG discussions. Dr. Bromley's memorandum containing this request is attached, as is a background paper prepared by OSTP to facilitate our discussion. You will note that Dr. Bromley would appreciate our recommendations covering several administrative matters as well.

Our meeting also will provide an opportunity to discuss topics which the Subcommittee might address in the future including S&T cooperation with Central and Eastern European countries. The meeting will be held December 10, from 4:00 p.m.- 5:00 p.m. at the National Science Foundation, Room 540.

Please phone Ms. Nanette Hawk at (301) 496-4784 to confirm your attendance.

I look forward to seeing you again.

A handwritten signature in cursive script that reads "Philip E. Schambra (acting)".

Philip E. Schambra, Ph.D.
Director
Fogarty International Center
and
Chairman
CISET Subcommittee on S&T
Cooperation with
Industrialized Countries

Attachment

Addressees:

Dr. Thomas Ratchford
Ms. Sara Bowden
Dr. William Tallent
Ms. Susan Lipsky
Mr. Stuart Schwartzstein
Dr. Harold Jaffe
Mr. Harlan Watson
Dr. John Boright
Mr. Mark Dowis
Dr. Alan Hecht
Mr. James A. Nix
Mr. Peter G. Smith
Mr. Dan V. Jacobs
Mr. Peter Allgeier
Mr. Stephen Litwin
Dr. Richard Ries
Dr. Richard Bradshaw
Mr. Ron Morony

RE:NH 12/3/90
DOC:SUB
DISK:ROB3

**EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20508**

November 26, 1990

MEMORANDUM FOR REGINALD BARTHOLOMEW

FROM: D. ALLAN BROMLEY *Duan*

SUBJECT: CISET SUBCOMMITTEE ON S&T COOPERATION WITH INDUSTRIALIZED COUNTRIES AND PREPARATION FOR FIRST MEETING OF U.S.-E.C. JOINT CONSULTATIVE GROUP

Thank you for your memorandum of November 17 outlining current activities of the CISET and enclosing the excellent report prepared by the CISET Subcommittee on S&T Cooperation with Industrialized Countries entitled "Implications of European Integration for Science and Technology in Europe and the United States." I found it to be one of the most informative pieces I have read in some time on the state of science and technology in the E.C. and our relations with the Community. Over the next few weeks I will review the report more fully and discuss with you and others the recommendations contained therein.

The report provides an excellent basis from which we can begin our activities under the newly formed Joint Consultative Group on Science and Technology (JCG). As you know, the first meeting of that group is tentatively planned for the week of February 18 here in Washington. The Executive Secretary of CISET or his designee will serve as Executive Secretary for the JCG. However, Dr. Schambra's Subcommittee can be particularly helpful in preparations for meetings of the JCG. Drawing on their recently completed work, I would like to request that Subcommittee reconvene 1) to recommend an agenda for the meeting which I could then propose to the E.C., 2) to recommend which other FCCSET Committees or agencies within the USG might develop position and briefing papers for the meeting, and 3) to advise me as to the preferred scope of discussions for the JCG. Members of my staff will participate in the Subcommittee's deliberations in order to facilitate preparations for the meeting.

Attached you will find a short summary of the status of the Joint Consultative Group as well as my decisions concerning preparations for the first meeting. This should assist the Subcommittee in its deliberations.

Again, many thanks for your update. I appreciate the excellent work of the Committee and welcome your new and ongoing initiatives.

Attachment

cc: Philip Schambra

STATUS REPORT ON JOINT CONSULTATIVE GROUP

BACKGROUND

On November 14, Dr. Bromley and Mr. Pandolfi, formally concluded an agreement through an exchange of letters (attached) to establish a Joint Consultative Group on Science and Technology (JCG). The JCG will serve as a forum for discussion on science and technology issues, enhance the exchange of information, and facilitate cooperation with the aim of increasing mutual understanding of U.S. and E.C. activities and programs related to science and technology. The group will not engage in, sponsor, or support new or existing cooperative R&D activities, or address ongoing bilateral relations with the member states of the European Communities. The group will only discuss issues which do not fall within the purview of other mechanisms, including bilateral groups such as the U.S.-E.C. High Technology Working Group.

On the U.S.-side, it has been determined that the executive secretary for the JCG will be the executive secretary for the CISET. The executive secretary will be responsible for coordinating preparation for JCG meetings and will ensure necessary follow-up. As necessary, the executive secretary may request assistance from USG agencies, the CISET and its Subcommittees, request from other FCCSET Committees will be coordinated with the Executive Secretary of FCCSET. For example, in the field of biotechnology, the executive secretary may ask for briefing material, reports, or other information from the U.S. side of the U.S.-E.C. Task Force on Biotechnology which is associated with the FCCSET Committee on Life and Health Sciences.

Dr. Bromley and Mr. Pandolfi have tentatively agreed that the first meeting of the JCG will be held in Washington the week of February 18, 1991. Dr. Bromley intends to propose to Mr. Pandolfi that the JCG consist of three permanent members and up to five associate members to be determined by the agenda items for the specific JCG meeting. Associate members may be drawn from the public or private sector as appropriate. On the U.S. side, the three permanent members will be the Assistant to the President for Science and Technology (chairman), OSTP Associate Director for Policy and International Affairs, and the Director of the National Science Foundation. It may be necessary to revise U.S. membership, both permanent and associate, depending up the E.C. response to our proposal.

Several issues remain to be decided prior to conveying an agenda for the first meeting to the E.C. These issues, which will be initially addressed by the CISET Subcommittee on S&T Cooperation with Industrialized Countries, are outlined below.

ISSUES

1) Proposed agenda: Mr. Pandolfi suggested five areas for initial consultation. These are:

- o prenormative research in biotechnology
- o information technologies
- o energy and environment
- o large scale scientific projects
- o research and development in Eastern Europe.

Dr. Bromley suggested one additional item:

- o mobility and supply of human resources.

The Subcommittee should consider whether this is an appropriate list for the first meeting. Then, based on its recommendations concerning the agenda, the Subcommittee should recommend which FCCSET Committee or USG agencies should prepare position papers and other briefing materials for the U.S. members of the JCG for the meeting. In addition, the Subcommittee should consider what issues and topics might be discussed in future meetings of the JCG.

2) Preferred scope: The Subcommittee should consider the following issues related to scope and make recommendations based upon its discussions.

- o Degree of policy vs. technical content of discussions
- o Depth and breadth of discussions. For example, to what extent does the JCG consider ongoing activities
- o Horizon for discussion—short, medium and long term perspective

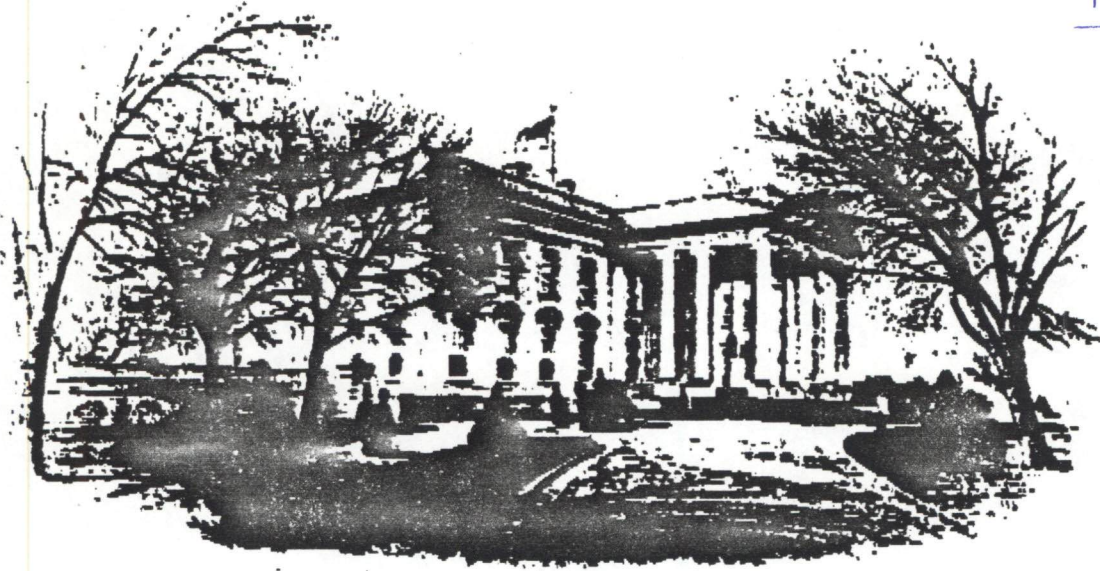
3) Administrative: Subcommittee recommendations on the following issues would be helpful:

- o How are activities of the JCG to be coordinated with other bilateral activities such as the U.S.-E.C. High Technology Working Group?
- o What should be the frequency of the meetings?
- o Where should the first meeting be located in Washington?
- o While costs should not be great, how should meetings of the JCG be financed?

Attachments

Executive Office of the President Office of Legislative Affairs

Science →
Technology Issues



FACSIMILE TRANSMITTAL SHEET

NUMBER OF PAGES INCLUDING COVER 3

DATE 4/2/91

TO Todd Buckholtz

FAX NUMBER 7739

OFFICE NUMBER _____

COMMENTS _____

FROM Jack Howard

FAX NUMBER _____

OFFICE NUMBER _____

SCIENCE, SPACE, AND TECHNOLOGY

Whereas the Senate has preferred single year authorizations for science and technology programs, the House has preferred multiyear authorizations to provide sound long-term planning of capital intensive projects, and will likely continue to seek such multiyear authorizations.

Emerging Technology Bill--The 101st Congress reached a final agreement on an emerging technology bill, but failed to bring it before both bodies before adjournment. The final agreement (1) set the authorization for the advanced technology program (ATP) at \$100.0 million annually with paybacks required and (2) established a National Capital Cost Reduction Commission chaired by the Vice-President with three members appointed by the President, House and Senate. It is likely that this legislation will move through both bodies quickly, provided it is based on the agreement reached at the end of the 101st Congress.

National Atmospheric and Space Administration (NASA) Authorization--Although the House passed a multi-year NASA authorization bill, the final agreement provided funding only through FY 1991 (\$15.0 billion). The 102nd Congress will therefore need to provide funding beyond the current fiscal year. As a result of the Report of the Augustine Advisory Committee on the Future of the U.S. Space Program, debate during reauthorization will likely focus on questions of reorganization and reform within NASA, as well as specific project funding.

Space Commercialization Bill--Republican Chairman Walker has submitted legislation designed to bring America's entrepreneurial skills to bear upon the exploration and industrial development of outer space. The bill requires an inventory of federal space launch support facilities which may be surplus to public or national security needs and makes such facilities available for auction to the private sector.

Additionally, the bill: (1) creates commercial space zones; (2) offers tax incentives to the private sector for building space zones and for space launches and manufacturing undertaken from or in such zones; (3) requires the government to procure launch services from the private sector when such services are not related to national security or government-sponsored research; (4) includes antitrust exemptions to permit private sector collaboration in space R&D and production; and (5) authorizes non-federal cash awards for persons who have substantially advanced space transportation, manufacturing, or R&D.

National Oceanic and Atmospheric Administration (NOAA)--Although the House sent two NOAA multi-year reauthorization bills to the Senate during the 101st Congress, neither bill was considered on the Senate floor. The 102nd is expected to take up a multiyear NOAA reauthorization measure providing over \$1.0 billion annually for: (1) "dry" NOAA activities; (2) stable, long-term support for weather service modernization including the replacement of aging satellites; and (3) global change research. The Science Committee's standing proposal is consistent with current Commerce Department planning and could serve as the basis for early action.

Environmental Protection Agency (EPA) Research and Development (R&D)--During the 101st Congress, the Committee passed an EPA R&D bill authorizing \$409.1 million in FY 1991, increasing to \$555.1 million in FY 1993. Because of jurisdictional claims by the Committee on Energy and Commerce, however, the measure failed to reach the House floor. Legislation is to include, among other things: (1) the R&D provisions required under the Clean Air Act (P.L. 101-549); (2) pollution prevention technology R&D; and (3) groundwater and indoor air quality and radon research.

Department of Energy (DOE) Civilian Research and Development--During the 101st Congress, the Committee only marked up two civilian DOE R&D programs -- renewables-conservation and the Super Conducting Supercollider (SSC) project. The Committee's jurisdiction over DOE's

- 16 -

civilian energy R&D projects totals over \$5.0 billion, yet in the 101st Congress other authorizing legislation was simply not marked up. During the 102nd Congress, the Committee is expected to be more active in authorizing funding for projects within its jurisdiction (e.g., advanced reactor legislation) based on the President's National Energy Strategy.

Uranium Enrichment--It was proposed in the 101st Congress that the Uranium Enrichment program be allowed to operate as a government corporation. The issue of converting the program into a profitable commercial enterprise with an equitable sharing of existing liabilities that protects the taxpayer will once again be considered by the Committee.

SMALL BUSINESS

Procurement--Legislation implementing recommendations for small business procurement programs from a number of White House Conferences on Small Business are anticipated.

Veterans Entrepreneurship Promotion--It is expected that the Veterans Entrepreneurship Promotion Act of 1991 will be reintroduced during this session. The legislation establishes programs to assist in the creation, development, and growth of small business concerns owned and controlled by veterans, targeting these businesses for government contracts as well as private-sector assistance

Oversight Hearings--Oversight hearings are expected to be held regarding the state of a number of SBA programs, especially those related to trade and exports.

Technology--The Committee will examine technological changes in the marketplace as well as the affect of these changes on the SBA and its programs.

VETERANS' AFFAIRS

Cost of Living Adjustment (COLA)--The Committee has made it a top priority to take up legislation related to the disabled veterans COLAs. The Committee anticipates the passage of a clean 5.4% COLA. It has been reported that the leadership is in support of an up-or-down-vote on the COLA which died in the Senate last year.

Agent Orange--The Committee expects to reconsider legislation to compensate those affected by Agent Orange during the Vietnam War. The legislation is likely to be similar to that which passed the House last year.

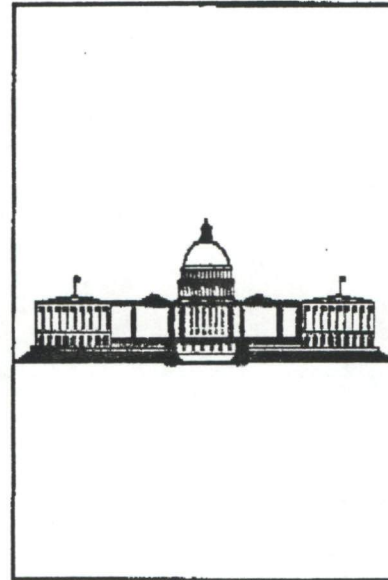
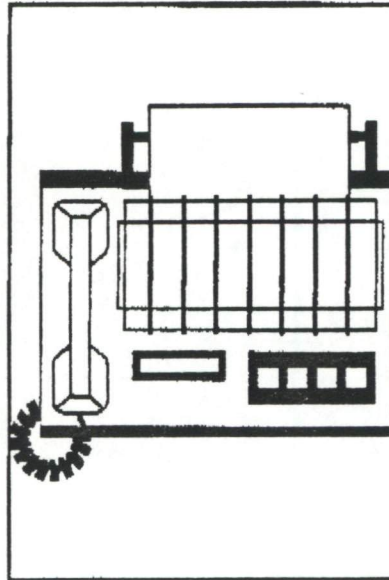
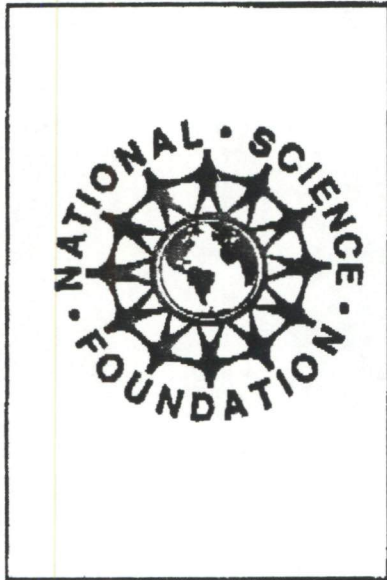
Soldiers and Sailors Amendments--Due to the need presented by the continuation of Operation Desert Shield, the Committee anticipates amendments to the Soldiers and Sailors Act. This Act provides assistance to those serving in the Armed Forces.

Physicians' Pay--The Committee anticipates legislation providing for more competitive recruiting of physicians and dentists for Veteran's Health care. Also included will be language to streamline nursing pay scales and provide for more equitable labor relations.

WAYS AND MEANS

Simplification of Tax Code--Over the past year the Committee has collected tax simplification recommendations from Treasury, the Majority, the Minority and the Joint Committee on Taxation. It will likely be a top priority this year.

NATIONAL SCIENCE FOUNDATION
OFFICE OF LEGISLATIVE AND PUBLIC AFFAIRS



TO: TODD BUCKHOLTZ.....
ADDRESS: WHITE HOUSE ECONOMIC POLICY COUNCIL.....
FAX PHONE: 456-7739..... OFFICE PHONE: 456-7968.....

FROM: JOEL WIDDER, DIRECTOR, LEGISLATIVE AFFAIRS
ADDRESS: NSF OFFICE OF LEGISLATIVE AND PUBLIC AFFAIRS
FAX PHONE: 202-357-9869 OFFICE PHONE: 202-357-9730

MESSAGE:

14 pages

HOPE THIS INFORMATION IS USEFUL.

NSF AND THE 102nd CONGRESS: ISSUES AND EXPECTATIONS

Significant legislative challenges are facing National Science Foundation in the 102nd Congress (1991-1993). They are subject to unexpected changes in the international arena, the economy, the federal budget, Congress, and its committees.

This article is divided into three parts. Part A describes the budget environment NSF will probably face over the next few years. Part B focuses on the committees with appropriations and oversight responsibilities for NSF, their priorities, and recent changes. Part C describes programmatic issues expected to be considered by the 102nd Congress and how they might impact on NSF.

PART A: THE BUDGET ENVIRONMENT

The FY 1991 budget process concluded on November 5, 1990, over a month after the start of the fiscal year. At that time the President signed into law a deficit reduction bill that is expected to reduce the deficit by more than \$40 billion in FY 1991 and by almost \$500 billion between FY 1991 and 1995. The deficit reduction bill represented agreements reached between the White House and the Congressional leadership.

What the Budget Agreement is Supposed to Accomplish

The five-year budget agreement seeks to reduce the deficit through a combination of revenue increases (\$137.2 billion), outlay reductions (\$281.4 billion), and debt service savings. Over one-third of the spending reductions (\$99 billion) will come from mandatory programs, including some increased user fees. The remaining two-thirds (\$182.4 billion) will come from cuts in discretionary appropriations.

Discretionary spending reductions fall principally on defense, at least for the first three years of the agreement. The summit establishes "spending caps" for FYs 1991, 1992 and 1993 for the three major categories that make up discretionary spending -- defense, non-defense, and international. The agreement sets a single ceiling on total discretionary spending for FYs 1994 and 1995. The ceilings will be enforced by an end-of-session sequester applied across-the-board to any of the three categories which exceed their "spending cap."

FY 1991-93 NON-DEFENSE DISCRETIONARY SPENDING (\$ in billions)		
FISCAL YEAR	BUDGET AUTHORITY	OUTLAYS
1991	182.7	198.1
1992	191.1	210.0
1993	198.3	221.7

Implications of the Spending Caps for NSF

The non-defense discretionary spending ceilings enacted as part of the summit are of critical to NSF. This portion of the budget includes not only NSF, but also other high-priority areas, including the space program, environmental protection, transportation, housing, health, energy, research, and education.

Over the next three years, total non-defense discretionary spending will increase by almost \$40 billion over the comparable level for FY 1990. However, over \$25 billion, or 60%, of this allowable growth was already included in the current FY 1991 budget. This will limit annual incremental growth for ALL non-defense discretionary spending will be limited to only about 5% in budget authority and 6% in outlays in FY 1992, and by only 3.7% in budget authority and 5.6% in outlays in FY 1993.

The limitation on all non-defense discretionary spending impacts the non-defense discretionary allocation that is made to the VA, HUD, and Independent Agencies Appropriation Subcommittee. This Subcommittee funds NSF, NASA, the Housing and Urban Development Department, the Department of Veterans' Affairs, the Environmental Protection Agency, and 17 other agencies.

The Subcommittee -- and consequently many of the agencies within its jurisdiction -- have received major funding increases over the last few years. For example, the Subcommittee's allocation for non-defense discretionary spending increased by more than 20% in FY 1991 to \$60.4 billion. This particular subcommittee has responsibility for one-third of all non-defense discretionary programs -- the largest of any non-defense subcommittee. Meanwhile, the average growth in other appropriations subcommittees for non-defense resources was about 15% in FY 1991.

The ability of the Foundation to continue to receive double-digit percentage increases depends upon the increases the VA, HUD, and Independent Agencies Appropriations Subcommittee is able to achieve within the parameters of the budget summit agreement. The Subcommittee anticipates a difficult time ahead, as clearly indicated in its conference report accompanying the FY 1991

appropriations act:

"The five-year budget agreement assumes an annual growth rate in domestic discretionary spending, and therefore, in the VA, HUD, and Independent Agencies Appropriations bill, of approximately five to seven percent."

PART B: THE CONGRESSIONAL PLAYERS

Traditional and Non-traditional Congressional Audiences

The basic budgetary and programmatic oversight functions are the responsibility of five congressional committees:

- o The House and Senate Budget Committees prepare the congressional budget resolution, in which NSF appears under Function 250, "General Science, Space, and Technology." Function 250 also includes NASA and the basic research programs of the Department of Energy (including the Superconducting Super Collider).
- o The House and Senate Appropriations Subcommittees on Veterans Affairs, Housing and Urban Development, and Independent Agencies are responsible for preparing NSF's appropriations bills. Other agencies included in the VA/HUD appropriations bill, and hence competitors for subcommittee funds, are the Housing and Urban Development Department, the Veterans' Department, NASA, EPA, and OSTP.
- o In the Senate, responsibility for NSF's authorization bills is shared by the Labor and Human Resources Committee and the Commerce, Science, and Transportation Committee. The Labor Committee has primary responsibility for NSF as a whole and sole responsibility for NSF's education and human resource activities. In addition, The Senate Labor and Human Resources Committee has sole responsibility for the confirmation of NSF and NSB nominations. The Commerce Committee has a more limited oversight function, but has been active in some specific areas, such as academic research facilities, global change and high-performance computing.
- o Finally, in the House, responsibility for NSF's authorization lies solely with the Committee on Science, Space, and Technology (HSST), which also has responsibility for most of NASA, NIST, EPA's research programs, and the civilian research programs of DOE.

As NSF's visibility has increased in recent years, so has its interactions with other congressional committees. For example,

- o Increasing concern over the protection of the Antarctic environment has required that the Foundation work closely with the House Merchant Marine and Fisheries Committee, the House Foreign Affairs Committee, and the Senate Foreign Relations Committee. These contacts will remain important in the 102nd Congress.
- o Over the past few years, NSF has participated in hearings and legislative activities of the Senate Rules Committee, the House Education and Labor Committee, the Senate Governmental Affairs Committee, the Joint Economic Committee, and others. Issues have ranged from science education and competitiveness to peer review, scientific fraud and misconduct, and international science.

Changing Chairmen

During the last four years, virtually every committee with jurisdiction over NSF has experienced changes in its leadership. While the pace of change is likely to slow in coming years, the Foundation must continue to work closely with new chairmen and senior members to ensure favorable reception of the agency.

A sample of these leadership changes includes the following:

- o Both chairpersons of the House and Senate VA/HUD appropriations subcommittees were replaced within the last three years. In the House, Representative Edward Boland, who chaired the subcommittee for close to 20 years, retired and was replaced by Representative Bob Traxler (D-MI). In the Senate, William Proxmire was replaced two years ago by Senator Barbara Mikulski (D-MD). The chairman of the full Senate Appropriations Committee was replaced two years ago, as Senator John Stennis retired making way for Senator Robert Byrd (D-WV) to assume the chairmanship.
- o The chairmen of the House and Senate Budget Committees were both replaced two years ago. The ranking minority member in the House has also recently changed. Today, Representative Leon Panetta (D-CA) and Senator James Sasser (D-TN) head these House and Senate panels, respectively.
- o The chairmanship of the House Science, Space and Technology Committee has changed hands three times over the last five years. The most recent change was in December 1990, when Representative George Brown (D-CA) was elected by his colleagues as the Science Committee's new chairman. Mr. Brown replaced Robert Roe (D-NJ), who became chairman of the House Public Works and Transportation Committee.
- o The chairmanship of the HSST Subcommittee on Science, Research and Technology, which has primary jurisdiction over

NSF in the House, has changed twice in the last year. Representative Doug Walgren gave up the post for another House Subcommittee chairmanship and was then defeated in the 1990 election. Representative Tim Valentine (D-NC) then assumed the chairmanship, but yielded it to Representative Rick Boucher (D-VA) when the House Science, Space, and Technology Committee reorganized on February 7, 1991.

- o The responsibilities of the HSST Science Subcommittee have also changed. In order to distribute the workload among the subcommittees more evenly, Chairman Brown split the science and technology functions of the old Subcommittee on Science, Research and Technology. The science functions, which include primarily NSF, were retained by the new Subcommittee on Science. The technology functions, which include primarily the National Institute of Standards and Technology (NIST), were combined with the old Subcommittee on Transportation, Aviation, and Materials to form the new Subcommittee on Technology and Competitiveness, now chaired by Representative Valentine (D-NC).

The membership roster for each of the Committees/Subcommittees in this new Congress is attached at the end of this report.

Committee Interests

Each committee has its own set of interests and priorities for the National Science Foundation. These priorities are briefly described below, and the issues themselves are addressed in more detail later in this discussion.

Both the House and Senate VA/HUD appropriations subcommittees have historically taken a keen interest in NSF's education and human resources activities, particularly those aimed at the precollege level. The subcommittees typically provide more than NSF's request for these activities, usually targeting additional funds for precollege teacher preparation and enhancement, informal science education, women and minorities programs, and, in FY 1990, the new Statewide Systemic Initiative in math and science education.

The new House Science Subcommittee, which retains jurisdiction over NSF, has a broad range of interests regarding NSF and science policy. In 1990, the Subcommittee contributed to the enactment of the "Excellence in Science, Mathematics, and Engineering Education Act" and reauthorized the interagency National Earthquake Hazards Reduction Program. In 1991, the Subcommittee will likely reopen the existing five year (1989-1993) NSF authorization act for the purpose of making the authorization levels consistent with appropriations, new initiatives, and organizational changes. The Subcommittee continues to be concerned about long-range planning and priority-setting in federal science and

technology policy, the balance between support for individual investigators and multidisciplinary centers, and precollege and undergraduate science education.

The Senate Commerce Subcommittee on Science, Technology, and Space has been particularly interested in high-performance computing, technology policy, and global change. These issues are discussed below in more detail.

Finally, the Senate Labor and Human Resources Committee can be expected to continue its oversight of NSF's math and science education programs, having recently completed a major science education authorization bill. In addition, the Committee will continue to press for more aggressive implementation of the Academic Research Facilities Modernization Act. The Committee views that program, and others, as important for providing all kinds of science institutions, research as well as teaching, with improved access to NSF programs.

PART C: ISSUES AND LEGISLATION

The challenges facing the Foundation are changing. Although some themes, such as competitiveness and science education, will continue to be heard in Congress, their tone will be moderated as new issues, such as the environment, come to the fore.

The idea that research and development is critical for any strategy to improve economic competitiveness is generally accepted. Attention is now turning to the theme of generic or precompetitive technologies. Supporters argue that to be truly competitive, the Nation must do a much better job of more quickly and efficiently getting its research results into practical application. To convince the public and the Congress to increase support for research, many in the Congress are saying it must be shown that U.S. tax dollars spent on research are benefitting U.S. industry and not further fueling the economic expansion of foreign competitors.

What follows is a capsule summary and analysis of various policy and program issues NSF has faced and will probably continue to face as the new Congress opens for business.

NSF Authorization Act

The House Science Subcommittee, which has primary jurisdiction over NSF in the House, is expected to reopen NSF's authorization act in 1991. Although the act does not expire until FY 1993, the Subcommittee may make budgetary adjustments and revisit particular issues.

The authorization act (P.L. 100-570), passed in 1988, is the Foundation's first five-year authorization. The centerpiece of

the act is the doubling of the Foundation's budget by 1993. The act also included a five-year, \$892 million authorization to establish an Academic Research Facilities Modernization program. Finally, the act authorized several specific programs, including the Experimental Program to Stimulate Competitive Research (EPSCoR), undergraduate science education activities, and Presidential Awards for Teaching Excellence.

The Science Subcommittee is expected to revise the authorization figures throughout the act. In particular, the science education figures will have to be substantially increased in order to accommodate the rapid growth in this particular program area. Similarly, the authorization for the U.S. Antarctic Program (USAP) may be adjusted to recognize substantial growth occurring in the USAP's Safety, Environmental, and Health Initiative.

