TABLE OF CONTENTS

OVERVIEW

National Science Foundation FY 2005 Budget Request Overview

Knowledge and innovation are powerful forces for progress in the lives of people and nations. The leadership of the United States and its unsurpassed standard of living rest on the solid foundation of achievement in science and engineering. Investments in fundamental research and education have supported decades of U.S. global leadership in discovery, learning and innovation.

The National Science Foundation requests $5.745 billion in FY 2005 to ensure that U.S. science and engineering capabilities and skills remain world class. These investments will enhance discovery and accelerate the country to greater economic and social prosperity.

NSF Funding by Appropriation
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Research and Related Activities	4,054.43	4,251.36	4,452.31	200.95	4.7%
Education and Human Resources	934.88	938.98	771.36	-167.62	-17.9%
Major Research Equipment and Facilities Construction	179.03	154.97	213.27	58.30	37.6%
Salaries and Expenses	189.42	218.70	294.00	75.30	34.4%
National Science Board	2.88	3.88	3.95	0.07	1.8%
Office of Inspector General	8.70	9.94	10.11	0.17	1.7%
Total, NSF	$5,369.34	$5,577.83	$5,745.00	$167.17	3.0%

Totals may not add due to rounding.

NSF research and education programs have provided a steady stream of benefits to the nation for over fifty years. NSF investments in the physical sciences are allowing us to probe the origins of the universe, to create new materials for the 21st century, and to understand the basic forces and processes that enable and shape biological activity. Engineering research underpins the operational fabric and infrastructure of contemporary society, such as power grids, water systems, and computer-communications systems, and improves the safety of structures in earthquake zones. Fundamental research in the biosciences has laid the foundation for exploring the human genome and now offers new possibilities for understanding the living world from molecules to organisms to ecosystems, providing new options for health, environment, agriculture and energy. NSF investments have pioneered advances in computing and networking, driving productivity throughout our economy. Insights from the social sciences have led to increased efficiency, especially in such areas as pollution control and allocation of scarce resources. Studies of our planet, including its polar regions, have laid the foundation for improved understanding of weather, climate, natural hazards and natural resources. The emerging fields of nanotechnology and biotechnology promise economic and social benefits that may well outstrip those we have witnessed over the past several decades.

Today, the nation faces new economic, social and security challenges that make maintaining the strength of our science and engineering enterprise an imperative. That means pioneering new frontiers in every field of science, engineering and technology. It means enriching education and experience for our world-class science, engineering and technology workforce and making it more diverse in the process.

At the same time, it means building strong partnerships within the global research community. The quest for knowledge has always been a global phenomenon, and it is even more so now. Expertise and creativity exist around the world. All nations understand the value of science and technology in transforming their economies and improving the well-being of their citizens. Many are making significant investments to promote research and education. The U.S. must strengthen and expand its international partnerships for mutual benefit, encouraging international collaborations that can deliver concrete solutions to stubborn national and global problems. Working with its partners, the U.S. can help shape a global research community committed to peace and prosperity.

We have crossed the threshold into a new era of exploration, one that will give us deeper understanding of our planet, the universe and ourselves. The opportunity to improve the quality of people's lives worldwide – through new products, processes and services – is within our reach.

The NSF FY 2005 Budget Request addresses these opportunities and challenges through an integrated portfolio of investments in People, Ideas, Tools, and Organizational Excellence, so that the job gets done effectively and meets the highest expectations of the U.S. public. In keeping with efforts to promote fiscal responsibility across the government, NSF's FY 2005 Request identifies three clear priorities:

- **Strengthen NSF management to maximize effectiveness and performance.** The FY 2005 Request assigns highest priority to strengthening management of the investment process and operations. The budget request includes an increase of over $20 million to strengthen the NSF workforce and additional investments of over $50 million to enhance information technology infrastructure, promote leading-edge approaches to eGovernment, and ensure adequate safety and security for all of NSF's information technology and physical resources.

- **Improve the productivity of researchers and expand opportunities for students.** Boosting the overall productivity of the nation's science and engineering enterprise requires increasing average award size and duration. The recent survey of NSF-funded principal investigators provides convincing evidence that an increase in award size will allow researchers to draw more students into the research process, and increasing award duration will foster a more stable and productive environment for learning and discovery. For FY 2005, NSF is focusing specifically on increasing average annual award size, devoting approximately $40 million to increase average award size to an annual average of $142,000. This represents a 2.2 percent increase over FY 2004 and a 51 percent increase over the past five years in average annual award size.

- **Strengthen the nation's performance with world-class instruments and facilities.** In an era of fast-paced discovery and technological change, researchers need access to cutting-edge tools to pursue increasingly complex avenues of research. NSF investments not only provide these tools, but also develop and creatively design the tools critical to 21st Century research and education. Consistent with the recent recommendations of the National Science Board, investment in infrastructure of all types (Tools) rises to $1.47 billion, representing 26 percent of the FY 2005 Budget Request.

