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U.S. National Science Foundation: An Overview

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Summary

The National Science Foundation (NSF) was created by the National Science Foundation Act of 1950, as amended (P.L. 81-507). The NSF has the broad mission of supporting science and engineering in general and funding basic research across many disciplines. The agency provides support for investigator-initiated, merit-reviewed, competitively selected awards, state-of-the-art tools, and instrumentation and facilities. The majority of the research supported by the NSF is conducted at U.S. colleges and universities. Approximately 83.1% ($2,506.2 million) of NSF's FY2002 $3,017.1 million research and development (R&D) budget was awarded to U.S. colleges and universities.[1] Preliminary data reveal that for FY2002, the NSF provided approximately 53.4% of all federally funded **basic** research conducted at the nation's colleges and universities, with the exclusion of biomedical research sponsored by the National Institutes of Health.[2] In addition, NSF provides almost 30% of the total federal support for science and mathematics education. This report will be updated periodically.

Background. The NSF's primary responsibility is to maintain the health and vitality of the U.S. academic science and engineering enterprise. In addition to ensuring the nation's supply of scientific and engineering personnel, the NSF promotes academic basic research and science and engineering education across many disciplines.[3] Other federal agencies, in contrast, support mission-specific research (i.e., health, agriculture, defense).

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[1] National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 2000, 2001,and 2002*, Detailed Statistical Tables, NSF02-321, Arlington, VA, May 2002, Table C-10.

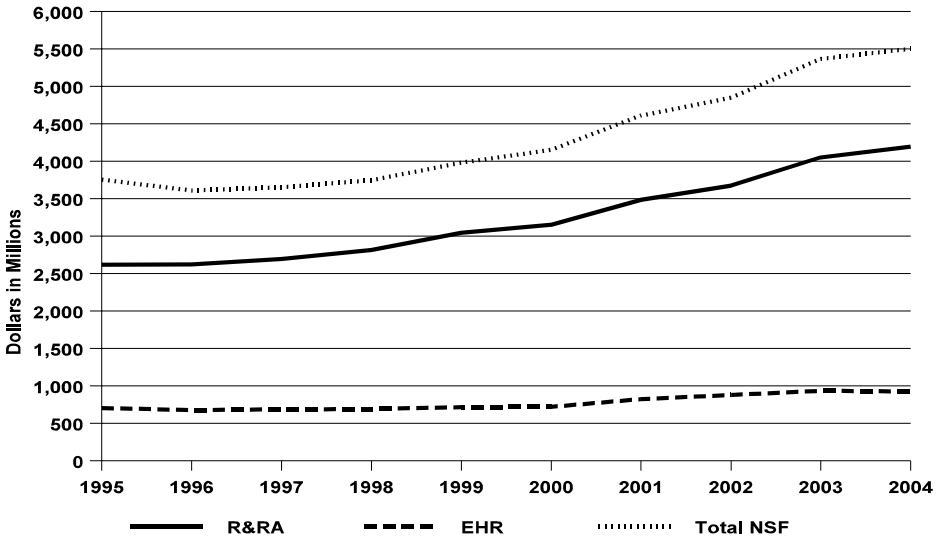
[2] Ibid., Table C-29.

[3] The NSF does not provide funding for research in clinical medicine, commerce, social work, or the arts and humanities.

The NSF provides support for investigator-initiated, merit-reviewed, competitively selected awards, state-of-the-art tools, instrumentation and facilities. The agency receives approximately 60,000 proposals annually, for research, graduate and postdoctoral fellowships, and science, mathematics, and engineering projects, and funds roughly one-third of them. Support is provided to academic institutions, industrial laboratories, private research firms, and major research facilities and centers. While the NSF does not operate any laboratories, it does support Antarctic research stations, selected oceanographic vessels, and national research centers. Additionally, the NSF supports university-industry relationships and U.S. participation in international scientific ventures.