The Science Subcommittee will probably also add more detail to the authorizations for the research directorates. The act currently provides line-item authorizations for the individual research directorates until FY 1991, after which time the act authorizes only a single sum for research and related activities. The Subcommittee is expected to add line-item authorizations for FY 1992 and FY 1993 within the total amounts authorized for research and related activities.

As part of the reauthorization process, the Science Subcommittee can be expected to focus on a number of specific issues, which may include the following:

- o The need to set priorities in science and the subsequent impacts on the allocation of NSF resources. "Prioritization" is a theme commonly sounded by the Subcommittee, which has long advocated a strong role for the Office of Science and Technology Policy.
- o Long-range planning and the effectiveness of the five-year authorization process. NSF advocated passage of a five-year bill based on the need for stability in programs and planning.
- o The balance between centers and individual investigator research, and the effectiveness of the centers programs. Like the appropriations subcommittees, the Science Subcommittee has advocated a "go slow" approach toward new centers. In addition, the Subcommittee is likely to request assessments of the first few years of the Science and Technology and Engineering Research Centers programs.
- o The state of existing specialized centers, such as astronomy facilities and the National Center for Atmospheric Research. The Science Subcommittee has expressed concerns that NSF is too willing to construct new facilities (e.g., LIGO, the 8-

meter telescopes) without fully funding or upgrading existing facilities.

- o Other issues of likely interest to the Science Subcommittee are discussed below. These include interagency initiatives involving high-performance computing, global change, education and human resources, and the relationship of research and development to economic competitiveness.

Education and Human Resources

Education will continue to rank among Congress' highest concerns in science policy. Over thirty pieces of legislation to improve science education were introduced in the last Congress, to say nothing of the many hearings, studies, and other activities that took place. With the passage of a major science education authorization bill in 1990, attention may turn away from new legislation toward oversight of NSF programs and the operation of the interagency FCCSET Committee on Education and Human Resources.

Today Congress generally considers NSF to be the leading federal agency in science and mathematics education. Appropriations for NSF's science education activities have annually increased by 30-40% in recent years, rising 46% in FY 1991 alone. NSF's programs and leadership are highly regarded, and the agency is frequently called to testify before Congress on science education reform.

NSF's leadership in this area was clearly recognized with the passage of the "Excellence in Mathematics and Science Education Act" (P.L. 101-589). Over 82% of the funds authorized in the Act for new and expanded precollege, undergraduate, and graduate science education programs is authorized to NSF. The Act also endorses a number of new initiatives by NSF, including statewide systemic reforms, women and minorities programs, and undergraduate activities.

Science education continues to be an issue of high priority, but Congress' attention will shift away from authorizations and toward appropriations and oversight. Some evidence of this change is being seen already. The House and Senate VA/HUD appropriations subcommittees have requested NSF to prepare a number of reports in 1991 on science education programs, priorities, and management. Among them is a request for NSF to conduct a comprehensive study of the effectiveness of federal science education programs, including those of NSF. In a similar vein, the Senate Governmental Affairs Committee has requested GAO to examine NSF's ability to administer effectively its research and education programs in light of the rapid increases in the Foundation's budget. Similar questions may be asked by the Science Subcommittee during its hearings on the NSF reauthorization.

Congress may also examine the Administration's structure for coordinating federal programs in science education. Legislation had been introduced to create an interagency coordinating committee similar to the FCCSET Committee on Education and Human Resources. Although Congress did not pass the bill, interest in effective interagency coordination is probably undiminished. Such interests could be fueled with the Administration's major interagency science education initiative included in the FY 1992 budget request.

Behavioral and Social Sciences

Several members in the Congress have expressed increasing concern over the perceived inattention by NSF to the behavioral and social sciences. The issue is one that may receive increased attention in the 102nd Congress, especially with the upcoming release of a report by a BBS task force that is expected to call for the creation of a separate directorate for the behavioral and social sciences.

Competitiveness and Technology Policy

During the 1980's, NSF repeatedly stressed the importance of basic research and science education to economic competitiveness. That message has been favorably received by many members in Congress, who have responded by supporting double-digit increases for NSF's budget.

NSF's message is aided by the long-awaited release of the White House's report on "U.S. Technology Policy." This brief report emphasizes the importance of basic research and science education, both areas of strength for NSF. In addition, NSF supports research in all five of the "advanced technologies" listed in the report as necessary for defense and civilian agency needs. One of these areas, high-performance computing, is the subject of a major new initiative in FY 1992, spearheaded by the National Science Foundation. Finally, NSF is working actively with state governments, another important area of interaction identified by the technology policy report.

Congressional interest in technology and applied research is expected to continue. The 101st Congress strongly supported legislation to authorize a three-year, \$400-million "Advanced Technology Program" within the Department of Commerce. Last-minute wrangling prevented final passage of the bill, but will very likely be reconsidered in 1991.

Environmental Protection in Antarctica and Impacts on the Research Program

Protection of the Antarctic environment will continue to get

Congressional attention this year. In 1990, Congress enacted legislation that imposed an indefinite ban on minerals development in Antarctic. Having "finished" this work for the time being, Congress has the opportunity to address certain unresolved issues, such as the imposition of U.S. environmental and historic preservation laws on Antarctic operations; creation of an Antarctic "World Park" safe from any development; regulation of tourism and fishing in the region; and a reevaluation of whether NSF is fully capable of operating the U.S. Antarctic program along with all its emerging environmental and regulatory functions.

The results of the meeting of the Antarctic Treaty parties in Chile in November and December 1990 will also affect congressional interest and activities. The meeting was convened to consider environmental issues. Congress may attempt to enact legislation based upon the agreements reached by the treaty parties.

A major debate on the Hill will focus on whether NSF -- a scientific, non-regulatory agency -- can or should run the non-scientific aspects of the Antarctic program. Some members believe that a regulatory agency should be given responsibility for policing compliance with environmental requirements under the Antarctic Conservation Act and other international accords. There is concern that NSF lacks the commitment or resources to carry out this important oversight function.

Some members feel that all domestic U.S. environmental laws should apply wherever federal agencies conduct "major federal actions." The Administration has steadfastly opposed the extension of domestic environmental laws outside the confines of the U.S. NSF, along with the State and Justice Departments, has strongly objected to legislation that would make the National Environmental Policy Act (NEPA) applicable to the Antarctic.

NSF has emphasized that it is in the process of implementing an environmental protection agenda. The Foundation expects to spend \$30 million by 1995 to clean up past problems and institute procedures to minimize future impacts on the Antarctic environment. This agenda will be implemented while NSF continues to support important scientific research, including global change, ozone depletion, and other environmental research.

NSF is concerned that NEPA would allow private litigants wishing to limit or prevent human activity in Antarctica to seek injunctions and halt important research projects regardless of NSF's compliance with its current environmental regulations. The potential for court injunctions would also lessen international cooperation among U.S. and foreign scientists.

Oversight of NSF's Internal Operations

The last Congress passed several pieces of legislation to in-

crease openness and disclosure among federal agencies. These acts directly affect NSF's internal operations.

The first is the Federal Financial Management Act. A key feature of this bill is the establishment within each agency of a centralized, coordinated financial management structure, headed by a Chief Financial Officer (CFO) and Deputy CFO. In addition, Congress intends to establish a uniform financial system throughout the federal government. A five-year, government-wide financial management plan is now required, as well as financial statements for revolving funds, trust funds, and commercial operations. NSF's Inspector General currently has the responsibility for auditing these financial statements.

Congress has also become more interested in general oversight over NSF's operations. Currently, the oversight committees are concerned with the ability of the Foundation to administer effectively its expanding budget and responsibilities. GAO has been asked to review NSF's grant management and administration procedures.

NSF will also be affected by any amendments to the Federal Advisory Committee Act (FACA) and regulations subsequently issued by the Office of Government Ethics. Legislation probably will be introduced to tighten controls, accountability, and use of government advisory committees. Due to its merit review process, NSF probably uses more advisory committees than any other federal agency.

Indirect costs remain a major concern for the Foundation. OMB has set out principles and procedures to govern indirect cost calculations. Problems, however, arise with the reliability of cost estimates and tracking. In addition, the scientific community is concerned that indirect costs are draining their research to underwrite university expenses. The Department of Health and Human Services, the Department of Defense, OMB, and five university associations have organized a working group to examine the problems associated with indirect costs. Representative John Dingell (D-MI), Chairman of the House Energy and Commerce Committee, has begun a series of oversight hearings to examine the indirect cost rate issue. The recent controversy surrounding Stanford University will underscore the indirect cost issue.

Global Change and the Environment

The 1990's is witnessing a reawakening of public concern for the environment, with global change being at the top of the list. Congress will expect the Foundation to assume a leadership role in some of these areas.

Congress and the President may disagree over the urgency of responding to global change, but there is no disagreement on the

importance of scientific research to understand this problem. Congress has generally supported the Administration's request for increasing funding in this area.

Congress also strongly supports the Administration's efforts to coordinate federal global change research through the FCCSET process. The organization charged with providing such interagency coordination is the Committee on Earth and Environmental Sciences (CEES). In 1990, Congress passed legislation writing the CEES charter into law, an indication of the importance Congress attaches to this issue and to CEES.

High-Performance Computing and Communications

High-performance computing and communications will receive increased congressional attention in 1991, possibly resulting in a separate authorization for this activity. For the past several years, NSF and other federal mission agencies, working through FCCSET, have been developing a coordinated, interagency program in high-performance computing. The centerpiece of the program would be the development of a multigigabit National Research and Education Network (NREN) that would link researchers and educators throughout the Nation.

The attention to the NREN and high-performance computing may contribute positively to discussions on NSF's other research and education programs. The NREN will avoid the "big science" stigma, because it will primarily serve individual investigators, including those in the traditionally "have-not" institutions that do not host major research facilities. Furthermore, the NREN will improve scientific and technological productivity, and hence competitiveness. Finally, the NREN will assist NSF's science education and dissemination efforts at the graduate, undergraduate, and possibly even precollege levels.

The NREN's strongest supporter is Senator Al Gore (D-TN), who in 1989 introduced legislation authorizing a multi-agency effort in high-performance computing. Progress on the bill was slowed considerably because of intercommittee wrangling over the leadership of the NREN. The Senate Commerce Committee and the Energy and Natural Resources Committee finally negotiated a compromise bill, which passed the Senate during the last week of the 1990 session -- too late for House action.

Senator Gore and House Science Committee Chairman George Brown (D-CA) have reintroduced the legislation, which is expected to move quickly in 1991.

Federal Organization and Support for Ecological Research

Ecologists have been leading the fight to create a National

Institute for the Environment (NIE). This new agency would primarily fund ecological studies, which some scientists contend has been ignored by other agencies and thus underfunded.

Several bills to establish a NIE were introduced in the last Congress. Although hearings were held in both the House and Senate, the legislation did not move. In the end, Congress appropriated \$400,000 to the National Academy of Sciences, through the Environmental Protection Agency, to fund a study in the feasibility of establishing such an Institute. The 18-month study will make recommendations regarding the criteria and mechanisms for supporting basic and applied research and training in the environmental sciences. The annual budget of the Institute is estimated to be approximately \$500 million.

The environmental community is sensitive to the fact that ecology research is underfunded but is not overly optimistic that new funds will be forthcoming. There are at least a dozen agencies, including NSF, that already fund environmental research. Questions have been raised as to whether funding for the NIE would merely divert funding from other sources or would duplicate support already offered by NSF to academic researchers. Advocates of the NIE respond that NSF is too dedicated to basic research to support the kind of research that is needed to address pressing environmental problems.

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COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. House of Representatives

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**SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Agenda for the 102nd Congress**

THEME I: PURSUING EFFICIENCY. For too long conventional wisdom has held that the goals of economic growth and environmental protection are mutually exclusive. However, pollution and wasted energy are simply indications of inefficiency. It should therefore be understood that industrial energy conservation and pollution prevention--both industrial and agricultural--are "win-win" situations: American business becomes more productive and competitive while environmental protection is enhanced.

A. Industrial Energy Conservation. An analysis of the Department of Energy's industrial energy conservation activities will seek to answer a number of questions: What role does industrial energy conservation play in the Administration's National Energy Strategy (NES)? Why does the NES highlight industrial waste reduction in the Industrial Energy Use chapter? What are independent estimates of potential energy savings in the industrial sector? What contribution can increased efficiency make to the competitiveness of U.S. industry? Links between efficiency improvements and pollution prevention will be explored.

B. Pollution Prevention R&D. The passage of the Pollution Prevention Act of 1990 and the anticipated reauthorization of the Resource Conservation and Recovery Act raise numerous questions: Where is EPA targeting its R&D priorities? Do these priorities reflect the passage of the Pollution Prevention Act? Why has DOE placed such an emphasis upon hazardous waste reduction in the NES? What is DOE doing with its waste reduction R&D program? Are these R&D efforts coordinated with EPA? What is the role of waste-to-energy projects in both waste management and energy policy? Are there both hazardous and solid waste reduction issues that should be addressed in the R&D title of RCRA? It is possible that this investigation could lead to a single hearing incorporating the findings of this and the previous entry.

C. Low-Input Agriculture. Both agricultural subsidies and research programs sponsored by USDA encourage the proliferation of large farms which practice monoculture farming and employ chemically intensive techniques. This approach has contributed to the high costs of farming, the demise of small and medium sized farms, and the growing contamination of groundwater supplies. For several years Congress has tried to force USDA to put more resources into the development and promotion of low-input, alternative farming methods less dependent upon intensive use of chemicals and crop specialization and more dependent on post-planting tillage practices. Congress has also encouraged USDA and EPA to cooperate more closely, so that low-input techniques will be taken into account when developing groundwater policies and conducting pesticide reviews. To date, USDA has moved very slowly and reluctantly on low-input farming -- a

3. Oversight of Contractors at Federal Technical Agencies. Because of hiring ceilings, many technical agencies under the Committee's jurisdiction, including NASA, EPA, and DOE, have become increasingly reliant on contractors. The Subcommittee will conduct a series of hearings and investigations on this trend, focused both on the effectiveness of the system in procuring technical products and services and on the ability of the agencies to maintain adequate oversight and accountability for their contractors.

a. For NASA, issues examined will include the effect of recent changes in procurement policies and procedures, GAO studies on cost and schedule overruns in NASA in general and in the Space Station in particular, a recent study by the National Academy of Public Administration on NASA's problems in managing its contractors, and the bias toward "low-bidders" in procurements. Related issues include the ability of technical agencies to attract and retain qualified personnel and the role of independent validation and verification in computer software procurements.

b. For EPA, issues examined will include the use and control of contractors in the formulation and implementation of EPA policies and programs and the emerging scandal of fraud at EPA contract laboratories, whose analyses are used to guide cleanup strategies at CERCLA sites and to support prosecution and claim recovery efforts.

c. The entire DOE complex, most importantly its weapons production facilities and its national laboratories, is managed and operated by private contractors. Historically, these operations have been virtually autonomous, with little management or control exercised by DOE. Moreover, government and agency policies uniformly shielded such contractors from any liability, effectively establishing a situation where there was no accountability or control. The problems associated with such a "least interference" policy have been manifested in a large number of contractor scandals, in addition to numerous management, environmental and safety problems at weapons facilities and national labs. The Subcommittee will be closely monitoring activities at these facilities to ensure that DOE is taking a more direct management role in the operation of its facilities, and that its contractors are adequately performing their assigned duties. The review will also cover DOE reform efforts related to contractor control and accountability, including award fees, indemnification policies, and implementation of Price-Anderson amendments authorizing DOE to levy civil penalties for violation of Department rules.

B. COST ACCOUNTABILITY

1. Superconducting Super Collider. The Subcommittee will hold hearings to investigate several issues related to the SSC: 1) reliability of cost estimates for SSC construction and operations; 2) status of efforts to secure international

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perfect example of the "pollution prevention" approach to environmental protection. The Subcommittee will examine the extent and severity of the threat to groundwater posed by agricultural chemical use; the potential economic and environmental benefits of low-input farming; the barriers to widespread implementation of low-input practices, with an accent on EPA/USDA policies and practices; and potential administrative and legislative initiatives which could eliminate those barriers.

THEME II: SEEKING ACCOUNTABILITY. Government agencies are entrusted with billions of dollars to manage and execute increasingly complex environmental and scientific programs and policies. A critical mission of the Subcommittee is to ensure that the agencies under its jurisdiction are making wise and reasonable use of the limited funds available to address these pressing issues. The Subcommittee will focus on the following inter-related areas: management of specific high-cost scientific projects (such as the SSC and the Space Station) and of environmentally critical projects such as the cleanup of the DOE Weapons complex; management and control of contractors hired to perform critical agency functions and to develop agency policies; and agency policies to ensure contractor accountability.

A. CONTRACTOR ACCOUNTABILITY

1. Nuclear Weapons Clean-Up. Estimates of the costs of correcting the environmental and safety problems at DOE weapons plants, and modernizing the facilities to ensure environmental compliance in the future, range as high as \$150 billion. In recent years DOE Secretary Watkins has initiated a number of programs and organizational changes designed to improve the "culture" at DOE and to effect an efficient and responsible restoration program. To date, the program has made little measurable headway. The Subcommittee will monitor the Department's policies and programs in these areas to identify problems that are obstacles to thorough and timely cleanup and restoration of the weapons complex and to the development of responsible attitudes and practices towards management and safety.

2. Performance/Liability Issues in NASA Contracting. The CHALLENGER accident and the Hubble Space Telescope highlight the lack of exposure for NASA contractors whose products fail to live up to design specifications. NASA is generally incapable of recovering damages unless fraud is proven. The Subcommittee will investigate the incentives and disincentives that NASA has in place to ensure that its contractors deliver products as promised. The investigation will focus on issues raised by the "NASA Quality Assurance and Contracting Reform Act of 1991" (H.R. 672), on GAO's findings with respect to the Morton-Thiokol settlement on CHALLENGER, on the Inspector General's findings on the Hubble contract, on ongoing studies of "award fees" by IG and GAO, and on investigations by the IG into counterfeit electrical parts.

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contributions to the project; 3) technical and management challenges; 4) evaluation of other options for meeting the scientific goals of the SSC, including participation in foreign high-energy physics projects; and 5) effect of SSC funding on other basic fields of science.

2. Space Station. By May of this year, NASA will submit to the Congress its final plan for Space Station redesign. There are a number of critical questions regarding the Station that the Subcommittee may investigate in conjunction with the Space Subcommittee. Is the final design sensible in terms of scientific goals and technological feasibility? Is it a cost-effective expenditure? Have repair time and EVA time been brought under control? Are the cost estimates reliable? Have we honored our international commitments? Has NASA implemented management initiatives as suggested or implied by the Augustine Commission and other observers. What will be done to reduce the bloated management in the program? What is the role if any of advanced launch vehicles in construction of the Station? Are there alternative designs to the Station that should be considered in the short term (e.g., Industrial Space Facility)?

3. Cost Estimations and Cost Controls in NASA. The Augustine Commission found that, by consistently underestimating program costs (e.g., the cost of the Space Station has risen from \$8 billion to \$38 billion in 6 years), NASA is chronically over-committed in terms of the projects that it is pursuing. A related problem is that NASA also tends to grossly underestimate operational program costs. Shuttle operational costs, for example, are eating up huge amounts of resources that might be available for other projects. In response to these problems, the Commission recommended that an independent cost-analysis group be formed within NASA to provide the Administrator with reliable cost estimates. The Subcommittee will examine NASA's implementation of this recommendation, in addition to recent related studies by the RAND Corporation, the Congressional Budget Office, and NASA. In addition, GAO has produced several studies on life-cycle costs of NASA projects and is scheduled to provide the Committee, within the next few weeks, an historical study of Space Station cost estimates.

C. MANAGEMENT ACCOUNTABILITY

1. NSF/Antarctica. Last year, in response to criticism regarding the environmental impact of U.S. operations in Antarctica, the National Science Foundation launched a Special Initiative for Safety, Environment, and Health in Antarctica. The Subcommittee will undertake a critical review of the effectiveness of this and other programs designed to reverse the growing environmental degradation of the ice-bound continent.

2. Waste Isolation Pilot Plant (WIPP). As the nation's first geologic repository for radioactive waste, WIPP will store transuranic waste from weapons programs. DOE has continually billed WIPP as an "R&D" facility, insisting that a decision on

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whether to utilize the facility as a permanent repository will only occur after a five-year testing program. Since 1988, DOE has tried to obtain Congressional authorization to withdraw the land from public use and emplace waste in the facility. However, the project has been plagued by a series of management, technical and scientific difficulties. DOE has been unable to prove that the in-situ tests it wants to conduct will yield data that will be helpful in making a determination on the facility's compliance with EPA radiation protection standards. It has been unable to justify the need for the vast quantities of waste it has proposed to use for its "experimental program". The project management has had difficulty complying with the Department's own Safety Analysis Report requirements to verify that the facility's design is sound and that the construction was carried out as planned. There are questions about compliance with RCRA standards governing land disposal of mixed wastes, and EPA's resolve in enforcing those standards against DOE. WIPP undermines DOE claims that it has sufficiently changed its management style and approach to environmental and safety compliance. The Subcommittee will closely monitor this project to ensure that DOE complies with all regulations and internal requirements before WIPP is allowed to be opened.

THEME III: GOVERNMENT IN THE ENERGY MARKETPLACE. Two-thirds of U.S. petroleum consumption occurs in the transportation sector, while only five percent of oil consumption occurs in the generation of electricity. What federal R&D activities will result in displacing petroleum in the fastest, cheapest, and cleanest manner possible? If increased electrical capacity is in fact required, what federal R&D activities will encourage the most cost-effective and clean technologies to meet demand?

A. New Electric Technologies. Brown-outs are forecast for parts of the U.S. by the end of this decade. What technologies offer the best hope of meeting demand at the lowest economic and environmental costs? What contribution can increased efficiency make in meeting expected demand? How would electricity demand be affected by the widespread use of electric vehicles? What are the priorities of DOE's R&D programs in the electric supply area? Is nuclear electricity the only near-term option for meeting this demand, as recently asserted by Dr. Bromley? Is the administration's heavy emphasis upon nuclear power dictated by hard-headed analysis of the options or by special interest pressure? Could photovoltaics reach the commercial market place sooner than the administration predicts if given additional R&D support?

B. Electric Vehicles R&D. Clean-air requirements and the national debate over energy strategies have highlighted the need for cost-effective electric vehicles. What is the short-term and long-term potential for electric vehicles to displace petroleum in the transportation sector? What progress has been made in

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developing promising alternatives to lead-acid batteries? Can government and industry research be effectively coordinated? How is U.S. industry positioned to capture export markets?

C. Energy Forecasting and Policy. Policy makers rely upon forecasts of future energy requirements to establish federal energy R&D priorities. How accurate have these forecasts been over the past 20 years? What is the range of forecasts for the next 40 years? Do these forecasts determine policy, and do desired policy directions influence the forecasts?

D. Uranium Enrichment. The administration and Congressional initiatives propose to restructure the U.S. Uranium Enrichment Enterprise (UEE) in an attempt to make it competitive in the world market. The success of such an effort will be determined by a number of factors: cost; development and implementation of Avlis technology; capacity; and future demand. The subcommittee will carefully review the status of and progress made on each of these factors.

E. Synfuels. The Synthetic Fuels Corporation ceased to exist on April 16, 1986. A multi-billion dollar effort to create a commercial industry from scratch ended a dismal failure. This is the perfect example of how not to displace petroleum use. Five years later, what is the status of the handful of projects funded by the SFC? What has happened to the Great Plains and Dowsyn projects? What is the current status of oil shale development? As we consider a new National Energy Strategy, what lessons can be learned from the SFC fiasco?

THEME IV: THE ROLE OF SCIENCE IN THE REGULATORY PROCESS.
"Policy-for-Science" refers to policies and activities that affect the way the scientific enterprise is conducted. An equally important, and often neglected, realm is "science-for-policy", which refers to the ways in which scientific findings and processes are used or abused in the formulation of policy. In a series of hearings, the Subcommittee will examine the interaction of science, economics, and politics in the formulation of public policy.

A. Electromagnetic Fields (EMF). Concern has grown that magnetic fields generated by electrical power lines and appliances may be related to cases of childhood leukemia and cancer in utility workers. In a series of joint hearings with the Environment Subcommittee, the Subcommittee will review current research to determine the level of consensus in the scientific community (including the recent EPA report on EMF and cancer) and will examine the future program of research needed to clarify health effects from exposure to these fields. The hearings will include discussion of research funded by the Electric Power Research Institute and of mitigation techniques.

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B. Global Change. The "Global Change Research Act of 1990", an initiative of the Committee, created an interagency U.S. global change research effort and pointed toward the development of effective international linkages in research and in technology transfer. Oversight of the U.S. research program should be undertaken, especially in light of criticisms that land and ocean studies are being squeezed out in favor of the \$17 billion space-based Earth Observing System (EOS). While EOS will no doubt produce interesting science, the project is very vulnerable to launch and mission failures and will require an as-yet unproven data management system to be effective. EOS should receive the same level of intense oversight as other "mega-projects" like the Space Station and the SSC. In addition to these research management issues, the linkages between scientific consensus and the U.S. position in international negotiations on climate change should be examined.

C. USGS/Groundwater. The USGS is the repository of expertise and information on geology and hydrology in the U.S. Government. Despite this position, and the resources provided to it each year, the USGS has historically not been used as a source of expertise and advice for the development of policies and regulations to protect groundwater supplies in the U.S. - an increasingly important task. The Subcommittee will review the mission and activities of the USGS to determine if the resources of this agency are being utilized in the most efficient manner.

THEME V: SCIENCE, TECHNOLOGY, AND INTERNATIONAL COMPETITIVENESS.
As competition in the international marketplace intensifies (particularly in high-technology areas), there has been a growing appreciation of the importance of science and technology to national competitiveness. A critical factor in competitiveness is the close cooperation between the Federal government, State and local governments, and industry in formulating and implementing effective policies. The Subcommittee will conduct a series of hearings examining the effectiveness of these linkages.

A. Science Education. The subcommittee will explore ways to strengthen science education in America. Special attention will be given to problems facing historically black colleges and universities.

B. Technology Transfer

1. Technology Extension Programs in manufacturing and energy efficiency. Hearings will be held to examine the performance and promise of the extension program approach in the areas of manufacturing technology and industrial energy efficiency. An "extension service" approach promises to be an effective way for the federal government to assist small and medium-sized firms in getting access to expert advice and exposure to the most modern technologies.

2. State Technology Transfer Programs. The Subcommittee will hold hearings on technology transfer efforts by the states, examining both the range of state programs and how states view Federal support -- i.e. what does the federal government do well and what might be done better? How can the federal government shape its emerging technology transfer programs in ways that are responsive and supportive of state efforts?

3. Protecting the federal government's investment in R&D at national labs. The Subcommittee will focus on federal policies and practices governing the transfer of technologies developed at government labs, to ensure that the public's interests and investments are protected and that the potential for conflicts of interest in the direction of future research is eliminated.

C. SEMATECH. Five years ago, Congress authorized the expenditure of \$500 million to support a government-industry consortium intended to regain U.S. leadership in semiconductor manufacturing. At the Committee's request, GAO is investigating SEMATECH's progress toward achieving the goals established in 1987, with a final report to be delivered in September. Since SEMATECH could be a model for further cooperation in improving industrial competitiveness, the Subcommittee should evaluate the consortium's success and identify lessons which might be applied to similar efforts in the future.

D. The Relation between Federally Funded Military and Civilian R&D. Hearings may be held to examine: the appropriateness of the balance between military and civilian R&D; the effect of both this balance and of DOD dual-use programs in promoting U.S. competitiveness; budget cuts at DARPA; and the implementation of DOD's environmental R&D initiatives.

E. Export of Renewable Energy Technologies. The Committee on Renewable Energy Commerce and Trade (CORECT) was established under P.L. 98-370 "to assist the U.S. renewable energy industry in developing international markets and to improve the coordination of Federal agency programs relating to industry marketing efforts". Yet overall, the collective efforts of the U.S. government can only be characterized as piecemeal. Successes in funding and exporting projects which are alternatives to fossil fuels are rare, and the global market share of U.S. companies in the renewables market is dwindling. The Subcommittee could convene hearings, in conjunction with the Environment or Technology Subcommittees, to assess renewables exports in general and CORECT in particular. The Subcommittees should consider: 1) how scattered successes in renewables could be leveraged into a comprehensive program of greater scope and impact; 2) policies that might bring about a quantum leap in the number of successful projects initiated by CORECT; and 3) new opportunities for government-industry joint ventures in the area of renewable energy.