NSF Strategic Goals: People, Ideas, Tools and Organizational Excellence

The National Science Foundation supports discovery, learning and innovation at the frontiers of science and engineering, where risks and rewards are high, and where benefits to society are most promising. NSF encourages increased and effective collaboration across disciplines and promotes partnerships among academe, industry and government to ensure that new knowledge moves rapidly and smoothly throughout the public and private sectors.

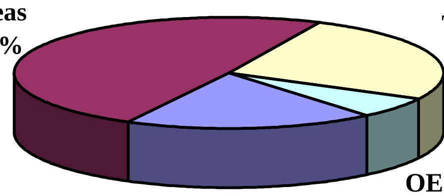
NSF Budget by Strategic Goal
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	1,117.00	1,133.77	1,064.82	-68.95	-6.1%
Ideas	2,689.00	2,788.99	2,845.05	56.06	2.0%
Tools	1,312.70	1,367.89	1,472.08	104.19	7.6%
Organizational Excellence (OE)	250.63	287.18	363.05	75.87	26.4%
Total, NSF	$5,369.34	$5,577.83	$5,745.00	$167.17	3.0%

Totals may not add due to rounding.

NSF's investment strategy establishes a clear path of progress for achieving four complementary strategic goals: People, Ideas, Tools and Organizational Excellence. "People, Ideas and Tools" is simple shorthand for a sophisticated system that integrates education, research, and cutting-edge infrastructure to create world-class discovery, learning and innovation in science and engineering. Organizational Excellence (OE) – a new NSF strategic goal on a par with the other three – integrates what NSF accomplishes through People, Ideas and Tools with business practices that ensure efficient operations, productive investments and real returns to the American people.

FY 2005 Budget Request of $5.75 Billion

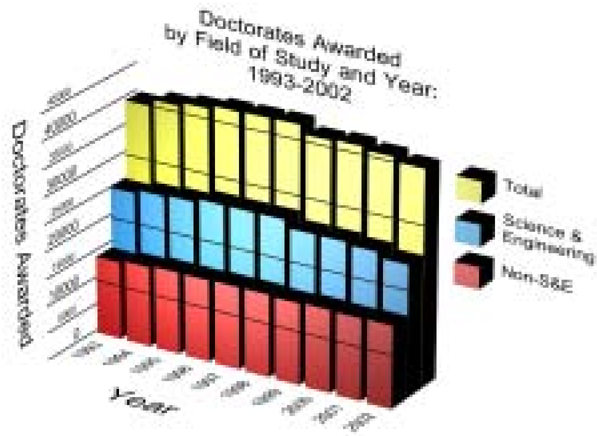


PEOPLE: Investing in the Nation's Talent

"A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens."

The rapid transformations that new knowledge and technology continuously trigger in our contemporary world make investments in people and learning a continuing focus for NSF. In our knowledge-based economy and society, we need not only scientists and engineers, but also a national workforce with strong skills in science, engineering and mathematics. Yet many of today's students leave secondary school without these skills. Fewer young Americans choose to pursue careers in science and engineering at the university level. Of those who do, fewer than half graduate with science or engineering degrees. The FY 2005 Request provides $1.065 billion for programs that will address these challenges.

Graduate fellowships and stipends. The FY 2005 budget funds significant expansion from a projected 5,000 fellowships in FY 2004 to 5,500 fellowships in NSF's flagship graduate student investment programs: Graduate Research Fellowships (GRF), Graduate Teaching Fellows in K-12 Education (GK-12) and Integrative Graduate Education and Research Traineeships (IGERT).



Adapted from NSF publication Science and Engineering Doctorate Awards: 2002

The NSF-supported Survey of Earned Doctorates found that the number of research doctoral degrees in all fields earned by students attending U.S. universities declined by 2 percent in 2002, dipping under 40,000, marking the first time in nine years doctorates fell below that level. NSF's continuing commitment to graduate fellowships and traineeships aims to attract increasing numbers of U.S. students to advanced studies in science and engineering.

FY 2005 stipend levels for fellows will remain at the $30,000 level established in FY 2004. Extending these increases to more graduate and postdoctoral students continues to be a high priority, long-range investment strategy for NSF. Total FY 2005 funding for these three programs is $240.74 million, $26.62 million over the FY 2004 Estimate.

Broadening Participation. Although the nation possesses an abundance of talent, we have not yet realized the full potential of our rich human resources and intellectual capital. The FY 2005 budget request furthers NSF's commitment to programs that make the science and engineering workforce more diverse and inclusive.

- **The Louis Stokes Alliances for Minority Participation Program** (LSAMP) has significantly increased the number of minority students earning baccalaureate degrees in science and engineering. The FY 2005 Request for LSAMP totals $34.30 million, equal to the FY 2004 Estimate.

- **ADVANCE** supports approaches to increase the representation and advancement of women in academic science and engineering careers. Funding for this program increases by $1.11 million over the FY 2004 Estimate for a total of $20.27 million in FY 2005.