Most of the research supported by the NSF is conducted at U.S. colleges and universities. Approximately 83.1% ($2,506.2 million) of NSF's estimated FY2002 $3,017.1 million research and development (R&D) budget was awarded to U.S. colleges and universities. Preliminary data reveal that in FY2002, NSF provided approximately 53.4% of all federally funded **basic** research conducted at the nation's colleges and universities, with the exclusion of biomedical research sponsored by the National Institutes of Health.[4]

Figure 1. NSF R&D Support in Constant 2003 Dollars, FY1995 -FY2004



Source: National Science Foundation FY2005 Budget Request to Congress, p. 170-B.

[4] While the FY2002 R&D appropriation of $3,017.1 million was only 3.7% of the total federal R&D budget, the agency plays an important role in maintaining the university-based research enterprise. The NSF provided 19.3% of all federally supported basic research and 12.8% of federal academic research. NSF was the second largest federal supporter of academic research in FY2002, eclipsed by the Department of Health and Human Services, which provided 69.1%. The Department of Defense, the third largest supporter of academic research, provided 6.3%. *Federal Funds for Research and Development: Fiscal Years 2000, 2001, and 2002,* Tables C-10, and C-29.

The NSF is an independent agency in the executive branch and under the leadership of a presidentially appointed Director and a National Science Board (NSB) composed of 24 scientists, engineers, and university and industry officials involved in research and education. The NSB and the Director make policy for the NSF.

Organization and Fiscal Year 2005 Request. The NSF has enjoyed considerable growth during a period of constrained R&D budgets. When measured in current dollars, its total appropriation increased more than 70.6% in 10 years — FY1995, $3,270.3 million; FY1999; $3,425.7 million; and FY2004, $5,577.8 million. Even when inflation is taken into account, its growth increased (in constant FY2003 dollars) by 46.6% during this 10-year period. The FY2005 request for the National Science Foundation (NSF) is $5,745 million, a 2.9% ($167.2 million) increase over the FY2004 level of $5,577.8 million. The FY2005 request provides support for several interdependent priority areas: biocomplexity in the environment ($99.8 million), human and social dynamics ($23.3 million), mathematical sciences ($89.1 million), nanoscale science and engineering ($305.1 million), and strengthening the workforce ($20 million). NSF maintains that researchers need access to cutting-edge tools to pursue the complexity of research, and funding to develop and design the tools critical to 21st century research and education. Approximately 26% of the FY2005 request ($1,472.1 million) represents an investment in infrastructure of all types. Increasing grant size and duration has been a long-term priority for NSF. The FY2005 request devotes $40 million to increase the annual award size to an annual average of $142,000, a $3,000 increase over the FY2004 level. The request provides $80 million for the President's Math and Science Partnerships program (MSP). (In the FY2005 request, the MSP has been transferred from the Education and Human Resources Directorate to the Integrative Activities account). Additional FY2005 highlights include plant genome research ($89.5 million), climate change research ($25 million), and international collaborations in science and engineering ($34 million).

The FY2005 request supports seven major directorates and other programs and activity accounts. The directorates are the Biological Sciences; Computer and Information Science and Engineering; Education and Human Resources; Engineering; Geosciences; Mathematical and Physical Sciences; and Social, Behavioral, and Economic Sciences. Six of the seven directorates are in the Research and Related Activities Account (R&RA). In addition to the directorates, the R&RA includes the U.S. Polar Research Programs ($281.7 million), the U.S. Antarctic Logistical Support Activities ($68.1 million), and Integrative Activities ($240 million). The seven major directorates are described below.

Biological Sciences (BIO). The FY2005 request of $599.9 million for the BIO Directorate supports programs structured to improve scientific understanding of biological phenomena, ranging from the study of fundamental molecules of living organisms to the complexity of biological systems. Types of support provided include research workshops, symposia, conferences, the improvement of research collections, purchase of scientific equipment, and operation of research facilities.

Computer and Information Science and Engineering (CISE). The CISE Directorate, proposed at $618.1 million in FY2005, supports programs focused on the fundamental understanding of computing and information processing, and the use of state-of-the-art computational techniques in scientific and engineering research. Currently,

areas of research emphasized are parallel processing, automation and robotics, large-scale integrated electronic systems, scientific computing, and networking.