F. Internationalization of the Aerospace Industry. The Committee held hearings in the 101st Congress on the proposal to

codevelop a next-generation fighter aircraft with Japan (FSX). Congress later passed a joint resolution disapproving the program on the grounds that the balance in transferred technologies was unfavorable to the United States. President Bush vetoed the resolution. Although commercial aircraft represents one of the few areas where the United States maintains clear competitive advantages in the international economy, U.S. airframe and engine manufacturers are forging closer ties with foreign firms due to the rising costs of development and to the need to protect foreign markets. The Subcommittee should examine Boeing/Japanese cooperation in the 777 and 7J7 development, the agreement between McDonnell-Douglas and Samsung in the Korean Fighter Program, and the dispute between the United States and the European Community involving subsidies to the Airbus consortium, to assure that commercial firms are not seeking short-term advantages at the expense of long-term U.S. economic security.

VI: MISCELLANEOUS ISSUES

Great Lakes Issues. Hearing issues could include: 1) oversight of technology development required for cleaning up contaminated sediments in the Great Lakes, with an emphasis on cleanup costs and amelioration of human health risks; 2) oversight of ecosystem research and control technologies related to exotic species unintentionally released into the Great Lakes (zebra mussel, spiny water flea, and ten others).

Scientific Misconduct. The Subcommittee should continue and enhance its involvement in the issue of scientific misconduct. This involves reviewing NIH and NSF guidelines for investigating misconduct as well as examining legislative solutions to problems related to institution's monitoring of and investigations into scientific misconduct.

Miscellaneous Space Issues. The Subcommittee could examine a number of space issues, including: 1) need for the space nuclear program, including a review of the recent purchase by DOE of a Soviet space reactor; 2) Space Shuttle issues, including safety, reliability, component fatigue (e.g., the current problem with cracks in fuel line door hinges), operational costs, and the status of "civilians in space"; and 3) the future of the Landsat program.

Aircraft Flight Management Systems. Northwest Airlines is the first U.S. airline to operate the Airbus A-320, a twinjet with new computer-controlled "fly-by-wire" technology. America West is preparing to introduce the A-320 on some of its routes. Some in the computer science community question the safety of these systems, since failure of the digital computers might disconnect the pilot from the aircraft's control surfaces and rudder. American Airlines is not satisfied with the performance of the new McDonnell-Douglas MD-11 it is now testing for certification.

10

Aircraft manufacturers are applying computers in "glass cockpits" and "fly-by-wire" to assist pilots as airlines reduce crew sizes to save money. Have the airlines considered the "human factors" involved as pilots become passive monitors in the cockpit? Does the FAA certification process for commercial aircraft adequately address the new technologies? Are FAA inspectors ready to deal with next-generation aircraft? The Subcommittee staff is working with GAO to design studies of these questions.

[3/14/91]

SCIENCE

Proponents of Technology R&D Emphasize Competitiveness

The U.S. must look to commercial applications to keep its edge, industry groups contend

Americans felt proud of the country's technological prowess when Patriot missiles started shooting down deadly Iraqi Scuds. They may not be so pleased to know that, if those Patriots were built today, defense contractors would likely rely on computer parts made in Japan.

The vaunted Patriot technology not only represents the United States' military and scientific expertise but symbolizes the country's widening technology gap.

Driven by this concern, a formidable array of interest groups — ranging from aerospace and computer-chip manufacturers to tool- and die-makers — are seeking to reframe the national debate on technology development. They have latched onto a competitiveness slogan that puts virtually every issue in terms of whether it helps the United States compete in the world economy.

"Electronics is the crude oil of the information age," says Michael Maibach, a lobbyist for Intel Corp., the U.S. company that made computer parts for the Patriot. "Mr. Bush is not going to be able to fight another gulf war unless he and this country face up to the fact that we need commercial goals, and certain technologies are critical."

Indeed, some industry representatives would like the federal government to do for competitiveness what the Sierra Club did for environmental issues in the 1970s: make it part of every policy debate. Some go so far as to say that Congress should require a "competitiveness impact statement" on all new legislation.

"The single most important thing Congress needs to do when it is making law is put on a pair of competitiveness glasses and think about how it will effect the long-term economic health of the country," says Kent

By Alissa J. Rubin

West Germany 15.3%

France
10.6%

Britain
8.7%

Japan
4.8%

U.S.
0.2%

PATT CHISHOLM

Share of R&D spending on industrial development of new technologies (1987), according to the Organization for Economic Cooperation and Development.

Hughes, president of the Council on Competitiveness, a Washington-based think tank that was an outgrowth of the Reagan administration's Commission on Industrial Competitiveness.

Administration Interest

Many members of Congress — Democrats in particular — are also worried about the nation's ebbing technological edge. Surprisingly, it now appears that even the Republican Bush administration is acknowledging the need for the government to do something about it — up to a point.

Last September, the White House issued a white paper on technology policy and followed it with fiscal 1992 spending proposals that would take the first steps toward allowing the government to chart the course of

technology development.

The administration proposed spending \$150 million to develop a way to link the nation's largest computers, which is supposed to help the United States maintain its international leadership in high-speed computer technology. It also recommended a \$36 million budget for the Advanced Technology Program — three times the level President Bush requested last year for the Commerce Department program that invests in embryonic high-technology projects.

These proposals are modest in comparison with the multibillion-dollar subsidies that Japan, West Germany and many other Western European countries spend on technology and product development.

But they represent a dramatic shift in the administration's thinking. Throughout the 1980s, the Reagan administration dismissed any subsidy of non-defense industry as blatant government interference in the workings of the free market. If government were to encourage some sectors of industry and discourage others, the thinking went, it would be "picking winners and losers" among specific products, which Reagan officials viewed as a step down the socialist road to state-run industries.

The Bush administration's willingness to temper the Reagan team's staunch opposition is an important first step, say industry groups. They also believe such positive signals from the White House could encourage Congress to push the administration even further toward promoting the technology aspects of science research and development.

"We've been getting soundings from both Democrats and Republicans that the white paper is a starting point for talking about the competitiveness issue," says Fred Nichols, who represents the recently formed National Coalition for Advanced Manufacturing.

The growing cottage industry of lobbyists carrying the competitiveness banner has amazed even those who have been familiar with the issue in Congress.

The lobby includes think tanks and other public-education organizations, including the Council on Competitiveness and such venerable business lobbies as the Electronic Industries Association, the National Association of Manufacturers and the Aerospace Industries Association.

Also on board are a new spate of manufacturing and computer consortia, including the National Coalition for Advanced Manufacturing and the Computer Systems Policy Project.

"They just keep popping up," said one House Science Committee staff member. "We can't schedule all the meetings they want. Every time you turn around, there's another coalition on the coalition on the council on competitiveness."

Finding the Money

Nowhere is the competitiveness question likely to draw more heat than over the funding for existing technology-development programs.

According to industry experts and their congressional allies, these programs have the potential to turn technological advances into money-making commercial ventures.

In federal policy-making, that emphasis on applied technology has always been a poor step-child to pure scientific research.

Yet experts generally agree that finding ways to apply the country's technological expertise is central to enabling the United States to retain its share of the world market in computers, electronics, car manufacturing and pharmaceuticals. "We need to turn this juggernaut of our science programs into useful, marketable products," says Rep. Don Ritter, R-Pa.

One obvious source of government funding for such efforts is the \$76 billion slated in fiscal 1992 for various research and development projects. That money is now spent almost exclusively on basic science and space programs; more than half (\$43 billion) is spent on defense-related science re-

Technology Development

Programs in the federal government's \$71 billion R&D budget that fund research with commercial applications (In millions of dollars):

Program	Fiscal 1991 Funding
Commerce Department	
National Institute for Standards and Technology (NIST)	
Advanced Technology Programs	\$ 36
Manufacturing technology centers	10
State technical extension program	1.3
Defense Department	
Defense Advanced Research Projects Agency	
Dual-use technologies	307
Energy Department	
Vehicle/highway system technology	162
Advanced electricity technology	245
Multi-agency	
High-speed computer technology	489

search.

But dipping into that pot would mean taking money from politically entrenched programs, including NASA and the superconducting super collider, the Energy Department's project to build the world's largest atom-smasher. It would also mean modifying somewhat the spending priorities at the Defense Advanced Research Projects Agency (DARPA), the Pentagon office that helps innovative defense technology projects get off the ground.

Looming as large obstacles to such priority rearrangements are the already huge investments the federal government has made in the \$20 billion-plus space station and the \$8.3 billion super collider. "The most serious problem we have will be reconfiguring those big science projects," says Rep. George E. Brown Jr., D-Calif., chairman of the House Science, Space and Technology Committee.

The other serious problem Congress faces is its lack of a convenient legislative vehicle to make broad changes. It is difficult if not impossible to make tradeoffs among science programs when there is no single science authorization or appropriations bill.

For example, if the Appropriations subcommittee in charge of NASA decided to reduce space station funding to free funds for the Commerce Department's Advanced Technology Program, there is no guarantee the money would go to the ATP, which another subcommittee handles

through a separate spending bill.

"We don't have the capability to shift priorities in the R&D budget," says Brown. "We have to weigh science projects against non-science programs, and we cannot make tradeoffs between military R&D and civilian R&D."

Given these potential obstacles, industry lobbyists and members of Congress expect that action on the competitiveness front this year will focus on funding for programs run by NASA and by the Commerce, Defense and Energy departments.

Commerce Department

The Commerce Department administers the only federal agency, the National Institute of Standards and Technology (NIST), whose primary mission is supporting industry's technology development.

NIST's proposed budget for fiscal 1992 is \$248 million.

Within that agency, ATP is the most focused on helping industry develop technologies. It is currently funded at \$36 million.

As authorized by the Omnibus Trade Act of 1988 and funded for the first time in 1990, ATP funds "pre-competitive technologies" that can be applied to an array of products being developed by different companies.

"If the ATP program had been around in the 1950s, it would have funded research on technology like the integrated circuit," says George Uriano, the program's director. Integrated circuits are now a fixture in thousands of products, "from watches to computers to thermostats to fax machines," he says.

So far, the program appears to be wildly popular with industry. In 1990, when it was funded at \$10 million, the agency received 249 grant requests totaling \$120 million.

Last year, both chambers passed bills calling for ATP funding of up to \$100 million in fiscal 1991, and House-Senate negotiators tentatively agreed to increase funding to \$200 million in fiscal 1992. The bill got caught in the legislative gridlock at year's end and did not make it through, but there are plans in both chambers to reintroduce it this year. (1990 Weekly Report, p. 3697)

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From the Academic Perspective:

A Good Budget for Science, But Troubles Lie Ahead

Robert M. Rosenzweig, President since 1983 of the Washington-based lobby for major research universities, the 56-member Association of American Universities, is among the capital's most seasoned participants in science-and-government politics. A political scientist, he was Vice President for Public Affairs at Stanford University from 1974-83 and is the author of *Research Universities and Their Patrons* (University of California Press, 1982) and many scholarly articles. Rosenzweig spoke with SGR Editor Greenberg on November 5, a week after Congress adjourned from its long budget turmoil. Following is the text, transcribed and edited by SGR.

SGR. Congress was pretty good to the research agencies.

Rosenzweig. We got the peace dividend. It shows up in education, in NIH, in NSF to a slightly lesser degree. It showed up in Medicare and Medicaid.

SGR. After many gloomy forecasts.

Rosenzweig. But from now on, if Congress is serious about what it says, and that's a big qualification, we're talking about three to five years of inflation

An Overview of Budget Shifts—P.4 Science Booster Loses Election—P.6

increases—essentially no real growth in budgets.

SGR. That's not the worst possibility.

Rosenzweig. True. But there are a couple of things that worry me a lot. One is the extent to which, particularly at NSF but elsewhere, too, there are systematic attempts being made to leverage federal dollars by getting more institutional dollars or state or business [support], or whatever. One of the messages of the fight over the Magnet Lab [awarded to Florida State University in a decision protested by MIT] is that, maybe, there's a lot more leveraging out there that they intend to get. In this case, it was [Florida] state money. That's a message that scares some places—mostly private institutions and public institutions in states that aren't very well off. Another thing that concerns me much more is the dynamic that seems to be set up by the next three to five years of budget problems. We're going to be fighting among ourselves a lot—universities and elements within universities, and universities and kindergarten through 12th grade. The domestic discretionary [budget] pool [established by the last

(Continued on Page 2)

On the Science-Policy Circuit Federal Role in Technology Is Becoming the Hot Issue

The trendy sci-tech issue of the moment in post-Cold War Washington is how the federal government can promote the extraction of riches from industrial research. Whether it actually can is the object of strong doubts, especially at the White House. Nonetheless, the task of finding out is shaping up as one of the capital's growth industries.

The signs are to be seen in money voted by the last Congress and also on the science-advisory circuit, sometimes a seedbed for ideas that eventually spread to political circles, and at other times, a fount of stillborn recommendations. The latest creation in this sector of the advisory scene

(Continued on Page 5)

In Brief

Junket Time: Visits to Australia and New Zealand, November 8-23, are on the agenda of the House Science, Space, and Technology Committee, with Chairman Robert Roe (D-NJ) leading the delegation. In a Committee press release, Roe explains: "We are long past the time when science and technology issues were domestic affairs."

W. Glenn Campbell, ex-chief of the Hoover Institution, has safely made it to the National Science Board after weaseling away from a newspaper report quoting him as saying, "Frankly, I would eliminate social sciences if I had the power to do it." Challenged by Chairman Edward Kennedy, whose Senate Labor and Human Resources Committee has jurisdiction over the nomination, Campbell didn't deny he said it. But in a response to Kennedy's written questions, he stated, "I do not believe that the social sciences should be eliminated from the scientific disciplines the National Science Foundation should support."

An open meeting on "Conflicts of Interest in Clinical Evaluation of Commercial Products" will be held by the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration, November 30 on the NIH Bethesda, Md., campus. An announcement discreetly notes that "Conflict of interest issues have arisen" from government-supported investigators testing drugs in which they have financial interests. For meeting registration: Ms. Bonnie Kaps, 301/402-0854.

The Gallo camp insists that with the elimination of some issues, their man has in effect been cleared of suspicions that he filched the identification of the AIDS virus (SGR, October 15). But NIH officials reply that the case is far from over. Meanwhile, Rep. John Dingell's staff is following the inquiry with acute interest.

... Study of Federal Role Mandated by Congress

(Continued from Page 1)

is an academic-industrial heavyweight Panel on the Government Role in Civilian Technology, homebased at the National Academy of Sciences. The Chairman is the well-credentialed Harold Brown, Secretary of Defense under Jimmy Carter, former President of Caltech, and currently Chairman of the Foreign Policy Institute at the Johns Hopkins School of Advanced International Studies. Serving with him are 14 members, senior figures mainly from academe and industry (see box).

The creation of the Panel and its placement at the Academy was a Congressional initiative written into the 1988 trade bill. But what with rounding up financial support and assembling a membership, the first meeting wasn't held until October 12-13. Support of some \$500,000 has been provided by the National Institute of Standards and Technology, the Department of Energy, NASA, and NSF.

According to an announcement from the Academy, the panel will report to the Congress and Secretary of Commerce in the fall of 1991. Topics to be addressed are:

- The virtues of the SEMATECH consortium model for "bolstering the comparative advantage of US firms in international competition."
- The industrial-research policies and practices of other countries.
- The eternal question of whether industrial technology would benefit from a civilian version of the Defense Advanced Research Projects Agency.
- The effectiveness of various federal programs to transfer technology from national laboratories to civilian industry.
- "The broad impact of cultural, economic, educational, and corporate management practices on R&D and technology commercialization efforts."

Meanwhile, Congressional Democrats, eager to get on with what the Bush-Sununu free-enterprisers disparage as "industrial policy," are not waiting upon the completion of scholarly studies. Instead, they're pumping substantial funds into several of their Reagan-era creations that have languished under presidential policies of malign neglect.

One of these, the Advanced Technology Program (ATP) at the National Institute for Standards and Technology (NIST), has been funded for this year at \$36 million rather than the \$10 million sought by the White House. With a still-unspent \$9 million kitty from last year's appropriation, ATP's first application period ended on September 24 with 249 applications, averaging \$500,000 each.

Ignored by Reagan, the program has been accorded a minimal tolerance by the Bush Administration. But its managers are ever-mindful of their political bosses' frequent declamations against government trying to "pick winners" in technology—a task that Bush and company deem beyond the powers of federal employees. Instead, ATP is intended to assist with research on "precompetitive,

Technology Panel Members

In addition to Chairman Harold Brown, members of the National Academy of Sciences Panel on the Government Role in Civilian Technology are:

John Armstrong, Vice President for Technology, IBM

C. Fred Bergsten, Director, Institute for International Economics, Washington, DC

William F. Brinkman, Executive Director for Research, Physics Division, AT&T Bell Labs

Dennis Chamot, Executive Assistant to the President, AFL-CIO Department for Professional Employees

Richard Cooper, Professor of Economics, Harvard
John Deutch, Professor of Chemistry, former Provost, MIT

Kenneth Flamm, Senior Fellow in Foreign Policy Studies, Brookings Institution

Edward A. Frieman, Director, Scripps Institution of Oceanography

Paul MacAvoy, Associate Professor, UC California, Berkeley, Haas School of Business

William J. Perry, CEO, Technology Strategies and Alliances, Menlo Park, Calif., former Under Secretary of Defense for Research and Engineering

James Brian Quinn, Professor of Business, Dartmouth College

Harry B. Schacht, CEO, Cummins Engine, Columbus, Indiana

Hubert Schoemaker, Chairman, Centocor, Malvern, Pa., and alternate, Harvey J. Berger, President, Research Division, Centocor.

Serving as Project Director is John S. Wilson, formerly with the Committee for Economic Development and the Congressional Office of Technology Assessment.

generic technologies," which presumably can benefit many firms.

While adding money for the ATP grant program at NIST, Congress also added additional funds for NIST's internal operations. The President sought \$198 million for NIST, an increase of \$34 million over last year's figure. Congress pushed the increase to \$51 million, for a record total of \$215 million for the NIST. Of that increase, \$14 million was earmarked for particular programs, mostly in highly active fields of industrial technology, such as semiconductors, materials processing, composites, and superconductivity.

The Bush White House is deep in consultations over how to revive his politically marred image and sinking fortunes.

(Continued on Page 6)

Surprise Loss for Science-Booster Doug Walgren

The science-affairs contingent on Capitol Hill came through the election unscathed—with one unanticipated exception, Rep. Doug Walgren, a Pittsburgh, Pa., Democrat who had been one of the most active members of the Science, Space, and Technology Committee. A fellow committee member who was considered to be in serious danger of defeat, Rep. George Brown (D-Calif.), won by a comfortable margin.

Never seriously challenged since he left law practice and was elected to Congress in 1976, Walgren lost to an aggressive opponent, Rick Santorum, by 80,764 to 85,251. Observers of the campaign say the outcome was determined in the final days by Santorum's vigorous anti-incumbent theme. Among other things, he accused Walgren of infrequent visits to the home district, a charge that has been the undoing of other long-seated members.

Walgren's home in affluent Potomac, Md., a suburb of Washington, was featured on TV ads as evidence that he had strayed from the home folks. Walgren was also accused of trying to boost the National Science Foundation budget above the President's request, and his wife's one-time employment with a high-powered Washington lobbying firm, Cassidy and Associates, was also introduced as something unseemly.

Starting in 1981, Walgren chaired the Subcommittee on Science, Research, and Technology, holding that post until last February, when he took the chairmanship of the Energy and Commerce Subcommittee on Commerce, Consumer Protection, and Competitiveness. The new post carried more political swat and was a move upward in House hierarchy. But Walgren retained an active membership on the Science Subcommittee, regularly participating in hearings that often drew very few of his colleagues.

Among his recent legislative achievements was the Science Scholarship Bill, which provides \$5000 college scholarships for one male and one female student in each Congressional district. He was also a leading sponsor of the newly enacted Hotel, Motel, and Fire Safety Act.

Walgren's Congressional experience shows again that

Technology Policy

(Continued from Page 5)

In industrial technology, as with most matters, the President has no heartfelt feelings. His Rasputin, Sununu, is an anti-industrial policy believer of deep faith. But many of the wounds that the President suffered in the last session of Congress are attributed to the ignorance and arrogance of his Chief of Staff, a PhD engineer with unshakable belief in his own wisdom. Reports circulate that with his halo tarnished, Sununu's influence has peaked, and that his tenure may not be invincible. If he goes, or suffers a reduction of power, the White House restraints on "industrial policy" are bound to be loosened.—DSG

support of science on Capitol Hill is more a matter of faith and conviction than political advantage. No scientific organizations are out there hustling campaign money for supportive members of Congress. George Brown, who preceded Walgren as Chairman of the Science Subcommittee, once commented to SGR that scientists display a great deal of interest in Congress, except at election time. It is doubtful that many scientists who benefited from Walgren's unflinching support for NSF knew of his existence.

Social Sciences Gain Attention

The social and behavioral sciences are making progress in another round of their eternal quest for the recognition that they earnestly feel has been denied them by Washington's granting agencies.

At the National Science Foundation, the object is a directorate of their own, rather than continued submersion within the Directorate for Biological, Behavioral, and Social Sciences (SGR, October 1). The Directorate had a budget last year of \$293 million, of which \$48 million is for "behavioral and neural sciences" and \$33 million for "social and economic sciences." The Directorate issue is under review by a task force at the Foundation.

Meanwhile, especially strong statements in support of the behavioral approach to health care are present in the report accompanying the Senate appropriations bill for the National Institutes of Health. Under the heading "Health and Behavior," the report states, "The Committee notes that extensive information, gained over the past three decades from epidemiological studies and clinical trials, indicates the importance of behavior and lifestyle in placing an individual at risk for cardiovascular, lung, and blood disorders."

Without specifying particular sums, the report adds, in reference to the National Heart, Lung and Blood Institute, that "Increased funding is included to support research on preventing unhealthy behaviors, assessing the health effects of changes in behavior, and disseminating validated findings to health professionals and the public." The report continues: "The Committee expects the Institute to begin planning to increase these and other health and behavior research and education efforts especially in the following areas: myocardial ischemia, smoking and body weight, risk reduction in children and minorities, stress and lipid metabolism, nonpharmacologic interventions, and interactions between stress and exercise."

Similar tasks are assigned to other parts of NIH. The National Institute of Child Health and Human Development, for example, is directed to undertake research "to expand our understanding of why some children, particularly adolescents, engage in risk-taking behavior, resulting in accidents that cause personal injury, or leading to drug or alcohol abuse or to unwise sexual behavior."

OFFICE OF CABINET AFFAIRS STAFFING MEMORANDUM

Date: 3-21-91

Due by: 4:00 Friday March 29

Subject: OMB Clearance: OSTP Report on 5 year outlook on

From: Haley Williamson Science + Tech.

	ACTION	CONCUR	FYI		ACTION	CONCUR	FYI
HOLIDAY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FITZHENRY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DANZANSKY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MCMUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ADAIR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PORTER	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BUCHHOLZ	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SCHALL	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
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GUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HEIMBACH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JACKSON	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

Please review & provide
 comments to me by 4:00
 on Friday March 29. Thanks

03/21/91 12:05 OMB LRD/ESGG 001
**EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
Washington, D.C. 20503**

MAR 20 1991

LEGISLATIVE REFERRAL MEMORANDUM

23 pages
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LRM #M-126

TO: Legislative Liaison Officer:

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NSF - Charles H. Herz - 357-9435 - 248

**SUBJECT: OSTP Proposed Report on Five Year Outlook on
Science and Technology**

Chapter 8 -- "Funding Research Facilities"

DEADLINE: Friday MAR 29 1991

The Office of Management and Budget requests the views of your agency on the above subject before advising on its relationship to the program of the President, in accordance with OMB Circular A-19.

Questions should be referred to Norine Noonan (395-3534).

James J. Jukes
JAMES J. JUKES (for)
Assistant Director for
Legislative Reference

CC:

Connie Bowers
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CHAPTER 8

FUNDING RESEARCH FACILITIES

Research in science and engineering requires laboratories, sophisticated instruments and equipment, and computing facilities. These in turn require appropriately-designed buildings to house them. Thus a concern for the nation's ability to expand the frontiers of knowledge and to remain competitive in science and technology with other nations requires ultimately a concern for bricks and mortar--for expanding and renewing the nation's research facilities.

Historically, academic institutions have performed more than half of all basic research conducted in the United States, and they also have the fundamental responsibility for training the nation's future scientists and engineers. In the period after Sputnik, in the 1960's and early 1970's, the Federal government contributed substantially to building the nation's academic research capacity. But these programs were phased out and other sources of funding have also been constrained, while the need has grown in parallel with the size and sophistication of the nation's research effort. As a result, the nation's universities have deferred many capital expenditures and have been unable to modernize and expand research facilities rapidly enough. Surveys indicate that a significant portion of U.S. academic research facilities have deteriorated and that colleges and universities face an estimated \$12 billion

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backlog in repairs and new construction for these facilities.

Concerns emanating from Congress and the academic community about the increasingly critical shortage of modern research facilities in universities and colleges led to extensive hearings during the 1980's in both the House and the Senate. The Congress mandated systematic data collection to document the magnitude of the problem, and the National Science Foundation conducted full-scale surveys in 1988 and 1990 and reported the results to the Congress. The Congress also passed legislation in 1988 establishing an Academic Research Facilities Modernization Program, intended to provide up to \$0.9 billion over five years for renovation and repair, but so far funded with only \$40 million over two years.

A second Congressional response to the growing backlog of repair and renovation projects and the need for new high-tech facilities has been an increasing--and controversial--trend to earmark Federal funds for specific facilities and specific institutions. While earmarking is a well-entrenched practice in many areas of government spending, its application to the funding of academic research facilities is a relatively new phenomenon, beginning in the early 1980's.

Earmarking is the practice of funding research facilities, instruments, or projects which have not been subjected to peer review and are not competitively awarded. It has been controversial both within the scientific community, where it violates established practices of expert review of technical merit, and within the Congress, because earmarks often stem from actions by

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appropriations committee that bypass the authorizing committees. Additional concerns are that the practice may waste scarce national resources and can disrupt agency budgeting and force inefficient reallocation of resources.

Of particular concern is the perception that the practice of earmarking is growing rapidly. In fiscal years 1980-1989, over 300 earmarks for academic facilities and projects totalling more than \$900 million have been identified--an average rate of \$90 million per year. In the FY 1991 budget, academic earmarks accounted for at least \$270 million and perhaps as much as \$348 million. In addition, research and development earmarks for non-academic institutions totalled an estimated \$460 million. At this rate of growth, the practice may rapidly become a serious threat to the peer review process itself as well as a significant constraint on the research activities of several agencies. At the same time, the amounts of funds appropriated through earmarking do not substantially reduce the backlog of research facilities needs.

OVERVIEW OF RESEARCH FACILITIES

In 1990, according to the most recent study by the National Science Foundation, 116 million square feet was allocated to research use at the nation's universities and colleges. Research facilities amounted to 40 percent of all space used for science and engineering in these institutions. Seventy percent of this research space was located at the 100 largest research-performing institutions and more than 85 percent was concentrated in five

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major fields: biological, medical, agricultural, and physical sciences, and engineering.

The quality of existing research facilities varied. Institutions reported in 1990 that 26 percent of their total research space was "suitable for use in the most highly developed and scientifically sophisticated research in its field." Another 35 percent of space was reported to be "effective for most purposes...." At same time, 39 percent was reported to be in need of repair and renovation (Figure 1).

Over the four-year period 1986-1989, institutions spent a \$4.5 billion to construct new research facilities and \$1.9 billion to repair and upgrade research space. Facilities spending was heavily concentrated in medical, biological, physical sciences, and engineering fields. Over this same period, public universities and colleges acquired nearly half of their funding for facilities construction and renovation from state and local government sources. Private institutions relied mainly on private donations, institutional funds, and debt financing. The Federal government provided only 11 percent of total direct funding for facilities at private institutions and 8 percent at public institutions. Direct Federal funds for new construction and for repair and renovation projects at academic institutions more than doubled during 1986-1989.

Facilities Needs

In 1986, the White House Science Council Panel on the Health of U.S. Colleges and Universities issued the Packard-Bromley report,

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which called for a 10-year, \$10 billion program to renovate and construct scientific research facilities. The report suggested that \$5 billion should come from the Federal government and the other half from non-Federal sources. Later studies have confirmed a growing backlog of facilities modernization and new construction needs.

In 1988, the National Science Foundation estimated that universities needed \$11.6 billion in research facilities improvements but planned to spend only \$3.0 billion over the 1988-1989 period. By 1990, the gap had widened: \$15.6 billion in research facilities needs compared with planned spending of about \$3.6 billion for the 1990-1991 period, leaving a \$12 billion backlog. Thus for every \$1.00 of new facilities construction or renovation that institutions planned for 1990-1991, they deferred an additional \$3.00 in needed construction spending and \$4.00 in needed repairs.

Academic research institutions ascribe the growing deficit in research facilities to a variety of factors, including:

- * the accelerating pace of scientific progress and the increasing development of new, more powerful instruments;
- * the high cost of specialized research facilities;
- * the impact of regulatory, technical, and other requirements on building standards;
- * the cost of upgrading older buildings and facilities, many of which are structurally inflexible and obsolete to the point where it may be neither cost effective nor possible to renovate

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them to meet today's research needs:

* chronic underfunding due to other priorities.

HISTORICAL PERSPECTIVE

As early as 1956 there were concerns about the condition of academic research facilities and the role of the federal government in providing assistance to improve them. In 1957, a report by the National Science Foundation concluded that the nation's laboratories were deteriorating and that rising college enrollments would place added stress on science laboratory needs. The launching of Sputnik shortly after the report was published served as a catalyst for substantially increased Federal support for facilities. In addition, a 1960 report issued by the President's Science Advisory Committee recommended expanding the research base by increasing the number of high quality research universities.

It was in this climate that a number of programs for construction or renovation of general research facilities were established. Several Federal agencies, including the National Institutes of Health, the National Science Foundation, and the National Aeronautics and Space Administration began sizable programs to expand and enhance research facilities. Most of these programs required cost sharing or matching funds from non-Federal sources. Federal research facility support programs and other initiatives of the 1960's and early 1970's were instrumental in helping to build and strengthen the nation's academic research capacity.

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Many of these facilities programs were phased out in the late 1970's and early 1980's in response to more austere budgets and changing national priorities. During the 1980's, there have been only a few programs for research facilities, mostly aimed at specific medical problems such as AIDS.

An Academic Research Facilities Modernization Program was established by the National Science Foundation Authorization Act of 1988 to "assist in modernizing and revitalizing the nation's research facilities." While this merit-based competitive program was authorized at nearly \$900 million over five years, only \$20 million was appropriated each year for FY 1990 and 1991. The purpose of the program is explicitly repair and renovation, not construction of new facilities. Grants totaling \$39 million to 78 colleges, universities, and nonprofit institutions nationwide were made in early 1991. These grants will be combined with over \$61 million in required matching funds from the institutions themselves, from state and local governments, and from private sources to provide over \$100 million in total support for projects in 37 states. The National Science Foundation is the only agency with broad research facilities construction authority at this time.

ISSUES IN RESEARCH FACILITIES FUNDING

Two methods have been used to provide federal support for science and engineering research projects, facilities, instruments, or other research-related expenses. The usual method is that of competitive grants requiring merit review, usually by expert

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representatives from the relevant research community; the grants are awarded by Federal agencies based on levels of program funding established by Congress. This form of collaboration among the Congress, the executive agencies, and the science and engineering community emerged from extensive discussion and debate following World War II. It defines an informal social contract under which the government grants to representatives of the scientific community an unusual role in determining the allocation of funds for research activities in return for expert advice on its research investments. The resulting competitive grants are based on published evaluation criteria and reviews by knowledgeable scientists and engineers. Since most competitive grant programs for facilities require a substantial matching commitment, federal funding is leveraged so that other sectors must also determine priorities and bear their fair share of the costs.

A second method for providing support to research facilities or projects is direct Congressional appropriations. Direct Congressional action, or earmarking, is an approach used by a Congressional committee or subcommittee to designate a certain portion of an agency's appropriation for a specific facility or project at a specific institution. Earmarking is a time-honored practice and widely used political tool in other areas, often as a redistributive device that addresses fiscal inequalities and legislative power. It has only recently become prominent as a means of appropriating Federal funds for academic facilities and projects. As applied to research facilities, the earmarking

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approach usually lacks competitive scientific or technical merit reviews or comparative analyses based on need or impact. Substantial matching or cost sharing by the recipient or leveraging of the public funds also may not be required.

Earmarking appears to have accelerated since the early 1980s. There are, however, few sources of academic earmarking information, and longitudinal data of a comprehensive nature do not exist. In many cases, reports cannot characterize the earmarks fully by location, institution, and type of activity. Intentional obfuscation of detail is apparent in some appropriations bills. Therefore, in systematic listings of earmarks, it is very difficult to identify amounts going specifically for academic research facilities. The reports that do exist acknowledge these deficiencies and point out that the total number of earmarks and their dollar value are probably underestimated in the data presented. Still, trends in the magnitude and direction of such earmarks can be ascertained from the few studies that have been completed.

Data from the Congressional Research Service and the University of California show that from FY 1980 through FY 1989, more than \$900 million was earmarked for at least 300 academic facility and research projects in the federal government's appropriations bills. "Identifiable apparent earmarks" rose steadily from just over \$10 million in FY 1980 to \$113 million in 1987, with a doubling to over \$200 million in both 1988 and 1989. Similar earmarks totaled \$132 million in FY 1990 and are estimated

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in a report by the Office of Technology Assessment to be at least \$270 million in FY 1991.

New Study of Direct Congressional Action

A more recent study done for the Office of Science and Technology Policy indicates that in the FY 1991 appropriation process, Congress earmarked a total of \$810 million for R&D items for specific institutions or locations (See Table 1). A total of 492 such earmarks were identified, of which 325 were in Agriculture, 48 in Energy, and 28 in DOD. On the basis of the often meager explanations given, 111 earmarks have been classified as for construction or provision of facilities and 381 for R&D operations. A total of 65 of the earmarks were specified in the appropriations bills; the other 381 appeared in appropriations committee reports only.

Some qualifications should be noted with respect to this analysis. The apparent earmarks identified excludes programmatic earmarks not pointed at particular institutions or locations, earmarks to established federal and national laboratories, earmarks for non-R&D related purposes, and "invisible" earmarks communicated by Congress to the agencies in ways other than the appropriation bills or reports.

The analysis includes earmarks for R&D operations as well as for construction of facilities, earmarks for on-going activities and for new activities specifically authorized by law where the budget recommended no funding, and earmarks where a specific

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institution or location appears to be implied although not named. In cases where the reports do not characterize the earmarks fully by location, institution, and type of activity, judgments have been necessary in classifying them for analysis.

The data available do not support judgments on the merits of the earmarks or on the motivations for the earmarking. Without a case-by-case review with agency or Congressional staff directly involved, it is not possible to determine to what degree each earmark was a response to advocacy by an institution, a Congressional initiative, or a recognition by Congress of a significant national or programmatic need.

Analysis of FY 1991 Earmarking. The FY 1991 data on apparent earmarking show that academic institutions can be reliably identified as the beneficiaries of only about half of the earmarks for which the type of recipient can be established. The data include 221 earmarks totalling \$724.4 million for R&D operations and facilities, of which only 101 (\$348.1 million) are for academic institutions. The other recipients include non-profit institutions, and private, state, local, and cooperative federal-state entities. In addition there are 271 earmarks in operations of the Department of Agriculture for which the data do not reliably identify the type of recipient.

For facilities earmarks only, the ratio is somewhat higher. Including those in the Department of Agriculture, academic institutions received 67 (\$276.3 million) out of the total of 111 (\$427.5 million). The agency breakdown of the 67 is 30 in the

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Department of Agriculture, 15 in the General Services Administration, 13 in the Department of Energy, 7 in the Department of Defense, and 2 all others.

There were no earmarks in most of the major programs supporting science in universities, including the National Science Foundation, the National Institutes of Health, the general science program of the Department of Energy, the National Aeronautics and Space Administration, and the Department of Agriculture competitive grants program. The exceptions are the Department of Energy programs in basic energy sciences, biological and environmental research, and energy supply programs (33 earmarks) and the Department of Defense university research initiative (7 earmarks).

Although comparable data for prior years is not available, it is apparent that there was a significant increase in Congressional earmarking in the FY 1991 appropriations. This and other evidence indicate a major change in FY 1991 in Congressional practices with respect to R&D earmarks, especially in certain subcommittees of the Appropriations Committees. The Energy and Water Resources subcommittees accounted for 33 earmarks. The Defense subcommittees accounted for 28 earmarks and specifically exempted them from previously enacted legislative requirements for competition. The Treasury-Post Office subcommittees inserted funding for 21 earmarks for R&D construction at non-federal institutions into the appropriation of the General Services Administration, which normally provides only for construction of federal office buildings. The Veterans-HUD subcommittees appear to have inserted

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more earmarks than usual in the funds for the Environmental Protection Agency and for the first time also inserted earmarks into the construction account of the National Aeronautics and Space Administration. It is not clear whether earmarking is on the rise in the Agriculture and Interior subcommittees or if the FY 1991 earmarks are simply a continuation of their normal practices.

Impacts of FY 1991 Earmarking. Generally, any earmarks within a constrained total put a corresponding squeeze on the agency's overall program. Analysis of the budget data cannot isolate the impact of these earmarks from other factors, but it can indicate some areas of greater or lesser apparent impact. It is possible, however, to compare for each program area the amounts earmarked with the net change made by Congress in the proposed FY 1991 budget. To the extent Congress has provided a net increase over the proposed budget for R&D, the squeeze has been applied elsewhere in the budget and the earmarks can be said to have been covered by "new money." To the extent that funding increases fall short of the amounts earmarked, and in all cases where Congress has reduced the proposed budget, there is a negative impact on the R&D budget which the agency will have to find ways to absorb.

On this basis, R&D earmarks totaling \$283.1 million appear to have been covered with "new money." Earmarks totalling \$403.4 million appear to have been partially covered by \$208.9 million in budget increases, so that the squeeze on them could be as little as \$194.5 million. In the few cases where earmarks were made in programs reduced by Congress, the budget squeeze will be the full

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amount of the earmarks; this is the case, for example, in some programs within the Department of Defense and in the National Aeronautics and Space Administration.

In total, this analysis suggests that the impact on R&D budgets of the \$809.6 million of earmarks will be net reductions totaling at least \$332.0 million. The reductions will be greater to the extent that agencies with budget increases are not able to apply the increases as offsets to their earmarks, and could be less to the extent they are able to accept earmarked items as adequate substitutes for programs in the budget.

From all indications, the most serious budgetary impacts would appear to be in Department of Energy programs budgeted under Energy Supply R&D, in the Agricultural Research Service, and in the Forest Service. In the other cases the earmarked amounts are a relatively small percent of the total budgets.

The FY 1991 earmarks include about 25 instances in which new centers, institutes, or other entities are to be established. In most of these instances continued Federal support in future years seems clearly implied. Most of the operations earmarks also imply continuing support in future years. Thus FY 1991 earmarks have put a built-in squeeze on future year budgets, an effect that will be compounded as additional earmarks are made each year.

Divergent Points of View

Much of the growth in research facilities funding since the mid-1980's has been due to Congressional earmarking of appropriations.

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The practice has been controversial, welcomed by some as an effective way to confront a serious national problem and deplored by others concerned that the tendency to use earmarks threatens the very fabric of academic institutions and the integrity of the U.S. research enterprise.

Those who support the concept of Congressional earmarking for research facilities point to the historical presence of this phenomenon over time and argue that it can be considered a form of constituent service. They also argue that universities and colleges who seek earmarks are merely exercising their constitutional rights to petition Congress on their own behalf. To supporters, the practice constitutes accepted ethical behavior on the part of Congress, particularly since everyone in the Congress has the opportunity to vote on any given earmarked project or facility.

Some who favor earmarking also cite a redistributive rationale, claiming that an "old boys network" is actively at work in the regular merit-review process of making research awards. In their opinion, merit review works to the disproportionate advantage of major research institutions, at the expense of smaller and less prestigious institutions that would like to establish a stronger research presence. This argument holds that earmarking is necessary to correct an unfair situation by allowing the "have nots" to improve their status relative to the "haves," so that they become more competitive. In this argument, earmarks are seen as furthering socially justifiable goals.

Data on earmarking, however, indicate that this may not be

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the case. Over the FY 1980-89 period, for example, more than 40 percent of the \$900 million in earmarks went to just five states, while two-thirds of the earmark dollars went to only ten states. Ten institutions received nearly 40 percent of all earmarked funds and the top twenty schools received nearly 60 percent of all earmarked funds. In FY 1990, 71 percent of the \$132 million in apparent academic earmarks went to 10 states, while the "top ten" earmark recipients accounted for 52 percent of the dollar value of all academic earmarks. It appears that the practice of earmarking may in fact be geographically inequitable, primarily benefiting only a handful of states and academic institutions.

Another rationale advanced for Congressional earmarking is that, more than 20 years, there has been no federal program for funding of research facilities on a merit-review basis. Before the implementation of the National Science Foundation facilities modernization program in FY 1989, there was no alternative for getting facilities funding, because no competitive federal programs existed. Proponents of earmarking argue that the current program is not large enough. If there were substantial competitive programs for research facilities, they assert, there would be less pressure from institutions to get earmarked funds and it would be correspondingly easier for legislators to refuse constituent demands.

Those who oppose earmarking in the research arena are concerned about the lack of competition and open debate regarding the merits of the project or facility to meet national needs and

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goals. The 1986 Packard-Bromley report on the health of U.S. colleges and universities stressed that assessments made by technically qualified review individuals and panels as to how reasonable and necessary a research project or budget is are generally viewed as sound and credible. The report recommendation that a facilities fund be established was accompanied by the recommendation that all proposals be subjected to review within the scientific or technological community involved.

While earmarking attempts to address a real problem, the limited availability of federal funds for research infrastructure, it often does it outside the quality control process which has worked so well in the past. Proponents of merit review cite instances when Congress has responded to the pressures for facilities earmarks by approving funds without debate or review by committees. There have been instances when facilities projects were added as last minute floor amendments, bypassing peer review, the agency, and the appropriate Congressional committee.

In a time of scarce resources for research, merit competition appeals to the American sense of fair play--everyone should compete fairly for the taxpayers' dollar. The competitive process uses standardized evaluation criteria to judge the merits of proposed facilities, the need for such facilities, and the capability of the institution. Moreover, the 1986 Packard-Bromley report argued that the system of awarding grants and contracts on the basis of technical review is essential to the U.S. ability to maintain excellence in science. The direct appeal to Congress for funding

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scientific facilities, it can be argued, threatens this process and, if the practice grows, could seriously undermine the system of competition for research funding.

Earmarking also upsets the decision-making balance and division of labor between the Congress, the Executive agencies, and the science and engineering community. The current tiers of decision making allow each body to contribute its unique expertise. Congress is charged with setting national priorities; Federal agencies evaluate specific activities to meet national objectives; researchers provide expertise to the agencies in an advisory capacity, providing merit review. In contrast, earmarking places all of the responsibility in the hands of Congress.

Partial responsibility for the possible erosion of the merit review process also lies in the hands of the scientists, engineers, and university research administrators who have been trusted by the Federal government to determine the nature of academic research activity and ensure its excellence. Increased reliance of the scientific community on direct political measures could destroy the perception of its objectivity and integrity, erode the trust with which it has been vested, imperil its autonomy, and forfeit its right to play a significant role in Federal resource decision-making.

Finally, it can be argued that bypassing the merit review process has the quality of being a short term solution to a long term problem. The major need that exists for research facilities cannot be satisfied by earmarking, nor is this process an efficient

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way to allocate scarce resources to meet this need. In this view, the Nation needs a comprehensive approach to meeting the needs for research facilities, preferably a cooperative one involving the Federal government, the academic community, the states, and other sponsors of research.

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7. National Science Foundation, Modernizing Academic Research
Facilities: A Comprehensive Plan, NSF 89-61, (Washington, D.C.)
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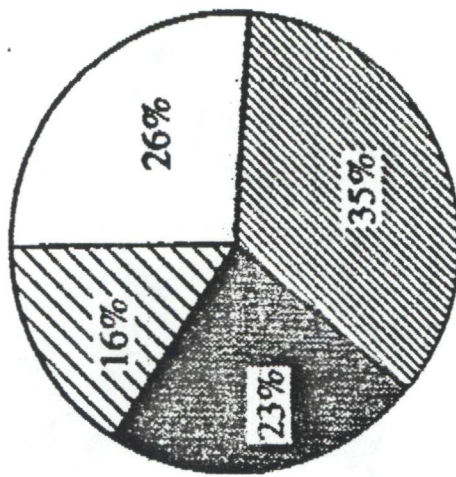
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House Science Council: Panel on the Health of U.S. Colleges and
Universities, Washington, D.C., February 1986.

9. James Savage, "The Distribution of Academic Earmarks in the
Federal Government's Appropriations Bills, FY 1980-1989" (Oakland,
CA: University of California) March 7, 1989.





10. James Savage, "Apparent Academic Earmarks in the FY 1990
Federal Appropriations Bills" (Oakland, CA: University of
California) December 19, 1989.

11. United States Senate, The Committee on Rules and
Administration, Hearing on Senate Resolution 206, "To Establish a
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Designated Institutions without Competition" (Washington, D.C.)
June 21, 1990.

FIGURE 1
Institution-assessed quality/condition of academic
research facilities: 1990



(base = 116.3 million sq. ft.)

-  Suitable for use in most sophisticated research
-  Effective for most uses
-  Needs limited repair/renovation
-  Needs major repair/renovation

use in redrawn form

Table 1

~~TABLE III~~

CONGRESSIONAL EARMARKS OF R&D ITEMS
FOR SPECIFIC INSTITUTIONS OR LOCATIONS
BY 1991 APPROPRIATIONS

A - BY AGENCY
(in millions)

Agency	Facilities		Operations		Total		In Law	Repts. Only
	No.	Amt.	No.	Amt.	No.	Amt.		
Defense	8	106.5	20	146.9	28	253.4	16	12
Energy	15	104.1	33	81.4	48	185.5	16	32
Commerce	2	3.0	12	11.4	14	14.4	4	10
Interior	2	.8	23	16.7	25	17.5	-	25
EPA	4	37.2	16	29.7	20	66.9	1	19
HHS	1	.2	1	3.2	2	3.4	1	1
Education	-	-	5	7.6	5	7.6	5	-
NASA	4	18.0	-	-	4	18.0	1	3
NSF	-	-	-	-	-	-	-	-
Smithsonian	-	-	-	-	-	-	-	-
GSA	21	60.7	-	-	21	60.7	21	-
Agriculture	54	97.0	271	85.2	325	182.2	-	325
TOTAL	111	427.5	381	382.1	492	809.6	65	427

OFFICE OF CABINET AFFAIRS STAFFING MEMORANDUM

Date: 3-19-91

Due by: 4:00 Wednesday, March 27

Subject: OMB Clearance: OSTP Report On Five Year Outlook on Science

From: Holly Williamson + Technology

	ACTION	CONCUR	FYI		ACTION	CONCUR	FYI
HOLIDAY	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FITZHENRY	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DANZANSKY	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MCMUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ADAIR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PORTER	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BUCHHOLZ	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SCHALL	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CASSE	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SECHLER	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
EVANS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WETHINGTON	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
FARRAR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WILLIAMSON	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GUNN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HEIMBACH	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JACKSON	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

Please review and provide
 comments to me by 4:00 on
 Wednesday, March 27. Thank you.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
Washington, D.C. 20503

MAR 18 1991

LEGISLATIVE REFERRAL MEMORANDUM

LRM #M-121

TO: Legislative Liaison Officer:

COMMERCE - Michael A. Levitt - 377-3151 - 324
DEFENSE - Samuel T. Brick, Jr. - 697-1305 - 325
EDUCATION - John Kristy - 401-2670 - 207
HHS - Frances White - 245-7760 - 328
CEA - Francine Obermiller - 395-5036 - 242
EPA - Thomas C. Roberts - 382-5414 - 326
NASA - Martin P. Kress - 453-1948 - 219
NSC - William Sittmann - 456-6534 - 249
NSF - Charles H. Herz - 357-9435 - 248

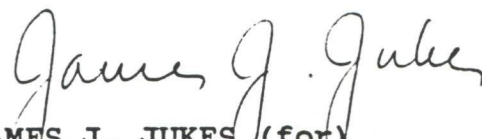
SUBJECT: OSTP Proposed Report on Five Year Outlook on
Science and Technology

Chapters 2, 3, 4, and 6 of this draft report to
Congress. The remaining sections will be sent to
you separately.

DEADLINE: Wednesday MAR 27 1991

The Office of Management and Budget requests the views of your
agency on the above subject before advising on its relationship to
the program of the President, in accordance with OMB Circular A-19.

Questions should be referred to Norine Noonan. (395-3534).


JAMES J. JUKES (for)
Assistant Director for
Legislative Reference

CC:

Connie Bowers
Greg Henry
Cora Beebe
Barry Clendenin
Barry White
Holly Williamson
Holly Fitter
Janet Forsgren

SCIENCE AND TECHNOLOGY

A Report to the Congress

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CHAPTER 2

CREATING AN INFORMATION-RICH SOCIETY

Supercomputers and the data networks that connect them are becoming increasingly important to scientific advancement, economic competition, and national security. The technology has the potential for extraordinarily rapid advances within the next five years--a 1000-fold improvement in computing speed and a 100-fold improvement in the capacity of data networks. As such, the technology is close to the point of having a transforming effect on industries, educational institutions at all levels, and society as a whole.

Such a transforming effect is already evident in scientific research and in engineering practice, where computational methods have joined, and in some areas displaced, the traditional methods of theory and experiment. In the design of commercial aircraft, for example, many engineering issues are resolved through computer simulation rather than through costly wind tunnel experiments. Access to supercomputers is already essential in many fields of research, from theoretical astrophysics to the study of complex biochemical molecules to climate prediction. Yet despite remarkable advances over the past 30 years in computer technology, operating software, and computational techniques, computers are not yet powerful enough to realize their full potential. Without a 1000-fold increase in supercomputer speeds, many fundamental scientific

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problems will remain unsolveable and many applications of computational science and engineering will remain out of reach.

Nonetheless, high performance computing is already emerging as a technology of great economic and social importance, in sometimes surprising ways. Supercomputers make possible a more efficient, integrated approach to the design and manufacturing of many kinds of products. They also make possible new, more powerful methods of managing or even creating information and the ability to display it in graphic forms that enable the human brain to grasp patterns and complexities heretofore unattainable. Supercomputers also exert a strong leverage on the rest of the computer industry. Historically, just 15 years separates the appearance of a new supercomputer and the availability of the same computing power in desktop machines.

So far, supercomputers are located primarily in major research laboratories and large companies. But for high performance computing to realize its potential, supercomputing power must also be accessible to researchers in all colleges and universities, to small and medium-sized businesses, and ultimately even to the classroom at both college and pre-college levels. What would make such widespread access possible is a national computer network capable of communicating at supercomputer speeds.

Computer networks are already in place. In a growing number of science and technology fields, progress and productivity in ~~modern research are increasingly dependent on the close interaction~~ of people located in distant places. Computer networks, by

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providing low cost communication and the essentially instantaneous transfer of data and graphic information, makes such interaction possible. Use of existing networks is growing very rapidly, doubling several times each year. Much higher communication capacities and speeds will be required to accomodate this growth, to handle the volume of data that supercomputers generate, and to expand and link existing networks into a system of national "data freeways" that can serve as the basis of a national information infrastructure.

High capacity networks have the capacity to shrink the world, rendering physical distances less important, and at the same time expand the world of information available to individuals. Access to the vast stores of information that already exist--in laboratories, in government agencies, in museums and libraries--and the computing power to shape and present that information in forms appealing to the human mind could enormously enrich American society.

POLICY RELEVANCE

The national stake in high performance computing includes the enhancement of research itself, because advances in this revolutionary technology enables advances in almost every other science and engineering discipline. Achieving the prospective 1000-fold leap in computing power is essential to solve critical problems such as pollution dispersion or climate prediction. A high speed network is equally essential to give the nation's scientists

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and engineers ready access to high performance computers and facilitate the collaboration of physically-distant research groups thus making the most efficient use of the nation's scientific talent.

But very fast, very powerful computers and the networks that link them together are tools of vital importance far beyond the university or the federal research laboratory. These technologies are economically important because they are becoming central to virtually every industrial field. Thus high performance computing can speed the pace of innovation and spur gains in U.S. productivity and industrial competitiveness by transforming the design and production process.

High performance computing is already important in national security and national defense, in the analysis of intelligence and in the development of advanced military technology. Its importance will increase as electronic battlefield management and missile defense become more central to military strategies.

Finally, high performance computing and communications has the potential to transform and enrich education at all levels, making immense libraries of information and powerful learning aids universally available in every school in the nation. A high-speed high-capacity network can link students to distant scholars or master teachers, can offer students at rural schools the same wealth of visual materials and advanced curricula that their urban counterparts have, and can make "hands on" science courses available even in schools that lack modern facilities that

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simulated laboratories. Ultimately the network can facilitate the ability of schools at all levels to offer individualized instruction to every student.

The Bush Administration has proposed a strategic Federal investment in the frontiers of computing and computer communications technologies that consists of four components representing the key areas of high performance computing and communications:

High Performance Computing Systems: the development of the underlying technology required for parallel computing systems capable of sustaining trillions of operations per second on large problems.

Advanced Software Technology and Algorithms: the development of generic software technology and algorithms for grand challenge research applications to realize the performance potential of high performance computing systems in a networked environment.

National Research and Education Network: the development of a national high speed network to provide distributed computing capability to research and educational institutions and to further advanced research on very high speed networks and applications.

Basic Research and Human Resources: support for fundamental research in computer and computational science and engineering, activities to significantly increase the pool of trained personnel, and support for efforts to accelerate technology transition.

The program provides for development of these revolutionary technologies within the framework of a partnership among

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government, industry, and academe which allows for rapid translation of laboratory results into new products.

STATE OF THE TECHNOLOGY

High performance computing technology is knowledge and innovation intensive. Its development and use engages the entire scientific and engineering community. Building upon fundamental research of the early 1980's, a new computing technology of scalable parallel processing computers emerged. By the mid-1990's, this innovative approach to high performance computing systems promises to achieve sustained performance improvements of a thousand-fold compared to current systems and a hundred-fold in network speed and capacity.

Hardware

The current generation of supercomputer achieve their performance through the use of the fastest possible individual components, but with relatively conservative computer architectures. These computers use up to eight parallel processors and reach speeds up to 10 billion operations per second, but their specific architectures cannot be scaled up significantly. Large scale parallel processing, in which the computational workload is shared among many processors, is considered to be the most promising approach to producing significantly faster supercomputers.

Experiments with parallel computers have demonstrated that computation speeds can increase almost in direct proportion to the number of processors in certain applications. Thus the approach to large scale parallel processing widely thought to be most likely

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to succeed is based on computer architectures known as "massive parallelism." Unlike current supercomputers, these architectures employ 100s to 10,000s of processors and high levels of circuit integration, albeit with somewhat slower individual components. Equally important, these architectures are scalable to higher levels of parallelism, simply by adding additional processors to the design, with corresponding increase in potential performance.

An important benefit of the scalable architectures is that a single design, with its attendant components and software, may prove to be useful and efficient over a performance range of 10 to 100 or more. This allows one design and one set of operating and applications software to be used for a family of workstations, mini-supercomputers, and very high performance supercomputers.

The United States is currently the leader in developing scalable parallel processing computers and the components for these computers. The first generation of such systems is now commercially available, constructed for the most part with general purpose components. This approach keeps overall costs down and can achieve very substantial speeds. Current or recently-announced general purpose processors, for example, operate in the range of 20-50 million instructions per second. Thus a parallel computer incorporating 500 such processors would approach the operating speeds of today's fastest supercomputers; a computer incorporating 20,000 of these processors would be required to approach the range of a trillion operations per second (teraflops).

First generation scalable parallel systems have demonstrated



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high performance for both numeric and non-numeric applications, including symbolic processing. Comparable systems do not yet exist outside the United States. Experience with these systems has shown that, even with existing software, they are effective for certain classes of problems. New approaches to software for these large scale parallel systems, now beginning to emerge, suggest that parallel computing can be applied to wide classes of scientific and engineering problems.

Second generation systems that incorporate higher speed components and more parallelism are already under development. These depend less on general purpose processors and more on integrated circuits that are specific to particular applications, which have become less expensive and more readily available. This approach may ultimately offer the highest speeds. However, exploiting parallel processing effectively presents significant challenges. Major efforts will be required to develop improved hardware, algorithms, and operating software to the point where they can be successfully applied to a broad range of problems.

Software

Computer hardware, by itself, can do little, until its power is tapped by the sets of instructions, or software, that guide computer operations. Historically, advances in software and in computational methods have proved just as important to advances in computing as hardware advances. In several classes of scientific computing problems, for example, hardware improvements yielded a 1000-fold speed-up over 20 years, while improvements in software

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and algorithms yielded a 3000-fold speed-up over the same period.

As high performance computing systems evolve, it is becoming clear that major advances in software are also essential to realize their full performance potential. Software development, analysis, and adaptation remain difficult and costly for traditional computer architectures, and parallel systems pose even greater challenges. New computers are often released with weak systems software and inadequate programming tools, thus slowing the availability of applications software. Current approaches to software development provide only limited capabilities for adaptable and reuseable systems, particularly where specific architectural features of computers have been used to obtain maximum performance. This focus on short term needs and the lack of portability significantly raises the cost of transition to newer architectures for many applications programs. New approaches that facilitate the reuse and portability of programs need strong support.