Education and Human Resources (EHR). The FY2005 request of $771.4 million for EHR supports science, engineering, mathematics, and technology education. People receiving support from the EHR include senior researchers, postdoctoral associates, graduate and undergraduate students, and teachers and students at the precollege level. Additional support is provided to individuals through informal science activities. More than 150,000 people are involved in the various activities and programs of the EHR.

Engineering (ENG). The ENG, with a request of $471.8 million in FY2005, is directed at enhancing the long-term economic strength and security of the Nation by fostering innovation and excellence in engineering education and research. It focuses on integrating education and research in interdisciplinary areas such as information and communication technologies, biotechnology, and environmental research.

Geosciences (GEO). The FY2005 request of $728.5 million for the GEO Directorate provides support to programs that promote knowledge and discussions concerning earth, including the sun, atmosphere, continents, oceans, and interior, and the linkages among them. One of the objectives of the GEO is to expand the knowledge of the biological, chemical, geological, and physical processes in the ocean, and at its boundaries, with the atmosphere and the earth's crust.

Mathematical and Physical Sciences (MPS). The FY2005 request of $1,115.5 million for the MPS would fund programs designed to increase the knowledge base in the relevant sciences; improve the quality of educational programs, with emphasis at the undergraduate level; improve the rate at which research efforts are translated into societal benefits; and increase the diversity of approaches and individuals in the mathematical and physical sciences.

Social, Behavioral, and Economic Sciences (SBE.) The SBE Directorate, proposed at $190.7 million in FY2005, supports programs directed at developing basic scientific knowledge about human behavior, culture, interaction, and decisionmaking, and about social, political, and economic systems, organizations, and institutions. The SBE also serves as the nation's primary data source on science and engineering human, institutional, and financial resources.

Other Program Activities and Accounts.

The Major Research Equipment and Facilities Construction (MREFC) account is funded at $213.3 million in FY2005, a 37.6% increase ($58.3 million) over the FY2004 level. The MREFC supports the acquisition and construction of major research facilities and equipment that extend the boundaries of science, engineering, and technology. Of all federal agencies, NSF is the primary supporter of "forefront instrumentation and facilities for the academic research and education communities." First priority for funding is directed at ongoing projects. Second priority is given to projects that have been approved by the National Science Board (NSB) for "new starts." In the FY2005 request, support is provided to three ongoing projects and three new starts. The three current projects are the Atacama Large Millimeter Array Construction ($49.7 million), EarthScope ($47.4 million), and IceCube Neutrino Observatory ($33.4 million). The new starts funded in

the FY2005 request are the National Ecological Observatory Network ($12 million), Scientific Ocean Drilling Vessel ($40.9 million), and the Rare Symmetry Violating Processes ($30 million). Additional NSB-approved projects are proposed for startup in FY2006 through FY2009.

The FY2005 request for the Education and Human Resources Directorate (EHR) is $771.4 million, a 17.9% decrease ($167.6 million) from the FY2004 level. Support at the various educational levels in the FY2005 request is as follows: precollege, $172.8 million; undergraduate, $158.9 million; and graduate, $173.9 million. The focus at the precollege level in FY2005 is at teacher development activities. This includes Centers for Learning and Teaching ($26.8 million), and Teacher Professional Continuum ($62.2 million).At the undergraduate level, support is given to the Robert Noyce Scholarship Program ($4 million), the National STEM Education Digital Library ($21.1 million), and Advanced Technological Education ($38.2 million). An increase in FY2005 for graduate level programs will allow NSF to raise the stipend of graduate fellows to $30,000 and to increase the number of offers for new fellowships and traineeships. Several programs are directed at increasing the number of underrepresented minorities in science and engineering. Among these targeted programs in the FY2005 request are the Historically Black Colleges and Universities Programs ($20 million), Model Institutions for Excellence ($9.8 million), Tribal Colleges and Universities Program ($9.9 million), and the Program for Gender Equity ($9.9 million). Funding for the Experimental Program to Stimulate Competitive Research (EPSCoR) is $75 million in the FY2005 request. An additional $30 million for co-funding activities in EPSCoR is provided through R&RA, bringing the total FY2005 request for EPSCoR to $114 million.