Parallel computers raise some specific software challenges, such as finding the most efficient distribution of tasks among processors. Although it is not yet possible to determine the optimum distribution in general, important progress has been made in the development of computational models and parallel algorithms for many key problem areas. Access to high performance parallel systems is an important element in such progress. Experience has shown that the quality of systems and applications software increases rapidly as computing systems are made more available. Collaboration of computer scientists, mathematicians, and

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scientists in critical areas of computing applications is another important factor, which can be enhanced by enabling geographically dispersed groups of researchers to work together through the National Research and Education Network.

Networks

Many educational institutions, government laboratories, and industrial research facilities are currently connected to the U.S. portion of a world-wide computer network called the Internet. The Internet falls short of a high performance national infrastructure. The National Research and Education Network is intended not only to provide access to research and educational institutions at all levels and locations, but also to deliver new capabilities. Some of these, such as distance learning, may initially be extensions of current technology. Networks capable of far higher speeds will be needed to support access to digital libraries and to large scale distributed computing resources, as well as to permit applications that require real time visualization of modeling and simulation results, rapid interrogation and retrieval of scientific data from specialized data bases, remote control of experiments and simulations, and teleconferencing.

The development of more powerful computers feeds both the demand for, as well as the growth of, more powerful data communications capability. As computing technology progresses, greater demands are placed on network performance as researchers conceive of new tasks and modes of use that require even higher performance. Current developments in large scale scientific

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computing are leading to truly distributed computing, allowing a given job to be executed on several different machines communicating partial results among themselves, sharing in different facets of calculations, and jointly assembling a final result for output. Such intermachine communication can in principle take place at speeds that are a hundred or more times faster than are possible on today's long distance networks.

One example of the potential uses for a high speed computer network is provided the radiology departments of some of the nation's leading medical centers. These departments have committed to digital transfer of radiology images on broadband local networks operating at speeds of 100 million to one billion bits (one gigabit) per second. In order for the National Research and Education Network to support these and other demanding applications, not yet contemplated, a substantial effort is needed in the areas of protocols (the formal structure of inter-computer communications), high speed computer interfaces for computers, and network equipment, such as switches. Another priority need is for advanced software that exploits the capabilities of the network to store computer files in a distributed manner and to serve as a national software library.

Multi-gigabit networks represent a change in kind, not just in degree, from today's networks. For example, consider that in a coast-to-coast communication at three gigabits per second there are at any instant "in flight" nearly nine megabytes of data, which is more than the memory of most personal computers and workstations.

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Some research on gigabit networks has already begun, but additional research will be needed to bring the technology to a commercial stage.

In addition to serving the needs of the scientific and research communities, the National Research and Education Network will provide valuable experience necessary for the successful development of a broader, privately-operated national information infrastructure. Such an infrastructure would allow consumers, businesses, and schools and government at all levels to share quality information and entertainment when and where they want it at a reasonable cost.

Applications conducted over a computer network vary in their flow of information from steady, as in a bulk file transfer, to "bursty," as in human-computer interaction via keyboard. Similarly, some applications can be carried out at relatively low communication rates, while others by their nature require high speeds (Figure 1). Traffic seen in the early days of networks appears near the bottom of the chart. More advanced applications are furthest from the origin. The chart illustrates that a gigabit network is needed not only to carry the aggregation of low speed traffic, but also to accommodate high speed uses.

People

A growing pool of scientific and engineering talent will be required if the potential of high performance computing and high speed networks is to be realized. ~~The most recent analysis by the~~ National Science Foundation, however, concludes that the greatest

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shortfalls of trained personnel in the United States will be in the areas of computer science and engineering, amounting to hundreds of thousands of people over the next decade. Additional efforts are needed to attract new talent into this field.

ILLUSTRATING THE IMPACT: GRAND CHALLENGES

Computers already play a fundamental role in the process of scientific discovery in almost every field. Yet scientists and engineers have long been limited in their ability to deal with a group of fundamental problems whose solution is critical to national needs and to the missions of federal agencies. These "grand challenge" problems include: prediction of weather and climate; determination of molecular, atomic, and nuclear structures; understanding turbulence, pollution dispersion, and combustion systems; mapping the human genome and understanding the structure of biological macromolecules; understanding the nature of new materials; and problems applicable to national security needs.

Computational or numerical methods have the potential to solve grand challenge problems. At present, however, such solutions would require years of calculation with the fastest supercomputers now available (Figure 2). The implications of this "computation gap" for a number of grand challenge problems are discussed in this section.

In Science

One example of the growing role of high performance computing in

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science concerns the genetic basis of cancer and other diseases. The genes are contained in DNA, the molecular thread in the nucleus of each living cell which guides the assembly of molecules and complete living organisms. When the DNA code is altered by mutation, serious diseases can result, such as cancer; this phenomenon was known to scientists studying animal tumors in the 1970's. They isolated cancer-causing genes, called "oncogenes" from animal tumors, and later found that similar genes existed in normal human DNA. This was a profound mystery. Why would people carry the seeds of their own destruction in their genetic inheritance?

In 1984, two separate research groups used a computerized searching algorithm to compare a newly discovered oncogene to the relatively few genes known at the time. To their astonishment, the cancer causing gene matched a normal gene involved in growth and development. Suddenly, it became clear that cancer might be caused by a normal growth gene being switched on at the wrong time. This fundamental and unexpected insight was an early example of a field that is now known as Computational Biology, the science of using computers to store and analyze data from complex molecules in living cells.

What is pertinent here is how rapidly the potential for--and the demand on--Computational Biology have expanded. The databases used in 1984 for the oncogene comparisons contained information about several thousand molecular units; now they contain over 30 million. Moreover, the current research program to map the entire human genome will acquire data on tens of billions of molecular

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units, ranging from simple organisms to human beings. The best computer algorithms for determining the similarity of molecules require time proportional to the length of the molecules being compared; if the methods used to analyze oncogenes in 1984 were applied to the three billion base pairs of the human genome, they would require hundreds of years of computer time on today's fastest supercomputers.

At the same time, progress in genetic medicine has made clear the large number of diseases that derive from a genetic defect or an inherited propensity, from cystic fibrosis to many forms of heart disease. Rational drug design based on the conscious alteration of complex biological molecules is increasingly the focus of pharmaceutical research. New computer designs and software methods will be essential to cope with the explosive growth of genetic and molecular data and to exploit it fully to relieve human suffering and disease. Functioning as intellectual amplifiers to detect similarities and differences in molecules whose size and complexity are too vast for the unaided human mind, high performance computer systems will be a critical tool for the life sciences in the 1990's and the health care systems of the 21st Century.

A similar phenomenon is occurring in the Earth Science field. Remote sensing instruments on satellites provide a growing flow of data and images to characterize the planet, reporting on temperature and cloudiness, tracking severe storms, assessing crop yields and the extent of deforestation. Storing, processing, and

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analyzing this data already requires substantial computing resources. To produce a global view of the Earth's ocean chlorophyll and land vegetation, for example, required the processing of over 2 terabytes (10^{12} bytes) of raw data, accumulated over several years. By the year 2000, advanced new satellite systems with higher resolution sensors are expected to increase the flow of data 1000-fold, sending back to Earth many terabytes of information every day. To fully utilize this information to describe and document changes in climate, in biological productivity, and in land use will require major improvements in the means for collecting, analyzing, distributing, and archiving data.

To answer critical questions about the future climate of the Earth and the impact of human activities requires the ability to predict, not just describe global change. Current computerized models of the atmosphere must be extended to include the coupled behavior of the full Earth System, including land, air, sea, ice, and biosphere components and to do so with far greater geographical resolution (see Chapter 4). The computational requirement exceed the capacity of even the most powerful of present computers by a factor of a thousand in speed. Also needed are advanced software and algorithms for handling massive amounts of data and working with coupled models of the Earth System.

On a regional level, high performance computers will be needed ~~to model air pollution and to predict the effectiveness of~~ regulatory control strategies, as mandated in the new Clean Air

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Act. Since the "killer fogs" in London, England and Donora, Pennsylvania caused the deaths of hundreds of people in the 1950's, the ability of the atmosphere to absorb and to cleanse itself of pollutant contaminants is no longer taken for granted. Legislation has mandated emissions controls on automobiles, factories, and power plants. However, reduction strategies of individual pollutant types do not always produce the desired results. In fact, these simple solutions can even make air quality worse due to complex chemical interactions of the remaining airborne contaminants.

Unburned hydrocarbons from fuels and oxides of nitrogen produced in the combustion process can be transformed in the atmosphere to ozone, the main constituent of urban smog. Pollutants may travel long distances from urban or industrial centers, contributing to the haze that obscures some natural wonders or the acid rain that endangers sensitive upland lakes and forests. Because these complexities of pollutant transport and transformation are costly and difficult to study experimentally, numerical models of the atmosphere have been developed to assess the effects of man-made emissions on air quality. But present computing limitations force simplifications in the scientific descriptions of chemical and physical processes, and slow examination of alternatives. Control strategies for each pollutant are often determined independently with little evaluation of pollutant interactions.

High performance computing will enable rapid numerical
explorations of pollutant interactions and resulting pollution

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levels and distribution. Advanced computer designs and software methods will also enable the optimization of pollutant control regimes to find those of lowest cost--an important consideration, since the potential cost to society of proposed controls is estimated to reach tens of billions of dollars. Improved visualization techniques will enhance the interpretation and evaluation of massive amounts of environmental measurement and computer simulation data. The result should be a better understanding of the actions needed to minimize pollutant damage to materials and environmental damage to crops while making our air safer to breathe for future generations.

On a local scale, high performance computing will make possible more accurate predictions of severe storms, hurricanes, floods, and other weather related phenomena. Current weather prediction models have been constrained both by inadequate data sets and by computer power. During the next five years, major progress will be made on the data using a combination of new ground-based and remote-observing systems. This leaves inadequate computer power as the primary stumbling block to operation of the advanced weather prediction models of the future.

Current weather prediction models have a resolution of about 40 kilometers, and hence must treat many small scale but physically significant events or processes, such as convection, indirectly. Fine scale details that may affect the prediction for the surrounding area--in, for example, thunderstorm evolution--cannot even be addressed by the model. Improved models with a resolution

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of less than five kilometers have already shown significant advances in the accuracy of predicting a wide variety of weather events, from severe thunderstorms to lake effect snowfalls. But each reduction of the model resolution by one-half requires an increase of computer power of almost a factor of ten, as well as comparable increases in supporting memory, mass storage and networks. For example, a model with five kilometer resolution could require a computer system capable of executing 20 trillion operations per second to produce forecasts on operational schedules. Hence high performance computing systems will be necessary to achieve the economic benefits of improved weather prediction.

In 1988, the world was excited by the discovery that a particular yttrium-barium-copper-oxide compound superconducts at a temperature of 935 Kelvin, still very cold, but much warmer than any previous superconductor. This discovery sparked a worldwide effort to expand research to discover new superconducting materials. The economic benefit of a high-temperature superconductor is beyond calculation, portending the development of, for example, much more efficient power transmission and lightweight, powerful magnets to revolutionize the transportation business. Advanced computing is a central part of the arsenal of research tools which will be necessary to reach that payoff. Despite these early successes, many questions remain before it is ~~understood how some materials superconduct when very similar~~ compounds do not. This understanding will be critical to predicting

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new superconductors, which might work at even higher temperatures, be less expensive, carry more current, or be more amenable to manufacturing processes. Increasing progress in all these areas is required before the impact of these new materials will be felt. The solution of physical models requires intensive calculations to understand the material structure. High performance computing can shorten the discovery process by allowing the development of accurate simulations to point experimenters in the most promising directions. For example, most of the groups looking for new superconductors are trying various copper-oxide combinations. Researchers are using high performance computers to explore the possibility of various combinations of elements that may lead to new superconducting materials.

In Industry

Since the invention of the integrated circuit in 1958, the number of transistors fabricated on a microchip has doubled every two years. The result is an ever-increasing complexity in the electronic design of chips, components, and packages. At present, for example, the complexity of detail incorporated in a single integrated circuit one centimeter square is equivalent to representing the map features, at a city block level, of the entire Eastern United States. The complexity of a five centimeter square module densely packed with a collection of chips would be the equivalent of a map of North and South America. Computers are ~~already an essential part of the design process, which involves~~ determining the interconnecting paths, selecting the right modules,

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testing the interfaces, and choosing the mix of technologies.

The complexity is rapidly increasing. The chips containing one-to-two million transistors of today will evolve in the mid 1990's to chips containing 10 million transistors. The diversity of microchip technologies combined in a single module will allow unprecedented flexibility for designers. Managing this complexity explosion would be overwhelming without the use of computationally based approaches that reduce the time to develop such systems while optimising the design itself. Thus, high performance computing applied to the microelectronic design process is itself an important tool in the evolution of high performance computing.

Similar examples abound in a wide variety of engineering and technological fields. Supercomputers are already used to predict the flow of air around a wing and other aerodynamic characteristics of aircraft and spacecraft prior to testing in wind tunnels or actual flight, because computational simulations of a particular design are faster and less costly. For advanced supersonic and hypersonic craft, wind tunnels tests will not be able to reach their designed speeds, making computer simulations even more important. Modelling the flow of fluids is also important in the design of automobiles and ships.

Improving the design and efficiency of internal combustion engines is important for both energy conservation and pollution control. Indeed, these goals appear to conflict, because automobile ~~engines are most efficient when run at high temperatures, but~~ increased temperatures also lead to increased nitrogen oxide

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emissions. What is required to optimise the design of an engine is a far better understanding of the combustion process, which involves over 400 chemical reactions of hydrocarbon and nitrogen. In present numerical models, however, only ten or less of the most significant reactions are used, and even so the calculations require several hours on today's large supercomputers. To simulate the full 400 reactions would require better algorithms running on a machine 10,000 times more powerful.

In Education

Computers increasingly fill important niches in all phases of the learning process, providing flexible instruments for interactive instruction and student based learning experiences. Their use in education both provides the skills needed to function in our increasingly technology-intensive world, and aids teaching and learning of all science and engineering topics. The development of the National Research and Education Network will accelerate and transfer the technology of computer communications to the needs of educators and students. The result will be to empower them to share resources and ideas on a national scale.

A recent project provides an illustration of educational collaboration on a national scale that the network would facilitate. Secondary school classes in many locations chose a day to measure the length of the sun's shadow from a vertical measuring stick on the school grounds at 12 noon. Each class consulted maps and geography books to find its school's latitude, and sent the results to a shared database located in the U.S. and Canada. All

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schools then received the database of measurements from around the world, and each class used the complete database to calculate the curvature of the earth, and from that, the earth's diameter. A normally dry recitation of facts became an engaging problem-solving exercise because the students themselves derived the answer from their shared measurements. Along the way they learned geography, geometry, statistics, and how to collect and share data over computer networks, which became a learning laboratory without walls. This project is similar to the way research scientists take advantage of high speed digital networks to conduct shared research that is "distance independent." What is needed is to scale up today's networks and make them not only faster, but also more "user-friendly," with improved services so that the National Research and Education Network is readily accessible to all U.S. educational institutions.

FIGURE LIST AND CAPTIONS

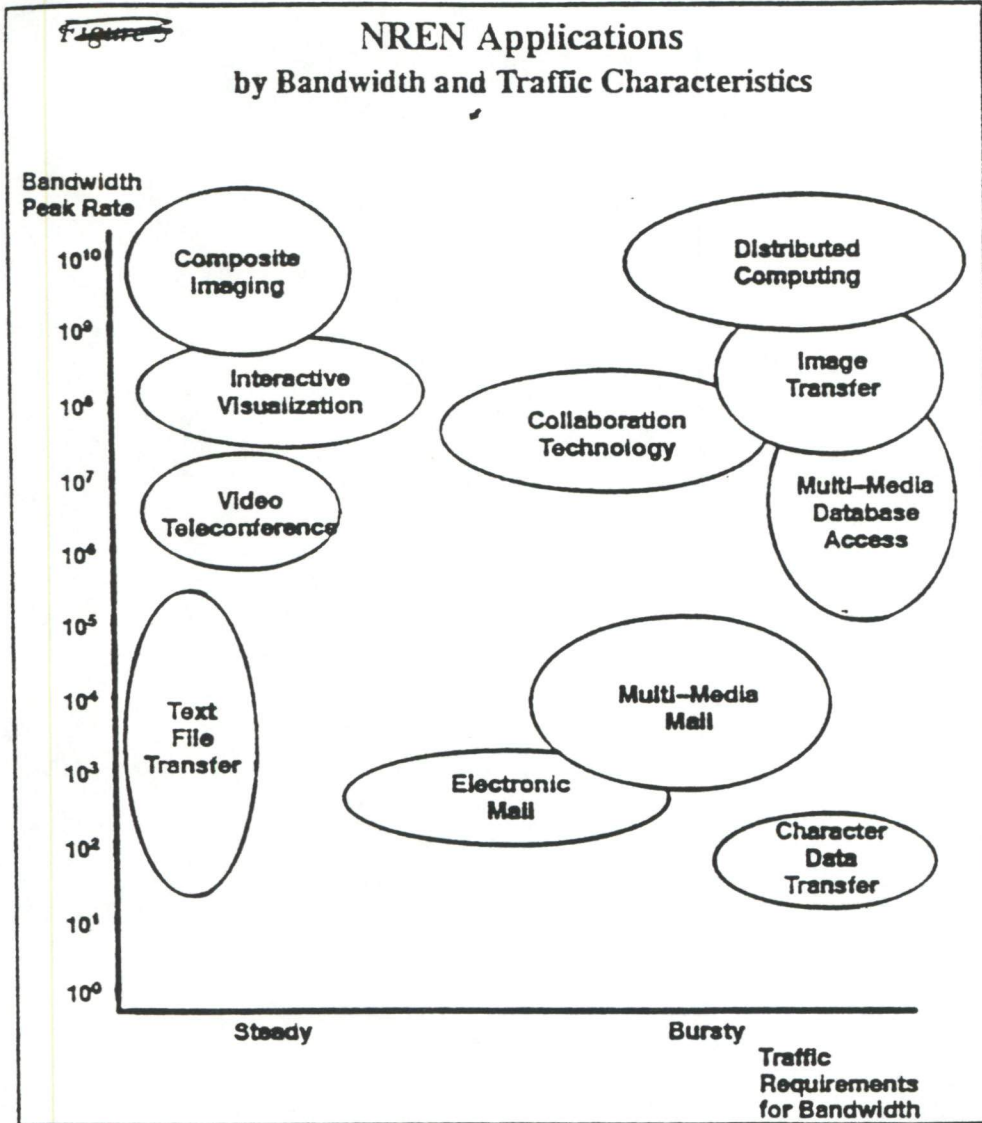
Figure 1. Network Capacities and Speeds Needed for Various Applications.

Figure 2. Grand Challenge Problems and Projected Computational Needs.

Fig. 1

24

origin and require more sophisticated protocols and network capabilities. This chart illustrates that a gigabit network is needed not only to carry the aggregation of low speed traffic, but also to accommodate high speed uses.



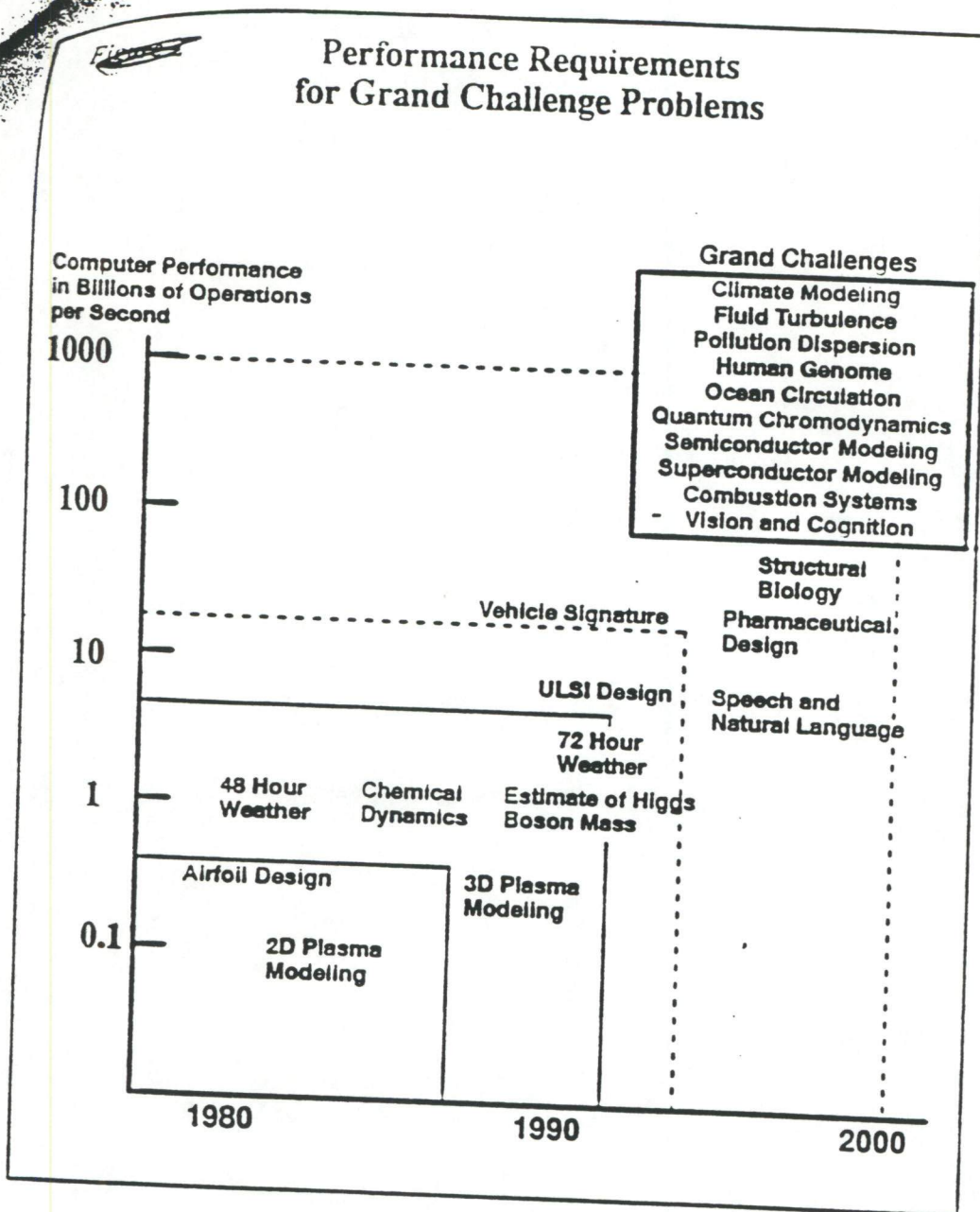
The vision of the NREN is of an interconnection of the nation's educational infrastructure to its knowledge and information centers. In this system, elementary schools, high schools, two and four year colleges, and universities will be linked with research centers and



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Fig. 2

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Chapter 3: ~~Biotechnology~~ ^e

HARNESSING THE SCIENCE OF LIFE

Biotechnology dates back thousands of years, to the time when human beings unwittingly began using microorganisms to ferment beer or cause bread to rise. Traditional breeding techniques used to gradually improve livestock or crop cultivars are also a form of biotechnology. But beginning about 20 years ago, scientists learned to alter precisely the genetic constitution of living organisms, initiating a new scientific and industrial revolution.

The new biotechnology is a rapidly expanding collection of tools or technologies that allow unprecedented control over and manipulation of the genetic material of organisms. This in turn allows the production of large quantities of rare, medically-valuable proteins, the modification of plants and animals to carry specific desired traits, and novel means of detecting disease, producing useful chemicals, and cleaning up environmental problems.

Biotechnology holds the promise of additional breakthroughs and a profound industrial transformation in the fields of medicine, food production, agriculture, energy, and environmental cleanup. It promises a wide array of benefits to humanity, including the ability to treat previously incurable genetic diseases; healthier meats, dairy products, fruits and vegetables; hardier, more productive crop plants; and additional production of renewable sources of energy.

Moreover, the nature of biotechnology is inherently attractive in many respects. Fermentation and most other processes found in the biotechnology industry take place

at low temperatures and consequently require much smaller amounts of energy than traditional chemical operations. Although some applications of biotechnology pose potential environmental hazards, it also has the potential to reduce environmental hazards compared to current practices. These characteristics, as well as its broad range of potential products, make biotechnology potentially applicable in and of benefit to every nation on Earth. Finally, biotechnology enhances the potential carrying capacity of the planet without depleting its resources and helps to exploit the richness of its vast genetic heritage, accumulated over billions of years, for human benefit.

In spite of the rapid growth of biotechnology and of the knowledge base on which it rests, however, many potential opportunities remain unrealized. There remain fundamental gaps in scientific knowledge. Because most biological research has focused on biomedical problems, relatively little is known about the biochemistry of plants, compared to the far better understanding of microbial or animal cells. The rules that govern the shapes of proteins, which in turn play a critical role in determining their biological properties, remain largely a mystery. Researchers still have a long way to go before the millions of chemical units that comprise the human genome are sorted out and identified. There are concerns about impending shortages of scientists and other skilled workers needed to adequately exploit research opportunities and to build the biotechnology knowledge base.

Even when discoveries are made in the laboratory, translating them into practical applications is often difficult. There are relatively few sources of funding for "proof of concept" research--as opposed to discovery--or for scaling up a biotechnology process from the testtube to a size large enough to attract industrial interest and support. Transferring new technology from a university or Federal laboratory to the

private sector poses additional problems. Certain biomedical applications of biotechnology raise novel and difficult ethical choices for society, which may take time and informed public debate to resolve. Additional barriers to commercialization include an uncertain regulatory environment, imprecise and sometimes ineffective laws and cumbersome procedures governing patents, antitrust questions, and international trade, and cautious public attitudes towards biotechnology products.

The potential of biotechnology gives ample human, national, and economic incentives to overcome barriers and to find ways to hasten the full application of this diverse group of technologies for human benefit.

POLICY RELEVANCE

The U.S. biotechnology industry is now comprized of more than 400 start-up firms, more than 200 established companies that have diversified into biotechnology--including many major chemical and pharmaceutical firms--and more than 200 supply firms in the United States alone. In just a decade and a half, this nascent industry has grown to produce U.S. products worth more than \$1.5 billion annually. A growing proportion of new drugs approved for life-threatening diseases are biotechnology products. Enzymes made in cell culture systems promise to change the way specialty chemicals are synthesized, making them cheaper and cleaner. Plants engineered to resist insect damage can reduce dependence on environmentally hazardous chemical pesticides. Researchers are harnessing some bacteria to produce silk and employing others to mine ore. In fact, biotechnology already has such an extraordinary range of uses that it is probably a misnomer to refer to a single "biotechnology industry."

Because of the pervasive role of biologically produced products in everyday life,

biotechnology industries have the potential to expand perhaps 25-fold by the end of the century and in the long run to surpass even the computer industry in size, importance, and rate of growth. Clearly, no industrial country concerned with its economic well-being can afford to ignore biotechnology.

American researchers developed much of the basic science of the new biotechnology, and the United States continues to lead the world in the commercialization of most emerging biotechnology products. But other countries have recognized the fundamental importance of biotechnology; their governments have focused on this area as critical to future economic growth and and their companies are beginning to challenge the U.S. lead in particular areas. Japan, for example, is targeting pharmaceutical applications of biotechnology in the same way that it earlier targeted the semiconductor and consumer electronic areas. Building on Japan's traditional strengths and strong lead in fermentation technology, its government is focusing on pre-competitive and applied research and product development. European investment in the new biotechnology is close to that of the United States, and European companies lead in the production of some types of biotechnology products, such as monoclonal antibodies.

The Bush Administration intends to maintain and improve U.S. competitiveness in biotechnology as an essential element in a growing and vigorous economy. To this end, it is giving priority attention to actions that can facilitate new discoveries and bring them to the market place to be available for all Americans and the rest of the world.

Securing the Science and Technology Base: In addition to the support of the basic research that undergirds biotechnology, the President's Council on

Competitiveness recommends vigorous efforts to transfer technology from federal or federally-supported laboratories to the market place and to train an expanded pool of biotechnology scientists and engineers; it is considering the need for expanded efforts in agricultural and environmental biotechnology research and in support of enabling and scale-up technologies.

Risk-Based Regulation: The President's Council of Competitiveness has recommended that Federal regulation should focus on the characteristics and risks of the biotechnology product, not the process by which it is created; regulation should be based on performance standards rather than on specifying the specific design or methods required to achieve a health or environmental goal.

Free Market for Biotechnology: The Bush Administration has proposed the passage of a capital gains tax rate reduction to help innovative small firms, such as those in the biotechnology industry, gain access to capital. The Administration is making improvements to the U.S. Patent Office and pursuing new international trade agreements in order to increase protection for intellectual property rights through patents.

STATE OF THE SCIENCE

Fundamental research often leads to unforeseen techniques or products of immense social and economic value. Past U.S. investment in biological research is in fact the basis for the present flowering of the biotechnology industry. A case in point is the group of biological compounds known as growth factors which stimulate cell growth. In 1959, Dr. Levi-Montalcini received a \$53,000 federal to study the first of

these compounds to be identified, nerve growth factor. Subsequently, a large array of growth factors has been identified, purified, cloned, and brought to commercial use. By 1989, just 30 years after Levi-Montalcini's pioneering work, sales of growth hormones by two U.S. biotechnology companies amounted to \$430 million annually.

Medical Applications.

An important use of biotechnology is the development of new, more potent medicines and the production of purer, more effective versions of existing drugs. As of January, 1991, 12 novel biotechnology products had been approved by the Food and Drug Administration for medical use in the U.S. More than 1,000 clinical trials of additional new drugs and biologics are under way.

Revolutionary new medical approaches treatments based on biotechnology, such as the use of gene therapy to correct inherited genetic defects, are under development. Children who suffer from the rare and devastating immune disorder known as Severe Combined Immune Deficiency Syndrome, for example, are having corrected genetic material inserted into their white blood cells in an experimental attempt to restore the cells' ability to fight infections. Similar gene therapy approaches may be tried for forms of cancer, hemophilia, sickle cell anemia, AIDS and other diseases. The recent discovery of a possible genetic basis for cystic fibrosis suggests a potential means of treating this disease.

Biotechnology has also made it easier to detect and diagnose diseases. With remarkable simplicity and precision, these methods can now detect a variety of genetically caused and other conditions. They vary from easily usable and inexpensive home diagnostic kits for pregnancy, to physician performed tests that simplify formerly complex laboratory procedures. More than 400 clinical diagnostic devices based on

biotechnology are used in clinical practice today. Of these, the most important have been the screening tests for blood products that have safeguarded the blood supply from contamination by the AIDS and the hepatitis B and C viruses.

Agricultural Applications.

No single industry is more vital to the wellbeing of the Nation and, indeed, that of the world's population, than agriculture. Moreover, as the largest commercial component of the U.S. economy, the health of the domestic agriculture industry has enormous implications for U.S. financial stability and competitiveness abroad. However, the application of modern biotechnology to agriculture lags far behind medical applications, which have progressed as a result of the vast knowledge of basic biology relevant to health sciences accumulated over the years. A comparable knowledge base simply does not exist in plants, animals, and agriculturally-important microorganisms. Therefore, assuring a rich science base which can support the development of agricultural biotechnologies is essential to bring U.S. agriculture into the next century.

Potential applications of biotechnology in agriculture include a better management of agroecosystems through decreased use of chemicals, maintenance of soil productivity, and better water management; improved agricultural products such as better quality food and fiber, higher content of desired nutrients or products, and crops and animals with higher tolerance to biological and environmental stress; and the development of new agricultural products. The need for more basic information is particularly acute in plant systems for which important traits have complex physiology and genetics, and have few parallels in microbial or animal systems. Recent advances have provided the opportunity to obtain this information and thus to apply genetic engineering technologies to benefit agriculture. In addition, the production of fertilizer

is a major consumer of energy in the United States. Biotechnology approaches to nitrogen fixation that would allow plants to grow their own fertilizer promise enormous savings in energy and benefits to the environment.

The new biotechnology can produce the same benefits as traditional breeding techniques, only more quickly and with greater precision. Enhancements of certain characteristics of tomatoes, for example, are expected to provide increased resistance to pests, thus reducing the need for chemical pesticides. Other enhancements could improve the texture and produce tomatoes with less spoilage between the farm and the consumer. Companies are fieldtesting a variety of crops with enhanced resistance to specific viruses, insect pests, and safer herbicides. Under development are improved staple crops such as soybean or corn with higher levels of specific nutrients and vegetable oils with lower levels of saturated fats.

Many manufactured foods such as cheese and yogurt require the use of bacteria or enzymes in their production. Scientists are modifying existing enzymes, isolating new varieties, and cloning other enzymes into microorganisms for easier isolation and purification. For example, chymosin, the enzyme used in the manufacture of cheese, has traditionally been available from the cow, but can now be made from specially developed microorganisms. Likewise, scientists are genetically improving the microorganisms used to ferment many food stuffs and beverages.

In the area of animal husbandry, biotechnology has enabled development of hormones that increase the ratio of protein to fat in pigs and the milk yield from cows. Additionally, veterinary diagnostic techniques and new drugs similar to those for humans are under development with several having reached the marketplace. One vaccine now under test holds great promise for controlling rabies in wild and domestic

animal populations effectively and inexpensively.

Environmental Applications

A healthy environment depends on the interaction of many different living organisms, from plants and animals to the communities of soil microorganisms that degrade biological matter and recycle nutrients. Biotechnology can protect these organisms and their interactions by introducing biological methods to replace toxic chemicals.

Biological pesticides such as the bacterium BT used to control gypsy moths break down quickly, leaving no harmful residues; genes from BT, inserted into crop seeds, can confer pest resistance. When toxic chemicals or waste materials do enter the environment, biotechnology offers an efficient means of dealing with the problem. The use of biological processes to clean-up wastes from human activities is well established: bacterial degradation of sewage forms the basis of a substantial portion of the waste treatment industry. Recent experiments in Prince William Sound and the Gulf of Mexico have demonstrated the value of microorganisms for clean-up of oil spills in the sea, on the shore and in wetlands.

Rather than laboriously gathering, screening, and breeding oil-eating bacteria from around the world, it is possible to create more efficient microorganisms using genetic engineering techniques. Biotechnology offers the the ability to manipulate one characteristic at a time in a well-characterized parent strain of bacteria, thus conferring greater knowledge of the final product. Thus biotechnology has potential application in breaking down toxic wastes and rendering them harmless through the action of specially designed microorganisms, enzymes, or catalytic antibodies. Another potential application of biotechnology is the rehabilitation of areas fouled by pollutants, such as the removal of chlorinated hydrocarbons from contaminated groundwater by

bacterial attack.

Early detection of small quantities of environmental pollutants could decrease markedly the costs of cleanup and return habitats to acceptable norms more rapidly. Biotechnology may be able to provide "indicator" organisms, sensitive enzyme assays, monoclonal antibodies, and other biosensors able to detect minuscule levels of potentially toxic agents and to provide early detection of ecosystems under stress. The vast majority of microorganisms in the soil, fresh water, and oceans cannot yet be cultured and, thus, cannot be isolated or identified by traditional microbiological methods. Recent advances in biotechnology such as the techniques of DNA fingerprinting and gene amplification now are making it possible to detect many of these microorganisms, even when present in low numbers, and to identify their essential role in the complex cycling of nutrients and gases in the biosphere. Changes in gene frequencies in near-shore populations of microorganisms, for example, may provide one of the most sensitive indicators of ocean environmental degradation.

To fulfill biotechnology's potential in environmental applications, however, further research is needed. Scientific understanding of different kinds of organisms and the contributions their activities make to the functions of different ecosystems is rudimentary at best. This is particularly true of microorganisms whose presence and activities are crucial for the continued viability of the larger, more visible organisms. Successful bioremediation of polluted areas will require improved processes for getting microorganisms into direct contact with contaminants, for effecting degradation of contaminants present in very low concentrations, and for manipulating the ecology of the treatment environment. In addition to the lack of basic information, there is a significant shortage of scientists and engineers with training in both biotechnology and

environmental disciplines.

Energy and Chemical Process Applications

Environmental and energy security concerns with fossil fuels such as oil are prompting a new look at renewable energy resources. Scientists are studying the use of microorganisms, modified plants, plant material, municipal and animal wastes, and other renewable materials as sources of fuels such as gasoline, alcohol, and natural gas. Examples include the use of wood to produce gasoline substitutes, and wood waste products such as bark and sawdust to yield ethanol. Biotechnology promises to accelerate such efforts by developing genetically-altered organisms and improved bioconversion processes.

Other energy-related research is focused on the potential of biological systems to enhance oil recovery, to clean and desulfurize coal before combustion, and to convert coal to gaseous and liquid fuels. For example, oil that otherwise would remain in the ground may be recovered through the introduction of certain microorganisms to oil wells. Biotechnology research aimed at reducing wastes from energy-generating processes and cleaning up energy-related waste is also underway.

Energy applications are special instances of the larger area of bioprocessing and bioconversion, in which biological means are used to accomplish chemical transformations. Examples include production of commercially valuable molecules, such as specialty chemicals and pharmaceuticals, that are often present only in low concentration in the starting materials. Thus, certain microorganisms are used to refine copper ores, recovering the metal without the environmental and energy costs of smelting and making economical the recovery from even low-grade ores. Bacteria have been recently discovered in the oceans which are capable of directly oxidizing and

precipitating iron, manganese, cobalt, nickel, and other valuable and strategic metals. Harnessing the genes and enzymes of these bacteria may make it possible to produce these metals catalytically from low-grade sources, bypassing other more expensive industrial approaches presently used. Other bacteria reverse these processes for a variety of different metals, both strategic and toxic, thus presenting further economic opportunities for exploitation, as well as the possibility of using engineered organisms for pollution clean-up.

Another class of applications includes the use of quite diverse biological systems and bioreactors to recover, produce, or modify novel molecules for commercial application. An extremely challenging problem in the synthesis of high value molecules such as pharmaceuticals is that of maintaining the proper stereochemistry in each step. In some cases the active molecule is only one of several dozen possible molecules having the same connections between atoms, but different shapes. Enzymes produce a desired molecule with a specific shape or stereochemical properties with almost perfect fidelity, so that biotechnological approaches to chemical synthesis have the potential for both minimizing the use of valuable starting materials and minimizing chemical waste. Chemzymes, artificial molecules designed to mimic enzymes, are expected to play important roles in biotechnological approaches to chemical syntheses.

In addition to greater specificity and lower wastes, bioprocessing typically takes place at lower temperatures than traditional chemical processing, resulting in energy savings, and can accommodate a wide range of non-petroleum starting materials. Thus the importance of biotechnology in the chemical and energy industries seems likely to increase over time.

To fulfill this potential, however, a broader base of fundamental science and

engineering knowledge is needed. Improvements must be sought in the biochemical pathways by which animal, microbial, or plant materials are converted into single-cell proteins, lipids, feedstocks, surfactants, specific pesticides, or other chemical products. More experience is needed with commercial-scale processes for transforming organic raw materials into useful products, including the design of novel bioreactors that can maintain the viability of living organisms in sometimes harsh environments.

The biochemistry of many important biological reactions, such as those which harvest the radiant energy of the sun to produce fuels and other biological materials, is not yet well understood. The biology of organisms that not only survive, but indeed thrive and multiply at temperatures near that of boiling water, is still a mystery, but one whose solution is likely to lead to useful enzymes of commercial catalytic value.

A deeper understanding of how enzymes function on a molecular level is needed to broaden the usefulness of isolated enzymes for chemical synthesis. For example, such an understanding should allow the production of chemically- or genetically-altered enzymes capable of carrying out a specific chemical step on a whole family of related molecules. In order to understand the biological and chemical action of proteins such as enzymes and receptors, scientists need to be able to predict their three-dimensional structure and to simulate their interaction with other molecules with powerful computers.

A fundamental limitation is the supply of scientific and engineering talent. The nation has an inadequate supply of well-trained microbial physiologists, biochemists, and geneticists to sort out the basic traits of presently recognized bacteria, let alone the isolation and characterization of the large number of microorganisms that exist in nature and that await study. **Enabling Technologies**

Much has been said about the hemorrhage of technology from the United States to other countries and the nation's seeming inability to translate basic science into commercial products. Biotechnology is no exception, but appears to be at a critical juncture. The U.S. lead in the basic sciences is still intact, albeit threatened, and while means exist to facilitate the "scale-up" process from the laboratory to industrial-scale production, there appears to be a bottleneck at the first step outside of the laboratory.

In biotechnology, each of the progressive steps of scale-up from test tube to flask to small fermentation vessel to large scale production facilities involves new scientific questions. These arise because living cells are vulnerable to shear forces, temperature and oxygen regulation, growth conditions and nutritional requirements, inhibiting effects of waste products, and other factors. The answers to these questions are attainable through fundamental research, the results of which can be applied generically to the development of myriad products.

Research of this nature is somewhat an orphan. Peer review committees tend to look down upon the more applied forms of investigation, while companies may feel that it is too far removed from product development. Smaller companies frequently do not have the capital to invest in high-risk research. The larger companies, on the other hand, may conduct such research but maintain the results as proprietary information, thus withholding its use from others.

The methods and techniques employed to move from laboratory to industrial scale production are known collectively as enabling technologies. Although they may vary from field to field, many are common, for instance, in the area of protein production. In this case, much of the technology employed today is more than 30 years

old. For example, human and animal cells are cultured in cumbersome and inefficient systems unsuitable for commercial scale. Progress in the development of superior bioreactor systems would achieve rapid increases in cost-efficiency. Another example of enabling technology is improved understanding of gene expression in a number of model organism systems. These studies might encompass the organisms most likely to be employed for scale-up production, including bacteria, viruses, yeast, and mammalian, insect and plant cells. Progress in enabling technologies would accelerate the translation of fundamental knowledge into new products and hence accelerate the benefits of biotechnology for humankind.

CHAPTER 4

MANAGING THE EARTH

During the past century, human society has entered into a new and momentous relationship with the global environment. As the human population and the scale of industrial civilization have increased, so has their impact on the Earth. For the first time in history, the human species has become an agent capable of influencing the entire planet. People have altered the face of the Earth by clearing forests, building cities, and converting wild lands to agriculture. Human activities have changed the composition of the Earth's atmosphere through the burning of fossil fuels, the expansion of agriculture, and the production and release of industrial compounds.

Already some of these activities have led to the partial degradation of the atmosphere's protective ozone shield, exposing both human and other forms of life to higher levels of ultraviolet radiation. The degradation has been most severe in a polar region remote from population or industrial centers, where airborne industrial compounds combined with unique meteorological conditions to form the Antarctic ozone hole, demonstrating the global reach of human activities.

A far more complex threat to the global environment is the possibility, not yet firmly established, that human actions will lead to an intensification of the "greenhouse effect" and thus to

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a significant warming of the Earth's climate. The complexity arises because changes in climate also occur naturally and because the response of the climate to human activities involves the entire Earth system--the land surface, its vegetative cover, the oceans and their currents, the polar ice caps, as well as the atmosphere. Thus reliable predictions of how and when the climate might change and what the practical effects of those changes will be are not yet possible. Nonetheless, scientists and governments around the world take seriously the possibility of human-induced climate change.

Ozone degradation, a warming climate, and other kinds of global change illustrate a common need. Humankind may have inherited the Earth, but the planet came without an owner's manual. Now, for the first time, human society finds itself in need of such knowledge in order to manage the Earth responsibly and to live in harmony with the global environment. To acquire an understanding of the Earth system, the interactions among its components, and the influence of human activity on them that is sufficiently detailed to make accurate predictions possible is the challenge of research on global change.

Scientists have already gained some insights into just how closely interconnected are the different parts of the Earth system. The oxygen that comprises nearly 20 percent of the Earth's atmosphere is so chemically reactive that it persists only because plants continuously release it in the process of photosynthesis. If plant life were to cease, the oxygen would

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rapidly disappear.

Carbon dioxide--a trace gas present only at about 350 parts per million in the atmosphere--provides even more subtle interconnections. Plants remove it and store it as cellulose and sugars. The oceans remove it too, and tiny lifeforms take it up and store it as the calcium carbonate in their shells. Some of those shells end up as debris on the seafloor. Over tens of millions of years, the seafloor sediments are cycled deep within the Earth and heated, releasing the carbon dioxide to the atmosphere again through volcanic vents. This biogeochemical daisy chain linking the atmosphere, the biota, the oceans, and the deep interior of the planet might seem a curiosity, were it not that the cycling of carbon is believed to have served as a kind of global thermostat, regulating Earth's temperature within a narrow range over billions of years.

Now human activities--burning carbon in fossil fuels that came originally from plant matter and hence from atmospheric carbon dioxide--are altering the natural carbon cycle, releasing carbon dioxide to the air in quantities large enough to increase atmospheric concentrations 25 percent since the dawn of the industrial era. The effects of this change--which include increased greenhouse warming of the atmosphere, but could also include potentially countervailing effects such as increased cloudiness or more plant growth--remain uncertain. But scientists have gained as well a healthy respect for what they do not know about the interconnections among the parts of the Earth system--

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interconnections that could intensify as well as mitigate global warming.

POLICY RELEVANCE

The global changes of greatest concern to national and international policy makers are those that could degrade the Earth's life-support system. Central to this concern are questions about the Earth's future climate, such as the global and regional distributions of temperature, precipitation, and storm frequency and intensity. Of equal concern are questions about how future climates may affect such components of the Earth system as sea level, biological productivity and diversity, and the chemical composition and water storage capacity of soils.

To create prudent environmental policies, therefore, will require a much improved scientific understanding of the Earth system, how it changes naturally, how human activities change it, and how it might respond to future changes in environmental conditions.

The Bush Administration is giving priority attention to research on global change. The research effort is centered on four broad problem areas or themes:

Global water and energy cycles: focusing on a better understanding of the role of clouds, the role of the oceans, the role of terrestrial ecosystems, and the role of polar ice sheets;

Global carbon cycle: focusing on a more precise knowledge of terrestrial and oceanic sources and sinks of key carbon

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compounds, including the chemical reactions which they participate in, the processes that control the fluxes of these compounds within the Earth system, and how these processes might vary as climatic conditions change;

Ecological systems and populations of living organisms:

focusing on the effects of global change at regional scales, including the responses of intensively managed and natural oceanic and terrestrial ecosystems to global change;

Climate modeling: building on all of the above efforts to develop an improved predictive capability of the Earth as a coupled system comprising air, land, sea, and biological components, with an emphasis on modeling regional effects in greater detail.

Special attention is also directed to research on economic issues associated with global change and with responses to it and to the data collection, storage, and analysis systems required to document the Earth system and support the research effort.

STATE OF THE SCIENCE

What is known beyond all doubt is that there is a natural greenhouse effect which keeps the Earth warmer by about 33° Centigrade than it otherwise would be. The geological record contains clear evidence of natural variations of climate and, over the past 160,000 years, evidence that changes in Earth's

~~surface temperature are closely correlated with changes in~~

atmospheric concentrations of greenhouse gases. It is also

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undisputed that atmospheric levels of carbon dioxide have gone up about 25 percent since pre-industrial times due to human combustion of fossil fuels and other organic matter and that levels of methane and chlorofluorocarbons (CFCs) have gone up even faster. These rates of increase are geologically unprecedented.

Based on a two-year study by an international team of scientists, the Intergovernmental Panel on Climate Change (IPCC), sponsored by the United Nations, concludes that global mean surface temperature has increased by 0.3° to 0.6° Centigrade over the past 100 years. This warming, according to the IPCC, is broadly consistent with predictions of climate models, but could also be due to natural climate variability. These same climate models predict a mean surface temperature increase of between 1.5° and 4.5° Centigrade from a doubling of carbon dioxide or its equivalent in other greenhouse gases. But these predictions must be regarded as uncertain, according to the IPCC, particularly with regard to the timing, magnitude, and regional patterns of climate change. Regional predictions are particularly important, since it is the rainfall and temperature in a particular region that matter to those who live there, not the global average.

The pattern of knowledge at present is one of concrete observations coupled with uncertain implications. The mechanisms connecting the parallel rise and fall of global temperature and ~~carbon dioxide levels in the atmosphere, for example, are still~~ obscure, and it is not clear from the geological record whether

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temperatures lead carbon dioxide or the reverse. Likewise the 1980's included five of the warmest years on record, as recorded by surface measurements, yet satellite measurements show no consistent warming trend for the decade.

At the same time, scientists caution that the uncertainties extend in both directions: climate models could understate as well as overstate the extent of any future climate change, and--given the incomplete knowledge of the Earth system--surprises cannot be ruled out. The emergence of the Antarctic ozone hole, neither anticipated or originally understood, was just such a surprise, and it demonstrated that the atmosphere is not so large, nor its inertia so great, that human activities cannot affect it under certain circumstances on human time scales. Human release of CFCs, combined with unique meteorological conditions, created the ozone hole in a few decades. Atmosphere-ocean interactions may harbor the possibility of additional surprises. If, for example, ocean circulation patterns could shift from one stable configuration to another, as paleoecological data suggest but do not yet prove, the potential impacts on climate could be large.

The risks associated with global environmental change and the scientific uncertainties surrounding it are both substantial. So, too, are the economic costs associated with addressing global change. Research thus provides the best means of assessing the ~~risks, reducing the uncertainties and providing a firmer basis~~ for national and international policy actions. Only a better

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understanding of the many components of the Earth system and their interactions can lead to an improved ability to predict of global change.

Global Water Cycles

Water plays a central role in the Earth system, and not only because of its essential role for all forms of life. Water's physical properties give it a role as a climatic thermostat and heat transport mechanism. A quantity of water can absorb more heat for each degree of temperature rise than the same amount of most other substances. Thus bodies of water have a large thermal inertia; lakes and oceans fluctuate little in temperature, making them the flywheel of the global heat engine. Likewise water absorbs or gives up more heat when changing among solid, liquid, and vapor states than do most other substances. Thus water evaporated by the sun carries heat into the atmosphere, where it is transported around the world by the atmospheric circulation and finally released when the water vapor condenses to form a cloud or precipitation. The world's glaciers and polar ice caps store more than three-fourths the world's fresh water, and their advance or retreat has a major impact on sea levels.

The global hydrologic cycle plays a pivotal role in the Earth's radiation and heat budgets. The distribution of clouds and water vapor, for example, play a key role in controlling the amount of solar energy absorbed by the Earth system as well as the infrared radiation emitted to space, and they strongly influence the redistribution of heat throughout the Earth system.

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The future availability of adequate water supplies is the most significant natural resource issue in many regions throughout the world. Any substantial rise in sea level would have major economic impact on low-lying coastal areas, resulting in erosion, inundation, and/or wetland loss.

The research projects accorded a high priority include the study of atmospheric water vapor (the most important greenhouse gas in the atmosphere), clouds and their role in climate system feedbacks, precipitation and its distribution over land and sea, changes in sea ice extent and amount, the role of the oceanic circulation in absorbing greenhouse gases and redistributing heat, and the interaction of terrestrial ecosystems with the atmosphere.

The flow of energy in the atmosphere is strongly influenced by the presence of all three phases of water (as water vapor, as condensed water in clouds, and as ice or snow) in the atmosphere. Clouds play a major role in the exchange of energy and moisture, yet are not well understood. For example, small changes in the distribution of relative humidity can alter the characteristics of clouds and hence alter the radiation balance of the atmosphere. Scientific understanding of these processes is held back by inadequate knowledge of how water in the atmosphere, forced to condense, is organized into clouds of varying type and spatial distribution.

The oceans are by far the dominant reservoir on the planet for both water and heat. Evaporation and precipitation over the

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ocean result in the exchange of latent heat, as well as water, with the atmosphere. In turn, precipitation and evaporation exert a strong control on salinity, water mass formation, and the deep circulation of the ocean. A prominent example of the interaction of the upper ocean and the atmosphere is provided by the phenomenon known as El Nino/Southern Oscillation (ENSO), in which major shifts in upper ocean and atmospheric circulation in the tropical Pacific result in changes in the distribution of rainfall over an area stretching from India and Australia to North and South America. Changes in the deep circulation of the ocean can also cause large global changes in the distribution of rainfall on time scales of decades to centuries, according to evidence from paleoclimate studies and experiments with coupled ocean-atmosphere models.

Recent research has shown the importance of land surface processes in regulating the supply of heat and moisture available in air masses as they move across continents. Although the basic processes that govern the movement of water, from precipitation, infiltration through the soil, ground water recharge and river runoff are reasonably well understood over small areas, they are poorly understood over larger regions and continental-sized areas. It is well known that soil moisture provides a source of atmospheric water vapor that can then produce precipitation. Thus a large area of wet soils can enhance precipitation, while a drought (and the associated dry soils) can become self-sustaining. But much better understanding is needed, for example,

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of the role of the release of water to the atmosphere from vegetation, lakes, and other land cover types, of the growth or shrinkage of glaciers at high latitudes or elevations, and of the dynamics of permafrost in polar regions. Plants play an important part in many of these land surface processes, for example by regulating the rate at which a land surface returns water vapor to the atmosphere, as do such human activities as deforestation, irrigation, urbanization, and the construction of dams.

During the past century, scientists estimate that sea level has risen about 20 cm from the observed worldwide retreat and melting of temperate glaciers, especially those in southeastern Alaska, and from thermal expansion of the oceans. Future sea level is expected to rise in response to global warming, but there are enormous uncertainties in both measurement and in the understanding of the underlying science. For example, there needs to be a better understanding of the relationship between carbon dioxide concentrations in the Earth's atmosphere, temperature and global ice volume.

Representation of the hydrologic cycle is one of the major acknowledged weaknesses in climate general circulation models. For example, in several coupled climate models, errors in the flux of water between ocean and atmosphere result in incorrect distributions of sea surface salinity and ultimately, unrealistic model results. On smaller space and time scales, projections of ~~regional drought using numerical models appears within reach~~ using extensions of existing weather prediction approaches.

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Global Carbon Cycle

In the chemistry of life, the chemical element carbon plays the central role. As fossil fuels, carbon compounds have played and still play the central role in this century's industrial expansion of human activities. In still another role, carbon compounds are central to the operation of the greenhouse mechanism that has maintained the Earth system at a habitable temperature for billions of years. All three roles interact in what scientists have described as a "large-scale geophysical experiment" now underway, an experiment exploring the impact of human activities on climate change.

The outcome of the experiment is not yet known. But what is certain is that human activities are altering the global carbon cycle, increasing the atmospheric concentrations of carbon-containing gases such as carbon dioxide, methane, and chlorofluorocarbons that absorb infrared radiation and thus increase the radiative heating of the atmosphere. The concentrations of other trace gases, such as carbon monoxide and the oxides of nitrogen, are also increasing, with effects on the formation or lifetimes of radiatively active gases.

Many of the key processes in the carbon cycle that control the sources and sinks of these gases are still poorly understood. Of the carbon dioxide emitted from the burning of fossil fuels, for example, only about half reaches the atmosphere: about half of the rest is apparently absorbed by the oceans, and the remainder--fully a quarter of the anthropogenic carbon dioxide--

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vanishes into a still unknown sink. Under these circumstances, predictions are difficult. Reducing these uncertainties will be essential to develop effective strategies for controlling anthropogenic greenhouse gas emissions or for altering the natural carbon cycle to enhance natural sinks.

The atmospheric concentration of carbon dioxide is now about 350 parts per million (ppm), and is increasing about 1.8 ppm per year. About 6 billion metric tons of carbon is released to the atmosphere annually as carbon dioxide from human activities. This amount is very small in comparison to the flux from natural sources, but it has been large enough to increase atmospheric carbon dioxide concentrations by 25 percent since pre-industrial times.

The research challenge is to understand the fate of the anthropogenic carbon--to determine the sinks that remove carbon from the atmosphere. The rate of carbon dioxide uptake by the oceans is controlled by both the exchange rate at the sea-air interface and the chemical, biological, and physical processes that transfer carbon-containing surface water to the deep ocean and sediments, where it is sequestered for long periods. These processes need to be better understood and the fluxes of carbon dioxide into and within the oceans more accurately known. There are suggestions that human influenced sources of nutrients may be increasing productivity and hence carbon uptake in oceanic ecosystems.

Similarly, in terrestrial ecosystems, there are suggestions

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that warmer conditions, enhanced photosynthesis due to higher carbon dioxide levels and increased use of nitrogen fertilizers, and changing land management practices may all have increased productivity and carbon dioxide uptake or storage. The challenge is to understand the amount of carbon stored in different terrestrial ecosystems and their components--including live biomass, detritus, soil, permafrost, and sediments--and the cycling and transformation of carbon within these ecosystems. It is particularly important to understand such factors as the impact of changing climate conditions, higher carbon dioxide levels, and the frequency of fires on the growth and carbon fixation by vegetation.

The atmospheric concentration of methane is 1.72 ppm, more than double the pre-industrial value, is increasing at a rate of 0.9 percent per year, and is greater today than at any time during the last 160,000 years. Methane is produced from a wide variety of human and natural sources, including natural wetlands, rice cultivation, enteric fermentation in domestic animals, burning of biomass, deposits of methane-containing materials known as clathrates, and venting or leaks of natural gas from wells and pipelines. The research challenge is to improve the quantitative knowledge of the fluxes of methane from these sources and the process that control its release.

Oxidation in the lower atmosphere is the major sink for ~~atmospheric methane, and results in an atmospheric lifetime of~~ about 10 years. Photochemical models currently suggest that the

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atmospheric oxidizing capacity may be declining, which would imply a longer residence time for methane. Oxidants for methane include ozone (from the stratosphere and from manmade smog) and other chemical species with both natural and man-made sources. There is now evidence to suggest that, during the past century, oxidant (primarily ozone) levels in industrialized and remote areas in the northern hemisphere areas have increased due to growing pollution. Investigating the atmospheric and physical chemical processes that affect the atmospheric lifetime is an important research need.