Policy Issues. There has been considerable debate in the academic and scientific community and in Congress about the management and oversight of major projects selected for construction and the need for prioritization of potential projects funded in the MREFC. In September 2001, NSF submitted to the Office of Management and Budget its report, *Large Facility Projects Management & Oversight Plan*, detailing the schedule for implementing the major components of an improved system for selecting, managing, and overseeing large facilities.[5] The plan was an outgrowth of the directive received by the NSF from the Bush Administration to improve its oversight of large projects. While the implementation plan included anticipated dates for the development of comprehensive guidelines and project oversight review, questions remained.

One continuing question focused on the selection process for including major projects in the upcoming budget cycle. Some members of Congress have described the selection process for funding major facilities as being "ad hoc and subjective."[6] In June 2002, Congress requested the National Academy of Sciences (NAS) to review NSF's management of its large facility projects, including the construction and operation phases. In January 2004, the NAS released the congressional mandated study of NSF's processes

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[5] National Science Foundation, *Large Facility Projects Management & Oversight Plan*, September 10, 2001, Arlington, VA, 9 pp. NOTE: While NSF does not directly construct or operate the facilities it funds, it does retain responsibility for overseeing the successful performance and completion of the projects.

[6] Letter to the National Academy of Sciences from the Senate requesting a study of the priority-setting process for NSF-sponsored large research facility projects, June 12, 2002, p.1.

for prioritization and oversight of projects in the MREFC. The report, *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*, offered the following recommendations:

- NSB should oversee a three-stage process whereby NSF develops a 10-20 year roadmap for large facility projects.
- Three levels of criteria categories - scientific and technical, agency strategic, and national criteria - should be used to rank projects within disciplines, sets of disciplines, and across all fields.
- New starts should be ranked in the annual budget request using clear rationale based on the roadmap.
- During execution phase, projects need greater independent oversight and review; likewise, effectiveness of the new NSF deputy for large facility projects should be reviewed in two years.[7]

Currently, the NSF is reviewing the findings and recommendations of the report in an effort to better fund and manage the MREFC account.

On February 2, 2004, the NSB released a report mandated by Section 22 of the NSF Authorization Act of 2002. The report, *Fulfilling the Promise*, was to address all of the unmet needs of the agency and to determine what infrastructure was needed to support NSF's programmatic expansion through FY2007.[8] The recommendations provided in the report are based on the budget levels contained in the authorization.[9] The NSB recommended a total investment of $19 billion for the NSF to sustain its position in science and technology. Rather than spread funding across all programs and activities, the report suggested that a more productive use was to focus on key strategic areas - - $1.2 billion for advanced tools and cyberinfrastructure, $1 billion to improve research productivity and student opportunities, $1 billion for exploration and research and education, $700 million toward building a competitive workforce, $200 million for maintaining management excellence, and $200 million to increase the number and diversity of institutions receiving NSF awards. It was the position of the NSB that increasing the size and length of research awards should be one of the highest priorities of the agency.

Rita R. Colwell resigned as director of the NSF, effective February 21, 2004. Colwell served as director since her appointment in August 1998. (Her appointed was to expire in August 2004). President Bush has designated Arden L. Bement, Jr. to serve as acting director of NSF. Bement is the former director of the National Institute of Standards and Technology, where he had served since December 2001.

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[7] The National Academies, *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*, Prepublication, January 2004, Washington, DC, pp. 15-24.

[8] National Science Board, *Fulfilling the Promise: A Report to Congress on the Budgetary and Programmatic Expansion of the National Science Foundation*, NSB03-151, December 4, 2003, Arlington, VA, 20 pp.

[9] P.L. 107-368, National Science Foundation Authorization Act of 2002, provides the following authorization levels: FY2003, $5,536.4 million; FY2004, $6,390.8 million; FY2005, $7,378.3 million; FY2006, $8,519.8 million; and FY2007, $9,839.3 million.