Ecological Systems and Population Dynamics

The living organisms of the Earth both play a part in and are affected by climate change. Plants are a major reservoir of carbon dioxide. Microbial activity is the major source of methane. Human activities such as the burning of fossil fuel, deforestation, and agriculture are increasing the levels of greenhouse gases. To understand these roles and the consequences of changes in climate on populations of living organisms and on the ecosystem communities with which they interact is of critical importance. What is at stake is both the carrying capacity of the planet and the wealth and diversity of Earth's biological resources.

At present, the net effects of warming on competing biological processes cannot be reliably predicted. Higher temperatures for example tend to increase both photosynthesis-
-which removes carbon dioxide from the atmosphere--and

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respiration in plants and microbial decomposition of biomass-- which release carbon dioxide. Present evidence is that respiration may increase more at higher temperatures, leading to increased release of carbon dioxide from terrestrial ecosystems. Increased soil moisture, on the other hand, would tend to increase plant growth and carbon storage. Higher levels of carbon dioxide also may increase plant growth in a number of ways, from stimulating photosynthesis to improving plant's resistance to water and nutrient stress to prolonging the growing season. There is considerable uncertainty about the operation of these processes in natural ecosystems.

Because species respond differently to climatic change, ecosystems are likely to change in structure and composition under conditions of global warming. Temperature changes comparable in magnitude to those predicted by today's climate models have in the past been associated with significant shifts in the geographical distribution of terrestrial plants and animals. During the Medieval Warm Epoch from 800 to 1200 AD, the boreal forests of Canada extended well north of their present boundaries and Scandinavian farmers grew grain as far north as 65° latitude.

Deforestation in tropical regions and forest harvesting and regrowth in temperate zones help to alter the flux of carbon dioxide between the land and the atmosphere. The net effect of these human activities are quite uncertain, however. The issue is further complicated by the over-fertilization of surface waters

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in the Northern hemisphere attributable to acid rain and the runoff of nitrogen fertilizers, which may be promoting carbon storage in biomass. Proposed reforestation efforts will also increase carbon storage.

The research need is to understand in a far more quantitative way both the effects of global change on biological systems and their contributions to such change. An important component is the impact of both planned human activities, such as agricultural pursuits or reforestation, and inadvertent, such as destruction of wetlands and wildlife habitat through overuse or alteration of nutrient balances through pollution. The study of population dynamics provides links among these interacting social, economic, biological and ecological variables, from small-scale experiments on how competing plants may grow in high carbon dioxide atmospheres to larger-scale considerations of how global food availability may be affected under global change. National and international decision makers must know how global change will affect biological resources, and what can be done to plan for it.

Sampling biological populations and building ecological databases is one important research focus. Crop yields, fishery and forestry resources, and the abundances of game and some non-game species are measured directly in many nations. Remote sensing from satellites can indicate the distribution of major plant life-forms. The application of sampling and monitoring methods needs to be extended over longer periods of time, in

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order to detect projected changes due to global change over a naturally variable background. The empirical climate records have made obvious the lack of detailed ecological databases with comparable data.

A second research focus is the exploration of factors that govern the response of populations to global change. Key unknowns include the extent to which climate and carbon dioxide levels control species composition and abundances, the importance of interspecific interactions in determining the composition of an ecological community, and how species interactions are likely to be altered under global change. In human-impacted environments, more understanding is needed of the consequences that global change will have on human health and on the vulnerabilities of economic institutions nationally, regionally, and worldwide. The consequences of global change for geographic distributions, dispersal and migration of populations, both human and otherwise, are poorly understood.

A more realistic accounting of the true environmental and economic costs of resource exploitation and management is necessary for wise stewardship of resources now and in the future. Better descriptions and models of the links between energy use, agricultural and forest management practices, land-use, human migration and gas emissions will be especially important for predicting both direct and indirect human contributions to global change.

Populations may collapse after reaching critically low or

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high numbers, or if important habitat or food resources are removed. Human populations and their institutions also show both continuous and discontinuous responses to environmental stresses. Greater understanding is needed of the concepts of thresholds in both economic and ecological systems. Biological and human populations susceptible to irreversible outcomes should be identified. The processes that lead to rapid changes in abundance or distribution, such as forest diebacks or fish population collapse, must be studied in relation to global change.

The scientific community has many well-developed tools for simulating the dynamics of single, and in some cases two or more interacting populations of plants and animals. Models of larger numbers of interacting populations must be improved, coupled to the physical environment, and scaled up to larger geographic regions. Human population and economic models should be integrated with resource and biological models, in order to provide a more complete description of the interaction of resource management and the distribution and abundance of species.

Climate Modeling and Prediction

Understanding and predicting changes in the Earth system requires that many distinct components be successfully linked. At present, models are used that predict separately the atmosphere, the oceans, the land surface, the terrestrial and marine ecosystems, ~~and other components of future environments. One reason is that~~ the capacity and speed of computers required to simulate the

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coupled ocean/atmosphere/land Earth system are presently inadequate. The estimated improvement in computational capabilities would require a thousand-fold increase (see Chapter 2). A second reason is that the processes that govern the interaction of the system's components are insufficiently understood. Improving the knowledge base and integrating the predictions from these various models is thus a central goal of research.

Given the complexity of the Earth system and its many feedbacks, prediction of climate and environmental changes is not straightforward. For example, the human-generated increases in atmospheric carbon dioxide concentration is a major factor potentially causing climate change. However, because carbon dioxide is the primary raw material for photosynthesis, increased carbon dioxide concentrations are also likely to have a direct biological affect manifested as changes in the extent and distribution of the Earth's vegetative cover. This, in turn, affects hydrology and surface albedo and could affect climate. Such complex Earth system processes and interactive feedbacks can only be understood through model simulations.

Today's global models simulate with acceptable confidence some of the important processes of global change, such as the direct response of the climate system to increased atmospheric concentrations of greenhouse gases, such as the warming of the troposphere and the cooling of the stratosphere. Many physical processes, however, are treated only in a rudimentary fashion by

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the models. These include the interaction between clouds and radiation, ocean circulation, changes in the distribution and abundance of biota, the role of the biosphere in recycling carbon, and ocean and terrestrial exchanges with the atmosphere of heat, water, carbon dioxide and other gases.

Today, scientists model individual components or limited subsystems of climate, such as the atmosphere; the atmosphere and ocean; or the atmosphere, ocean and prescribed land-surface, rather than the entire coupled system. More reliable climate change predictions, especially at the regional scale, will require representation of the integrated behavior of the climate system with fully coupled subsystem models.

The primary climate models, called general circulation models, predict a variety of climatic variables, such as temperature, precipitation, winds, snow accumulation, and soil moisture. Integrating these largely atmospheric models with those for the ocean, the land surface, and the biotic changes in those regimes will be necessary for improved prediction.

Observations of a wide variety of past and present physical, geological, chemical, and biological parameters associated with the atmosphere, land, and ocean will be required to improve scientific understanding of how the Earth functions as a single coupled system. Good data and information management are essential to accomplish this. Data sets must be organized and assimilated so the model simulations of present and past environments can be compared to nature as a test of model

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accuracy.

Model development requires greater understanding of processes within each component of the Earth system, such as cloud-radiation interactions, and of processes that involve interactions between two or more of the components, such the role of the oceans and terrestrial biota as sinks for atmospheric carbon dioxide, together with the changes that may occur in these processes under different climatic regimes.

Economics Research

Economic activities play a central role in determining the level of energy, land use, and industrial activity that contribute to global change. Thus economic research and methods provide an important tool for evaluating the effects on society of global changes. Economic considerations are also important in evaluating the costs and human consequences of actions that might possibly be taken to alter the timing or magnitude of global change, and thus to the choice of policy response options.

The key needs for research are to document economic trends that determine human inputs to global change throughout the world, to study the economic consequences of responses to global change, and to develop means of assessing issues that crosscut the physical, biological, and economic sciences. This includes, for example, a better understanding of the economic forces driving technological change and productivity growth and of the underlying adaptive capability of economic sectors faced with climate changes and the nature of economic growth, especially in

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developing countries. An ability to represent this improved understanding in economic models is also required, in order to evaluate international market and trade effects and to develop consistent scenarios and predictions of trace gas emissions and global change effects.

Global environmental changes could have profound impacts on the resources and systems which determine the health, abundance, distribution, and well-being of human beings and other species. Irreversibility of species loss and other potential consequences of global change and the need to consider a time frame of 50 to 100 years or more pose special problems for economics and decision science research. Researchers must re-examine discounting and the general topic of valuing future outcomes and costs, drawing on approaches from both the social and physical sciences.

Economics research can make several important contributions to establishing a foundation for policy analysis. First, economics research can address issues in strategy, gaming, negotiation, compliance and enforcement that are relevant to the global change policy process. Second, research can examine the strengths and weaknesses of the types of generic policy instruments that are potentially applicable in the global change context. Finally, research can contribute to the development and refinement of tools, such as internationally linked macroeconomic models that will play an important role in policy analysis.

CHAPTER 6

SHAPING THE MINDS OF TOMORROW

America is facing a quiet crisis in science and mathematics education. Compared to the achievements of students in other countries, the performance of American students is declining. Many elementary and secondary school teachers have inadequate preparation for and lack current knowledge of their subjects.

Quality of education is not the only concern. Too few students are pursuing courses of study that will qualify them to fill critical scientific and technical jobs in the future. Unless this trend is reversed, the prospect is that the United States will increasingly have to depend on foreign nationals to staff its university science departments and its industrial laboratories. Shortages are already evident in the supply of technicians and technically-inclined workers of all kinds on whom the nation depends to keep its airplanes flying, its computers on line, and its production machinery humming. In particular, the number of women and minorities seeking science courses and careers is very low. Yet this group comprises the largest share of new entrants to the workforce and must be drawn on for a larger share of the nation's scientists and engineers if shortages are to be avoided.

On a broader scale, the American public is not well informed about science and uncomfortable with quantitative reasoning. Such ~~widespread illiteracy (about science) and innumeracy make it~~

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difficult for many people to function effectively as citizens in a society marked by growing complexity and technical sophistication or even to grasp issues that affect their lives, from AIDS to the environment.

The link between science and mathematics education and U.S. international competitiveness in science and technology became an issue overnight in 1957 with the launch of the Soviet space satellite Sputnik. During the ensuing three decades, American higher education has retained its position of international preeminence. By contrast, however, U.S. standing in precollege mathematics and science education has eroded. This has occurred even as science and technology have become increasingly common in the American home and workplace.

The concern, acknowledged in scores of reports, is broader than science and mathematics alone and puts at risk more than the future supply of scientists and engineers. The crisis in precollege education goes directly to the U.S. ability to compete economically and hence to provide jobs and a growing standard of living for its citizens. As the Commission on Excellence reported just a few years ago in A Nation At Risk, "If an unfriendly foreign power has attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves." Yet the nation is only now beginning to respond with the sense of urgency appropriate to a problem of this magnitude.

Just such concerns led President Bush, in September of 1989,

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to convene the nation's first Educational Summit with the Nation's Governors. The Summit led to the adoption of National Educational Goals that established targets for American educational achievement by the year 2000 and serve as the framework for the national movement to improve education. Three of the six Goals are directly related to mathematics and science education (see Box). Perhaps no goal is more critical to America's future international competitiveness than Goal #4: "By the year 2000, U.S. students will be first in the world in science and mathematics achievement."

Improved achievement in science and mathematics education are central to economic competitiveness because research and development--and the improved technology and new products and processes they lead to--play a crucial role in improving economic productivity. At the same time, more and more jobs--even ordinary jobs--in the high tech workplaces and automated factories of the future will require technical skills.

In America, education is a partnership effort. The fundamental partnership is among teachers, students, and parents. There is a similar partnership among Federal, State and local governments. In precollege education, for example, the Federal role is to focus attention on the need for improvement and to marshal support from a range of sources, while providing only 6 percent of total national funding. In graduate education, at the other end of the education spectrum, Federal dollars are sometimes the only source of funds for student support.

But improving mathematics, science, engineering, and

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technology education will require greater efforts from all participants, including Federal, State and local governments, teachers, parents, students, professional associations, business and industry, community-based organizations, and organizations of individuals underrepresented in mathematics and science. Each has a stake in the quality and success of science, mathematics, and engineering education, and each has a unique and critical role to play.

box

NATIONAL EDUCATION GOALS

GOAL 1

By the year 2000, all children in America will start school ready to learn.

GOAL 2

By the year 2000, the high school graduation rate will increase to at least 90 percent.

GOAL 3

By the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter including English, mathematics, science, history, and

~~geography, and every school in America will ensure that all~~

students learn to use their minds well, so they may be prepared for

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responsible citizenship, further learning, and productive employment in our modern economy.

GOAL 4

By the year 2000, U.S. students will be first in the world in science and mathematics achievement.

GOAL 5

By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

GOAL 6

By the year 2000, every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning.

POLICY RELEVANCE

Scientists, engineers, and technicians contribute in a critical way to the nation's economic competitiveness. Yet if present trends in American education continue, this country will not be able to produce enough scientists and engineers to meet its workforce needs. As large numbers of those who entered the scientific workforce after World War II begin to retire, insufficient numbers

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of students are moving through the science pipeline to take their places. For example, the number of bachelor's degrees granted to engineers has declined in recent years (Figure 1). Over the next 17 years, the National Science Foundation estimates a cumulative shortfall of more than 100,000 Ph.D. scientists and engineers. The shortage of well-trained technicians is even more acute, with a shortfall of about 2 million expected by the end of the century. There is even a shortage of technical competence among new entrants to the general workforce, with many major industrial corporations reporting that the majority of employment applicants lack basic skills and abilities for today's computerized workplace.

One cause of these problems is the bleak state of enrollments in high school mathematics and science courses, which are frequently electives. In 1987, less than 50 percent of U.S. high school graduates took chemistry of any type, and only about 20 percent took physics. Underlying these numbers is a growing disenchantment with science and technology as prospective careers. Among freshman entering college, interest in science majors has declined by one-third over the past two decades; interest in engineering has fallen by a fourth since 1982; and interest in computer science has plunged by two-thirds in just four years.

The problem of keeping students in the science pipeline is even greater for women, persons with disabilities, and minorities underrepresented in science and technology, who, with foreign national, will comprise 85 percent of the net new entrants into the American workforce between now and the year 2000 (Figure 2). These

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individuals, who traditionally have not been part of the technical workforce, will be called upon to replace the decreasing percentage of white males seeking engineering and technical jobs. Today, only 8 percent of bachelor's degrees and 4 percent of all doctorate degrees in science and engineering are awarded to blacks and Hispanics, who together comprise 20 percent of the total population. By the turn of the century, minority students will account for more than 40 percent of our elementary and secondary school population. Thus it is urgent that the nation take steps to ensure greater participation by these groups in the scientific and technical workforce.

Without growth in student interest and ability in science and technology, America's once-impressive lead in science and engineering talent may begin to falter. Japan, for example, has doubled its technical workforce in the last two decades and, with half the population size of the United States, trains almost as many engineers each year. Turning around the quality of mathematics and science education in a decentralized public school system that involves over 40 million students and 2.3 million teachers in over 80,000 schools and 15,000 school districts will not be easy. But education is a ticking time bomb at the heart of the U.S. economy: the nation cannot address its long-term economic and social needs and may even find itself unable to compete in the emerging global economy of the 21st century, if it does not educate its children

~~adequately.~~

Instilling excellence in science and mathematics education is,

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therefore, an important mission of the Federal government. The Bush Administration is giving priority attention to precollege education, focusing resources and attention on the crucial elementary and secondary years. The program has four goals:

A Stronger Teaching Force. Major efforts will be made to enhance the skills of teachers. Teachers will gain greater exposure to cutting-edge science, update their knowledge, and become better prepared to educate students. More students in the science pipeline will form a larger pool of future teachers in critical scientific and technical fields. The teaching force can also be expanded by offering encouragement and incentives for mid-career professionals from science and technical disciplines to enter teaching through innovative programs in alternative certification. In addition, scientific and technical experts can assist teachers by serving as classroom resource people.

Better Educated Students. Increased efforts will be directed to motivate students to stay in the mathematics, science, and engineering pipeline. The program will link curricula with the real world of science by increasing student exposure to the latest scientific and technical developments, using hands-on activities and contact with Federal experts and facilities. Targeted Federal programs will help students complete high school with competency in mathematics and science and encourage them to enter college to receive further education in these subjects.

A More Scientifically Literate Public. Increased coordination will better enable Federal agencies to provide science and

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technology information to the public and increase public understanding. A more scientifically literate population will be better prepared to make well-informed risk assessment and to evaluate policy choices on difficult scientific and technical issues confronting the Nation.

A More Diverse Scientific and Technical Workforce. The multiple programs reaching groups underrepresented in science, such as women, minorities, and the disabled, will improve career awareness and educational opportunities for these groups, integral to the future workforce of the Nation.

THE STATE OF EDUCATION

Educators regard the precollege years, kindergarten through high school, as crucial in determining a child's lifetime understanding and performance in mathematics and science. Research suggests that attitudes toward mathematics and science are largely established during the primary school years and solidified in the middle school years. Fully half of American children conclude by the seventh grade that these fields are not open to them as options for continued educational growth or potential employment, thereby reducing the science pipeline by 50 percent (Figure 3). Precollege science and mathematics learning is also the foundation of science literacy in the U.S. population, shaping both the electorate and the workforce.

~~Three general areas of concern have been identified: student~~
learning; teachers, instruction, and curriculum materials; and

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reforming the broader school system.

Student Performance

A Nation at Risk and many reports that have followed it have called for the reform of American mathematics and science education, citing alarming lags in student achievement compared to that of other nations. In a recent international achievement survey that compared students in the United States and 15 other nations, American high school seniors scored among the bottom fourth on calculus and algebra achievement tests. Even the best American mathematics students--the top 13 percent--generally placed in the bottom 25 percent internationally. In a comparison with students in 12 other countries, U.S. high school students finished ninth in physics, eleventh in chemistry, and dead last in "advanced placement" biology. Overall, American high school students performed below their counterparts in Japan, China, Mexico, Canada, and Thailand.

In many of our high schools, science and mathematics courses are frequently ignored electives or, too often, are simply unavailable. Nearly 30 percent of U.S. high schools offer no courses in physics, 17 percent offer none in chemistry, and 70 percent offer none in earth or space science. Textbooks for the courses that do exist are sometimes inadequate. In the midst of a scientific information explosion, it can still take half a decade to update textbooks to include current knowledge.

To promote interest in the study of mathematics and science, educators must begin to reach children at a younger age. For many

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students now in school, it may be too late. They may have already learned that "science is not for them," or that "mathematics is too hard." Their teachers may have never had a college-level course in the subjects they must teach. Many children will never do a science experiment in class, take a field trip to a museum, or use a computer during their entire precollege education. Yet, when they complete their 13 years of basic education, they will enter adult life in the most technically challenging living and work environment the world has ever known. A recent study by the Hudson Institute for the Department of Labor has documented a growing shift in the labor market toward jobs that require higher skill levels--better quantitative skill and higher literacy levels.

America's Teachers

Teaching is a profession in crisis. In spite of their tremendous responsibilities, many teachers endure low salaries and low status, and recruiting teachers is becoming a great national challenge.

In the United States today, there are 2.3 million public school teachers in grades K-12. The Department of Education estimates that over the next decade, schools must hire 1.6 million new teachers, or an average of 160,000 teachers a year. Yet the primary source of new teachers, college students majoring in education, has fallen 55 percent since 1972 and today supplies only about half the teachers needed in the future. If it is becoming difficult to recruit teachers, it is even harder to retain them. Twenty percent of new teachers leave during their first year, and more than half leave before the sixth year. The nation is currently losing

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thirteen mathematics and science teachers for each new one entering the profession.

The numbers of new mathematics and science teachers do not in any case meet the need. Over 60 percent of junior high and high school principals say they have difficulty hiring teachers for physics, chemistry, and computer science classes. With decreasing enrollments in mathematics and science at the undergraduate level, the problem is likely to increase.

There is also concern for the quality of mathematics and science teaching. The American Association for the Advancement of Science concluded that few elementary school teachers have adequate preparation in science and mathematics before they begin to teach these subjects. In many instances such teachers have had only one or two courses in mathematics and science, and almost 50 percent have had no additional college coursework in the past 10 years. Leading professional associations of mathematics and science educators have established standards for coursework preparation for teachers. By their estimates, two-thirds or more of the nation's teachers do not meet these standards (Table 1):

Table 1
Percentage of teachers meeting standards of preparation

	science	mathematics		
elementary school teachers	33%	18%		
middle school teachers	22%	14%		
	biology	chemistry		physics

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high school teachers 29% 31% 12%

This problem is compounded by the fact that too often, teachers are required to teach out of their fields and work with outdated or inadequate instructional materials in science and mathematics. Because teachers have little contact with the practicing scientific community, they are frequently unable to tie real-life applications to the basic scientific concepts they must teach. If student performance is to be improved by the year 2000, mathematics and science instruction must increase in quality well before the end of the decade.

The Broader School System

There is growing recognition that teachers and students individually cannot solve all the difficulties encountered in mathematics and science education. For example, many mathematicians, scientists, and educators have advocated the use of hands-on learning in elementary and secondary classrooms. Yet studies indicate that little hands-on science is taught at the elementary school level and that the amount of hands-on assignments and student experiments has actually declined in recent years. In secondary schools, instruction in 50 minute periods makes it impossible to do many kinds of science experiments or to explore complex mathematical problems in detail. Restructuring efforts are underway in many parts of the Nation. The Federal government has ~~recognized and will continue to support these State and local~~ reform efforts.

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Public Science Literacy

A high quality basic science and mathematics education is a prerequisite for those who eventually choose careers in science and engineering fields, but it is equally necessary for the balance of our population if our citizens are to understand the scientific and technical issues that affect their lives: space policy, nuclear energy, AIDS research, or man's impact on the environment. Media coverage of important science and mathematics topics must increase and become better informed as well.

Although Americans have universal access to education and broad access to information, the state of American public scientific literacy is distressing. In one recent study, half the adults questioned did not know that it took one year for the Earth to orbit the Sun. Science literacy will be critical to an increasingly wide range of jobs--from repairing heavy machinery to using a scanning electron microscope, from using computers in the office to operating an automated production line. In addition, science literacy is already an important job component in careers as diverse as food production, transportation, communications, forestry, water and environmental management, weather monitoring, national defense, and public health. It is increasingly likely that each individual will have several jobs during his or her lifetime, and must have the basic skills and flexibility necessary to change with the changing job market. In short, the quality of basic

~~science and mathematics education is an issue for all Americans~~

citizens, workers, educators, and parents.

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NEW INITIATIVES

One key dimension of educational reform is a direct outcome of the Education Summit: The sense that the time had come for national goals in education--national goals with local implementation.

An initiative to establish just such goals for mathematics education has been underway for some time under the auspices of the National Council of Teachers of Mathematics. This pioneering grass-roots effort is leading to a national framework for mathematics curricula that can be implemented in each state. The Association of State Supervisors of Mathematics is undertaking additional programs to translate the national goals into state and local plans by training over 900 teachers who can then further spread the reform effort. Similar efforts are underway in science education.

Another initiative comes from innovations and experiments with new educational technologies that are likely to have a major impact on schools. These innovations, summarized in a report from the Congressional Office of Technology Assessment, include satellite networks that have enormous potential for sharing master teachers and for teacher training right in the schools. There are already three different national consortia providing interactive video instruction on a regional or national scale. There is also increasing recognition of the power of computers and high speed computer networks to give students broader access to information and learning tools, to share vast amounts of data and programs within a school or across the nation, and ultimately to customize

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instruction to the needs of each individual student (See Chapter 2). New educational technologies are likely to intensify pressures for restructuring the schools and removing antiquated barriers.

A third type of initiatives for educational reform in science and mathematics might come from closer ties between teachers and scientists. One aspect of this would be involvement of the nation's scientists and engineers, and of universities and research institutions of all kinds, in the educational process. Scientists and engineers can come to the classroom to teach or serve as technical resources and mentors to teachers and students. Likewise, pre-college science and mathematics teachers can be brought closer to the mainstream of science. Individual Federal agencies can play an important role in this process, since many agencies conduct research and maintain laboratories or technical facilities located in every State, the District of Columbia, Puerto Rico, and the Territories. This unparalleled collection of facilities could be utilized more fully to serve mathematics and science education, benefiting local communities and the nation as a whole. The Department of Energy, for example, has developed formal partnerships between its National Laboratories and rural and urban school systems. These partnerships provide technical assistance to the school systems, including short courses and institutes for teachers on energy-related topics, the loan of equipment, and help in developing classroom and out-of-classroom science experiments; they also provide summer research appointments for teachers and students and mentoring of students by laboratory scientists.

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Many initiatives are already underway. More will be needed, if the nation is to meet its needs in science and mathematics education and to fulfill its obligation to the next generation.

FIGURE LIST AND CAPTIONS

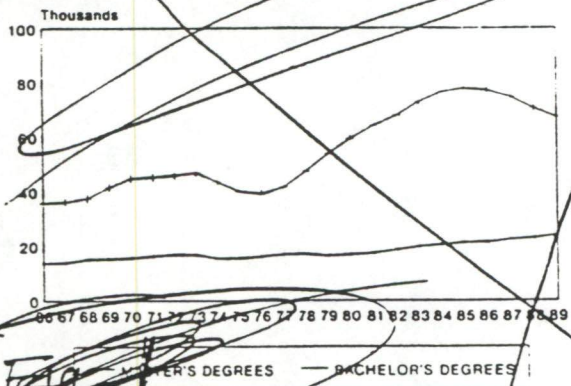
Figure 1. The Engineering Talent Pool/U.S. Engineering Bachelor's Degrees, 1980-1989.

Figure 2. The Changing Labor Force/Net New Workers, 1985-2000.

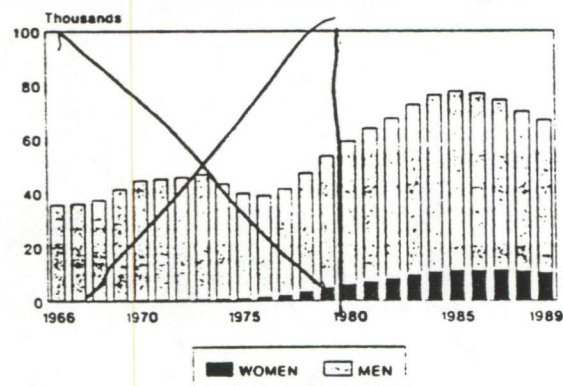
Figure 3. The Science Pipeline/U.S. Students Interested in or Pursuing Science and Engineering Careers

Fig. 1

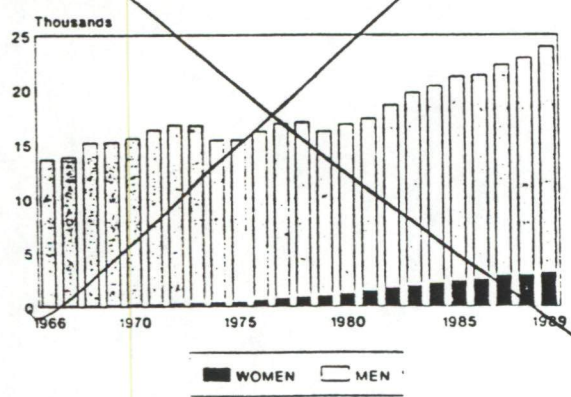
Figure 2
Engineering Degrees, 1966-1989



Engineering Bachelor's Degrees, 1966-1989



Engineering Master's Degrees, 1966-1989



Source: National Science Foundation

Figure 2 indicates a recent four-year decline in engineering bachelor's degree recipients, which is expected to be reflected at the master's level in the near future. Figure 2 also shows the low level of participation by women in these degree programs. In addition, the number of entering freshmen planning to major in engineering has dropped by 25% since 1982.

As a result of these and other factors, America's once-impressive lead in science and engineering personnel may begin to falter. Japan, for example, has doubled its technical workforce in the last two decades and, with half the population size of the United States, trains almost as many engineers as we do each year. Federal resources can help build a stronger technical workforce and maintain American inventiveness and discovery.

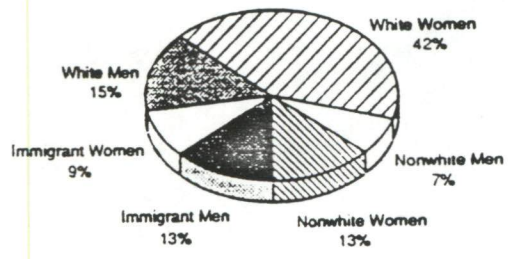
Underrepresented Groups

The problem of keeping students in the science pipeline is even greater for women, persons with disabilities and minorities underrepresented in science and technology, who, with foreign nationals, will comprise 85% of the net new entrants into the American workforce between now and the year 2000 (Figure 3). These individuals, who traditionally have not been part of the technical workforce, will be called upon to replace the decreasing percentage of white males seeking engineering and technical jobs. Today, only 8% of bachelor's degrees in science and engineering are awarded to blacks and Hispanics (20.2% of the total population combined); together, these minorities currently earn only 4% of all science and engineering Ph.D.s. At the turn of the century, minority students will account for more than 40% of our elementary and secondary school population. The Nation must take steps to

Fig. 2

ensure greater participation by these groups in the scientific and technical workforce.

~~Figure 2~~
The Changing Labor Force
Net New Workers, 1985-2000



Source: U.S. Department of Labor

Public Science Literacy

A high quality basic science and mathematics education is a prerequisite for those who eventually choose careers in science and engineering fields, but it is equally necessary for the balance of our population if our citizens are to understand the scientific and technical issues that affect their lives: space policy, nuclear energy, AIDS research, or man's impact on the environment. Media coverage of important science and mathematics topics must increase and become better informed as well.

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Science literacy will be critical to an increasingly wide range of jobs—from repairing heavy machinery to using a scanning electron microscope, from using computers in the office to operating an automated production line. In addition, science literacy is already an important job component in careers as diverse as food production, transportation, communications, forestry, water and environmental management, weather monitoring, national defense, and public health. It is increasingly likely that each individual will have several jobs during his or her lifetime, and must have the basic skills and flexibility necessary to change with the changing job market. In short, the quality of our basic science and mathematics education is an issue we must all face—as citizens, workers, educators and parents. Federal resources can play a role in broadening the base of American science literacy.

Fig 3

Teacher preparation is also an issue. The American Association for the Advancement of Science concluded that few elementary school teachers have adequate preparation in science and mathematics before they begin to teach these subjects. Leading professional associations of mathematics and science educators have established standards for coursework preparation for teachers. By their estimates, only the following percentages of teachers meet these standards:

- 33% of elementary school teachers (science)
- 18% of elementary school teachers (math)
- 22% of middle school teachers (science)
- 14% of middle school teachers (math)
- 29% of high school teachers (biology)
- 31% of high school teachers (chemistry)
- 12% of high school teachers (physics)

This problem is compounded by the fact that too often, teachers are required to teach out of their fields and work with outdated or inadequate instructional materials in science and mathematics. Because teachers have little contact with the practicing scientific community, they are frequently unable to tie real-life applications to the basic scientific concepts they must teach. If we are going to improve student performance by the year 2000, we must significantly improve mathematics and science instruction well before the end of the decade. By bringing them closer to cutting-edge science, innovative curriculum and materials, Federal agencies can help prepare teachers so that they can communicate the excitement of science to their students.

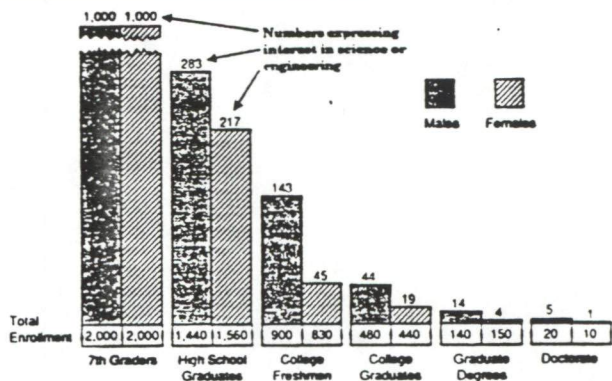
Workforce/Scientific Competitiveness

A Nation at Risk and the many education reports that followed also warned that without a growth in student interest and ability in science and technology, America's world marketplace competitiveness in these fields would be in jeopardy. At similar risk would be the premier position of America in scientific research and development. As large numbers of those who entered the scientific workforce after World War II begin to retire, insufficient numbers of students are moving through the science pipeline to take their places.

Figure 1

The Science Pipeline

Pool of Potential Scientists and Engineers Among U.S. Students



Source: National Science Foundation

If trends in American education continue on their present course, studies indicate that this country will not be able to produce enough scientists and engineers to meet its workforce needs. As Figure 1 illustrates, by the time children are in the seventh grade, fully half declare no interest in science. At the other end of the science pipeline, only six of every 4,000 seventh graders (five men and one woman) will ultimately receive a Ph.D. in science or engineering.

**SOME REMAINING ISSUES
RELATED TO
FEDERAL TECHNOLOGY TRANSFER**

NOVEMBER, 1990

FEDERAL LABORATORY CONSORTIUM
FOR TECHNOLOGY TRANSFER

Refer comments to:

WASHINGTON, DC OFFICE
1550 M Street, NW
Washington, DC 20005
202-331-4220

SOME REMAINING ISSUES RELATED TO FEDERAL TECHNOLOGY TRANSFER

At its 1990 Spring National Meeting, the Federal Laboratory Consortium (FLC) convened a panel to consider outstanding issues regarding the implementation of the Federal Technology Transfer Act of 1986 (FTTA). In conjunction with this panel, the FLC has developed this summary of some remaining issues that may require policy level resolution. With very few exceptions they are institutional and process issues for which no new legislation would be required. The summary of issues is deliberately brief and is intended to describe only the essence of each issue. The FLC is providing this to member agencies and remains available to expand on the issues and share experiences and information about current practices related to these issues. The FLC welcomes comments and suggestions on these and other issues.

FOREIGN COMPANY ISSUES

An underlying concern for all involved in domestic technology transfer of federally supported research and development is an issue related to identification of foreign companies and preference for U.S. companies.

DEFINING PREFERENCE POLICIES

The Federal Technology Transfer Act of 1986 states that "business units located in the U.S. which agree that products embodying inventions made under the cooperative research and development agreement (CRDA) or produced through the use of such inventions will be manufactured substantially in the United States" will receive preference for CRDAs. Presently, each department, agency and/or laboratory must interpret this language independently, and some foreign CRDAs do exist.

Is "substantial manufacture" the only relevant consideration for defining preference policies? Should guidance be provided to ensure that U.S. corporations receive preference? If so, how do we define a "U.S. corporation"? How do such policies fit with the Nation's international agreements?

PATENTS, COPYRIGHTS, LICENSES

Appropriate handling of intellectual property is critical to successful technology transfer and encompasses a breadth of practical issues.

COPYRIGHTING OF SOFTWARE DEVELOPED BY FEDERAL EMPLOYEES

Copyright law now prohibits copyright protection for works created in the course of federal employees' official duties. This applies to computer software. Also, for practical or legal reasons, some software cannot be adequately protected by patents. Such software can have substantial commercial value. Federally developed training materials also are not copyrightable, and may also have commercial value.

This is clearly a controversial issue. From the perspective of technology transfer, lack of copyright protection is a real barrier because the private sector will not invest in further development and commercialization. However, too much protection could impede future innovation.

The GOCO organizations are not subject to the prohibition against copyrights because they do not have federal employees. Their experience reveals how important proprietary rights can be to further commercialization of software developed with federal funds. Experience proves the value of software protection in preventing foreign companies from gaining advantage over U.S. firms in marketing software developed at U.S. Government expense.

Is there a way to make available copyright protection for all federally funded software without impeding innovation?

FILING FOR FOREIGN PATENTS

Federal laboratories usually do not file for foreign patents. Also, foreign patent applications can be complicated by technical publication in the U.S. Issues here include the importance of foreign patents, their costs, and the role of the private sector.

What guidance might be developed to share with laboratories for their consideration when faced with business decisions regarding filing for foreign patents?

GUIDELINES FOR EXCLUSIVE LICENSING

At present, there is no general guidance for entering into exclusive licensing agreements with regard to the following issues. Would it be possible to lay out broad guidance with respect to:

- 1) non-U.S. businesses?

- 2) exclusivity limited to specific fields of use?
- 3) announcements of license availability?
- 4) alternative licensing arrangements (e.g., royalties based on sales, and equity in lieu of royalty)?

READY ACCESS TO INTELLECTUAL PROPERTY ATTORNEYS

Some laboratories have no readily available intellectual property attorneys to assist with copyrights, patents, and licensing. Others find their system is overloaded or soon will be.

What mechanisms might be used to evaluate and remedy this situation?

LICENSING NOTICES FOR CRDAs

The federal code, effective since 1985, requires notice of the intent to grant an exclusive or partially exclusive license to be published in the Federal Register in order to provide the opportunity for objections to be filed. On the other hand, in order to better effect the commercialization of inventions developed under the CRDA, the FTTA permits the government to grant or agree to grant in advance, to a collaborating party, patent licenses or assignments, or options thereto, on any invention made in whole or in part by a Federal employee under the CRDA.

Would it be useful to develop parallel licensing regulations specific to the CRDAs and limit the application of existing codes to all but CRDAs?

IDENTIFICATION OF PROSPECTIVE LICENSEES

The current federal code, effective since 1985, requires that the prospective licensee be identified when publishing a notice of intent to license a technology.

Industry representatives indicate focus should be only on the technology to be licensed and not on the prospective licensing company. The identification provides important information to their competitors. It provides an opportunity to object, simply to deter their competition.

Should consideration be given to amending the federal code to address this issue and to generally make it fully consistent with the spirit of the FTTA?

Should consideration also be given to establishment of an appeals

procedure that specifically identifies and limits the right to bring an action to parties with a substantive case or controversy?

ROYALTIES OR OTHER INCOME FROM UNPATENTED TECHNOLOGY

There is no statutory guidance regarding royalties or other income from unpatented federal laboratory technologies and the disposition of such income.

Could guidance be developed for use by laboratories?

TECHNOLOGY DEVELOPED BY SBIR RECIPIENTS

Technology developed by SBIR recipients may remain unprotected by patents for two main reasons:

- (1) small businesses may not have the resources necessary to seek patent protection themselves, and
- (2) SBIR recipients may lack the motivation necessary to disclose and assign inventions to the Government for possible filing of patent applications.

As a result, the SBIR recipients could find themselves competing with large businesses for exclusive licenses granted by the Government on inventions developed under the SBIR awards. Motivation could be provided by regulations that give preferential treatment to SBIR recipients wishing to exclusively license from the Government those inventions assigned to the Government by the recipient.

Would it be beneficial to consider revising the Government licensing regulations with respect to SBIR to be consistent with the spirit of the FTTA? One revision could grant SBIR recipients the option to exclusively license from the Government those inventions that they have assigned to the Government and on which the Government has decided to seek patent protection. Such a modification of the licensing regulations might help promote the commercialization of inventions originating under the SBIR program.

TO LICENSE OR NOT TO LICENSE

In some instances, potential licensees approach a laboratory to license a technology and do so without having in place an organization which itself has proven expertise and capability for commercializing the technology. Not all laboratories consider licensing under such conditions. Is it appropriate to develop guidance that might be used to aid laboratories with this and related issues?

MEETING THE NEEDS OF LABORATORIES

Laboratories across the country which are engaged in domestic technology transfer continue to confront new issues where there may be no clear precedent. Some of these issues are very far reaching in their effect on the transfer process.

CONFLICT OF INTEREST

Everyone wants to avoid both conflict of interest and its appearance. Yet as federal laboratory employees transfer technology to the private sector many issues arise. Examples include: May laboratory employees consult on commercial projects that they worked on earlier, such as when it was a CRDA? May laboratory employees hold equity positions in a corporation whose technology they helped develop? Should laboratory employees disclose their financial holdings prior to working closely with industry? May laboratory employees be part of personnel exchanges with industry without being vulnerable to conflict of interest charges?

Concerns about such issues may be impeding technology transfer. Might consistent guidance substantially reduce the adverse effects?

EXPEDITING CONSULTANCY AGREEMENTS

Availability of expert consultants from federal laboratories may be critical to effective technology transfer associated with licensing of patents and in other cooperative areas. Not all federal laboratories have the statutory authority to do work for the private sector on a reimbursable basis (outside of a CRDA). Even in those situations where the authority exists, not all federal laboratories permit their employees to consult for the private sector. In some laboratories, consultancy agreements for a few days work receive the same level of scrutiny as do multi-million dollar agreements. Other laboratories have not developed procedures to permit consulting.

Could general guidance be designed to simplify the process which makes federal laboratory employees available as consultants?

CRDA LANGUAGE

The FTTA clearly does not intend to encumber the CRDA process with all the requirements that pertain to government procurements. However, even with this prohibition, in some instances, regulation wording is being borrowed from the procurement process inappropriately for CRDAs. These decisions are being made at each agency or laboratory.

Would it be useful to develop guidance for use by agencies and laboratories as to provisions which are appropriate to include in CRDAs?

CONSISTENT LEADERSHIP

Laboratory investigators do not necessarily see consistent support for technology transfer throughout the entire management structure of agencies and laboratories.

What can be done to develop strong consistent support for domestic technology transfer within and across agencies and laboratories?

FAIRNESS

Small and large businesses alike raise the issue of fairness with respect to federally supported research and development. Large companies have sufficient resources to assign one or more employees to technology-seeker positions, even including searching for CRDA opportunities with federal laboratories. Small businesses generally lack these resources, and yet provide a very significant share of new products and new jobs. Fairness issues are also of concern within the categories of both small and large businesses.

The Federal Laboratory Consortium, the Department of Commerce, including the National Institute of Standards and Technology, and some federal laboratories have made fruitful efforts to reach out to small businesses and to find ways to meet their needs. Can this process be significantly strengthened through the development of broad guidance to encourage each agency and laboratory as part of their technology transfer efforts to work with small as well as large businesses?

SHARED RISK/NEW APPROACHES

Success in domestic technology transfer will require many new approaches. Yet individuals in agencies and laboratories whose approval is necessary may act very conservatively as they have no guarantee of reward if the project is a success and perceive some personal risk in case of failure.

Could mechanisms be devised which would encourage development of new approaches and provide means for sharing the risk in approval while rewarding success?

FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS

Some Federally Funded Research and Development Centers (FFRDCs)* may be unsure as to whether they are included under the definition of the term "laboratory" in the section of the FTTA and have the ability to arrange CRDAs.

Would clarification ensure that all of the FFRDCs have the same clear opportunities to participate under the FTTA?

RESPONSIBILITIES OF LABORATORY PROFESSIONALS

Although the FTTA makes it clear that, consistent with their mission responsibilities, technology transfer is a responsibility of each laboratory science and engineering professional, many are unaware of the opportunities for technology transfer and their responsibilities to promote it.

How might laboratory employees be better informed?

LABORATORY PERSONNEL POLICY

Although the FTTA requires laboratory directors to ensure that efforts to transfer technology are considered positively in laboratory job descriptions, employee promotion policies, and evaluation of job performance of laboratory scientists and engineers, full implementation has not been achieved.

Is there an acceptable means of achieving broader conformance with this requirement?

FACILITATING ACCESS TO LABORATORIES

Not all laboratories are equally represented in information about laboratory activities and expertise compiled for use in facilitating technology transfer.

Would there be an acceptable means for gaining laboratory cooperation to assure more uniform access to laboratory technology and expertise?

* FFRDCs are R&D performing organizations exclusively or substantially financed by the Federal Government that are supported by the Federal Government either to meet a particular R&D objective or, in some instances, to provide major facilities at universities for research and associated training purposes. Each center is administered either by an industrial firm, a university, or another nonprofit institution.

TRAINING TECHNOLOGY TRANSFER ACT OF 1988 (PL 100-418)

The Training Technology Transfer Act of 1988 (TTTA) appears to centralize technology transfer of education and training software whereas the FTTA provides for a broad, decentralized approach. The TTTA is intended to facilitate the transfer of education and training software developed by federal agencies to the public and private sectors and establishes an Office of Training Technology Transfer (OTTT) within the Department of Education. The Act has provisions which could be construed to be in conflict with the FTTA of 1986.

The Act allows grants to prospective users of government developed training and educational software and provides the authority to the Department of Education to obtain services, equipment, personnel and facilities from other federal agencies to aid in technology transfer, even though those same agencies have the authority under the FTTA to transfer technology directly to the public and private sector.

Would review and clarification of the relative rules of the OTTT and the federal laboratories be most timely as the OTTT becomes operational so that it may serve to enhance technology transfer in these important areas?

MEETING NEEDS OF THE PRIVATE SECTOR

The private sector is taking an increased interest in federally supported technology. Some industries are seeking means of affecting the nature of the R&D while others are looking for consistency in the implementation of the technology transfer legislation.

EXEMPTIONS FROM FOIA DISCLOSURES

The National Competitiveness Technology Transfer Act of 1989 (PL 101-189), an amendment to the DOD Authorization Bill which amended the Federal Technology Transfer Act of 1986, provided up to a five-year exemption from Freedom of Information Act (FOIA) disclosures for technical information developed under CRDAs with federal laboratories.

Would it be useful to get input from the private sector regarding the value of FOIA exemption and the implementation of this provision and develop general guidance for agencies to use?

RELEVANCE OF FEDERALLY FUNDED TECHNOLOGY TO U.S. PRIVATE SECTOR

The U.S. private sector has not traditionally looked to government-funded R&D as a major technology resource for commercialization. As technical partnerships become more

prevalent, it may be important for industry to affect the direction of federally-funded R&D.

What approach could be taken to consider how elements of the U.S. private sector might appropriately be involved in the planning, evaluation, and implementation of government R&D programs, including how industry input might help to assure that the commercial potential of program results, expertise and facilities are considered while carrying out existing mission-oriented R&D?

* * *

The FLC is dedicated to promoting the rapid movement of Federal laboratory research results and technologies into the mainstream of the U.S. economy. From this perspective, the FLC has compiled these issues in order to draw attention to areas where improvements would accelerate technology transfer. The FLC welcomes comments and suggestions on these and other issues.

APPENDIX OF ACRONYMS

- CRDA - Cooperative Research and Development Agreement
- FFRDC - Federally Funded Research and Development Centers
- FLC - Federal Laboratory Consortium for Technology Transfer
- FOIA - Freedom of Information Act
- FTTA - Federal Technology Transfer Act of 1986
- GOCO - Government-Owned, Contractor-Operated
- OTTT - Office of Training Technology Transfer
- SBIR - Small Business Innovation Research
- TTTA - Training Technology Transfer Act of 1988

Science and Technology

Issue: Should the EPC become more directly engaged in policy on science and technology matters?

Reasons for More EPC Involvement:

- the President needs to do more to get more credit for Administration initiatives in the civilian high technology field

- success in the Persian Gulf confirmed wisdom of U.S. investment in military technology; makes evident the need for commitment on the civilian side

- the making of policy on civilian technology matters is fast moving outside the Cabinet Council structure

- the Administration may be drifting into policies and processes inconsistent with reliance on markets and the private sector

- because potential Democratic candidates, such as Gore, will likely push technology themes, the Administration needs a better handle on this issue at senior levels

Assistant to the President for
Science and Technology

Chairman,
Federal Coordinating
Committee on Science,
Engineering & Technology
(FCCSET)
(Interagency council)

Director,
Office of Science and
Technology Policy (OSTP)

Chairman,
President's Adviser on
Science & Technology
(PCAST)
(private sector panel)

Committee on
Physical, Mathematical
Engineering Sciences

Committee on
Sciences
Earth and Environment

Committee on
Life Science and Health

Committee on
International Science,
Engineering and
Technology

Committee on
Education and
Human Resources

Committee on
Radiation Research and
Policy Coordination

Committee on
Industry and Technology

Associate Director for
Life Sciences

Associate Director for
Industrial Technology

Associate Director for
Policy and
International Affairs

Associate Director for
Physical Science and
Engineering

Assistant Director for
National Security

Assistant Director for
Environment

MAJOR OSTP ISSUES AND ACTIVITIES 1989-1990

- o Develop High Performance Computing Initiative
- o Participate in Federal Budget Process on R&D
- o Coordinate Administration's Scientific Work on Global Climate Change
- o Formulate Math/Science Education Goals of Agencies with respect to R&D
- o Establish FCCSET Structure

EPC APPROACH TO S&T ISSUES

- o Goal: bring S&T policy issues affecting competitiveness into the EPC orbit.
- o Vehicle: activate the Science & Technology EPC Working Group chaired by Dr. Bromley.
- o Rely on the mid-1990 understanding with Bromley that significant S&T policy issues requiring decision go through the EPC or DPC.
- o Abandon the "comprehensive strategy" approach articulated in March 1989.
- o Instead, focus on specific, manageable issues.
- o Seek to establish credibility of the S&T Working Group as an available forum for future S&T issues.

PROPOSED AGENDA FOR S&T WORKING GROUP

- o Review Pending Legislation on Technology Policy
 - o American Technology Preeminence Act
 - o High Performance Computing Initiative
 - o Prospective Critical Technologies Legislation

- o Develop Guidelines Regarding Industry/Government Cost Sharing and Joint R&D
 - o Initial focus: electric car consortium in the National Energy Strategy

- o Develop Plan for the National Critical Technologies Institute

- o Develop position on Uruguay Round disciplines on Government support for R&D (perhaps better suited as TPRG issue)

CHARTER

FEDERAL COORDINATING COUNCIL FOR SCIENCE, ENGINEERING, AND TECHNOLOGY

The Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) is established pursuant to Public Law 94-282, Title V of the "National Science and Technology Policy Organization and Priorities Act of 1976" to consider cross-cutting science, engineering and technology issues. Specifically,

The Council shall consider problems and developments in the fields of science, engineering, technology and related activities affecting more than one Federal agency, and shall recommend policies and other measures designed to:

- (1) provide more effective planning and administration of Federal scientific, engineering, and technological programs,
- (2) identify research needs including areas requiring additional emphasis,
- (3) achieve more effective utilization of the scientific, engineering and technological resources and facilities of Federal agencies, including the elimination of unwarranted duplication, and
- (4) further international cooperation in science, engineering, and technology.

OBJECTIVES

In fulfilling this mandate, the FCCSET's two major objectives are:

- o to coordinate science, engineering and technology activities affecting more than one Federal agency and surface and resolve science, engineering and technology policy issues with respect to those activities.
- o to develop authoritative scientific, engineering and technological expertise and advice for the Executive Branch.

FUNCTIONS

To accomplish these two objectives the FCCSET will:

- o serve as a forum for coordinating science, engineering and technology programs affecting more than one Federal agency, sharing information, reviewing and implementing national and international policy objectives and developing consensus with respect to science, engineering and technology activities;
- o identify research and development needs and priorities;
- o issue reports, studies and assessments of current scientific, engineering and technological capabilities in fields of research and development of concern to the Executive Branch;
- o inform other policy making bodies of review, studies and analyses underway;
- o identify science, engineering and technology issues and concerns of importance to the nation and give expertise and advice to policy bodies;
- o work closely with the Office of Management and Budget in developing and reviewing annual and long-range Federal budget plans in selected cross-cutting areas of science, engineering and technology;
- o improve planning, coordination and communication among Federal agencies engaged in science, engineering and technology.

ADMINISTRATIVE PROVISIONS

To accomplish these functions the FCCSET is authorized to:

- o detail employees to the Council to perform such functions, consistent with the purposes of the FCCSET, as the Chairman may assign to them;
- o establish committees for the purposes of conducting studies, making reports, coordinating Federal science, technology and engineering activities that involve more than one Federal agency, and making recommendations to the FCCSET;
- o develop, review on an annual basis, charters for committees, and assign high priority agenda items as necessary;
- o Council meetings shall be called by the Chairman as deemed appropriate and such agency member shall attend at a senior policy level;
- o Council proceedings, studies and reports, either preliminary or final, shall be printed and distributed only with the Chairman's authorization.

MEMBERSHIP

The Council shall be chaired by the Director of the Office of Science and Technology Policy and shall be composed of one senior policy level representative of each of the following Federal agencies:

Department of Agriculture
Department of Commerce
Department of Defense
Department of Education
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Department of State
Department of Transportation
Department of Veteran's Administration
National Aeronautics and Space Administration
National Science Foundation
Environmental Protection Agency

Ex-Officio Members:

Director, Office of Management and Budget
Assistant to the President for National Security Affairs

Other agencies may be requested to participate in meetings of the Council concerned with matters of substantial interest to such agency.

DETERMINATION

I hereby approve and adopt this Charter which is determined to be consistent with PL-94-282 which establishes the FCCSET.

Approved:



D. Allan Bromley
Chairman, Federal Coordinating
Council for Science, Engineering
and Technology

June 6, 1990

Date:

**ENHANCING RESEARCH AND DEVELOPMENT
AND EXPANDING THE HUMAN FRONTIER**

- o **R&D:** The budget proposes to invest about \$76 billion in 1992 for research and development, including R&D facilities. This is an increase of over \$8 billion, or 13 percent over 1991. The budget proposes over \$13 billion for basic research, \$1 billion or about 8 percent over 1991. Federal civilian R&D will increase by 10 percent while defense-related R&D will increase by 14 percent.
- o **Space:** The budget proposes \$16 billion for space activities, \$2 billion, or 15 percent, over 1991. The budget for the National Aeronautics and Space Administration (NASA) will increase by 13 percent to \$15.7 billion.
- o **Biotechnology:** The budget proposes over \$4 billion for biotechnology, \$319 million, or 8 percent, over 1991.
- o **NSF:** The budget proposes an 18 percent increase for the National Science Foundation (NSF), to a total of \$2.7 billion, continuing the commitment to double NSF's budget between 1987 and 1994.
- o **Individual Investigators:** The budget emphasizes support for individual investigators at universities, and proposes \$50 million for a new program to provide state-of-the-art research instrumentation to academic researchers. Funding for grants for basic research through NSF will increase by 16 percent, and a 9 percent increase for research project grants at the National Institutes of Health is proposed.
- o **High Performance Computing and Communications:** The budget proposes a total of \$638 million, an increase of \$149 million, or 30 percent, over 1991 for a new initiative in high performance computing and communications. This initiative involves 8 Federal agencies. The goal is to assist in the development of computing capability with about 1,000 times improvement over current systems by 1996.
- o **Energy R&D:** The budget proposes over \$900 million, an increase of \$227 million or 34 percent above 1991, for research investments in targeted, high-payoff technologies in support of the National Energy Strategy. The R&D initiatives would increase the efficiency of energy use, develop alternatives to petroleum and advance new electricity technologies.
- o **Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS):** The budget proposes an increase of 5 percent to \$1.2 billion for R&D on HIV/AIDS. The budget includes a total increase of \$558 million, or 15 percent,

for HIV/AIDS research, treatment, prevention and income support.

- o Superconducting Super Collider (SSC): The budget proposes an increase of \$291 million, to a total of \$534 million, to support continued work toward the transition from prototype superconducting magnets to production, and to begin the construction of facilities.
- o Mission to Planet Earth and the U.S. Global Change Research Program (USGCRP): The budget includes an increase of \$232 million, or 24 percent, to a total of \$1,186 million to support a broad range of research efforts, including NASA's Mission to Planet Earth/Earth Observing System (MTPE/EOS) and ground-based programs such as the World Ocean Circulation Experiment.
- o New Launch System: A new space launch system is proposed, jointly funded by the Department of Defense and NASA (\$175 million each in 1992), consistent with the recommendations of the Advisory Committee on the Future of the U.S. Space Program.
- o Mathematics and Science Education: The budget includes an increase of \$225 million, or 13 percent, to \$1,941 million, for a major initiative in mathematics and science education. This initiative will help address problems that limit the pool and performance of math and science learners. Of the total increase, \$146 million, a 28 percent increase, is targeted toward the precollege level.
- o Human Genome Project: R&D for this project will increase by \$35 million, or 26 percent, to a total of \$169 million in the Departments of Energy and Health and Human Services (National Institutes of Health).
- o Research and Experimentation (R&D) Tax Credit: The budget proposes that this credit be made permanent and be reformulated to increase its effective rate.

Table II-2. ENHANCING RESEARCH AND DEVELOPMENT AND EXPANDING THE HUMAN FRONTIER—HIGHLIGHTS

(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Basic Research				
Doubling the NSF budget	2,316	2,722	+406	+18
Increasing Basic Biomedical Research at NIH	4,634	4,968	+334	+7
Human Genome Project	185	169	+35	+26
Agricultural Research Initiative	73	125	+52	+71
Superconducting Super Collider	243	534	+291	+120
Applied Research				
High Performance Computing and Communications	489	638	+149	+30
Energy R&D	676	903	+227	+34
Advanced Manufacturing and Materials	1,316	1,310	-6	—
HIV/AIDS	1,152	1,210	+58	+5
Moving Fusion Energy from Science to Engineering	275	337	+62	+23
Aeronautics R&D	482	543	+61	+13
Expanding R&D at the National Institute of Standards and Technology	215	248	+33	+15
Maintaining National Security: Defense R&D	37,783	43,247	+5,464	+14
Expanding the Geographic Frontier: Space Exploration				
Space Transportation Infrastructure	4,901	5,517	+716	+15
Space Science	1,774	2,141	+367	+21
Mission to Planet Earth (Global Change)	954	1,186	+232	+24
Mission From Planet Earth	2,199	2,470	+271	+12
Expanding the Human Frontier through Biotechnology	2,788	4,107	+319	+8