Course, Curriculum, and Laboratory Improvement (CCLI). CCLI aims to assure that undergraduate students in the nation's two- and four-year colleges and universities have access to high quality science, engineering, mathematics, and technology education. The program promotes the identification, development, adaptation, implementation, dissemination and assessment of exemplary curricular and laboratory educational materials and instructional models. FY 2005 support for CCLI and related efforts across NSF is $50.97 million, an increase of $5.98 million over the FY 2004 Estimate of $44.99 million.

Partnerships for Innovation. The Partnerships for Innovation program stimulates the transformation of knowledge created by the national research and education enterprise into innovations that create new wealth and strong local, regional and national economies. Partnerships for Innovation are funded at $10.0 million, slightly above the FY 2004 level of $9.94 million.

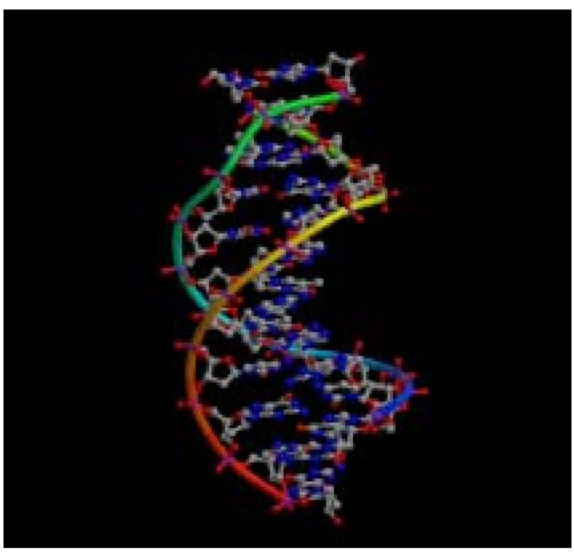
Math and Science Partnership. NSF will continue to support activities already initiated under the Math and Science Partnership program with an investment of $80.0 million in FY 2005.

IDEAS: Opening New Frontiers

"Discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Fundamental Science and Engineering. New knowledge is the lifeblood of the science and engineering enterprise. Investments in Ideas are aimed at the frontiers of science and engineering. They build the intellectual capital and fundamental knowledge that drive technological innovation, spur economic growth and increase national security. They also seek answers to the most fundamental questions about the origin and nature of the universe, the planet and humankind. Investments totaling $2.85 billion in FY 2005 will support the best new ideas generated by the science and engineering community.

Increasing both grant size and duration is a fundamental, long-term investment priority for NSF. Larger research grants of longer duration will boost the overall productivity of researchers by freeing them to take more risks and focus on more complex research goals with longer time horizons. More flexible timetables will also provide researchers with opportunities to provide expanded education and research experiences to students. Investments in FY 2005 bring NSF average annual research grant award size to approximately $142,000, an increase of $3,000 over FY 2004. Average annual award duration will continue at approximately 3.0 years.



This representation of the structure of DNA is housed in the Protein Data Bank (PDB), which holds the three-dimensional structures of nearly 24,000 proteins and other macromolecules in its growing – and publicly accessible – collection. The PDB's holdings profile DNAs, RNAs, viruses, and various proteins, such as enzymes central to photosynthesis, growth, development and brain function. NSF and other agencies recently renewed their commitment to this "treasure chest of shared discoveries." Credit: Protein Data Bank

Centers Programs. Centers bring together and integrate people, ideas and tools on scales that are large enough to have a significant impact on important science and engineering fields and cross-disciplinary areas. They assemble a critical mass of talented partners, from a number of disciplines and sectors, to focus on specific research challenges. Centers also provide opportunities to integrate research and education, conduct innovative and risky research and, through the development of partnerships, serve as resources for industry, government and the educational community at large. An important goal beyond research results is developing leadership in vision, strategy, and management of the research and education enterprise.

- **Science and Technology Centers (STCs).** The FY 2005 Request provides $30.0 million to initiate a new cohort of six Science and Technology Centers. The Science and Technology Centers Integrative Partnerships Program supports innovation in the integrated conduct of research, education and knowledge transfer in fields of basic science, mathematics and engineering. The total FY 2005 Request of $72.39 million also provides $42.39 million for continuing support of eleven ongoing STCs.

- **Science of Learning Centers.** The FY 2005 budget provides $20.0 million to continue support for multidisciplinary, multi-institutional Science of Learning Centers. These centers will advance understanding of learning through research on the learning process, the context of learning and learning technologies. The Centers will strengthen the connections between science of learning research and educational and workforce development and build effective collaborative research communities.

- **Other Centers Programs.** The FY 2005 Request includes increases for a number of key Centers Programs. Nanoscale Science and Engineering Centers (NSECs) receive an additional $3.10 million, to a total of $33.79 million. These additional funds will support two new nanotechnology centers with multidisciplinary capabilities and will enhance award size of some existing centers. Following recommendations from the "Twenty-Year Review of the NSF LTER Program," the Long Term Ecological Research (LTER) investment increases by $2.30 million, to a total of $22.82 million. Increased funding will provide incentives for interdisciplinary collaborations at LTER sites. Funding of $3.50 million will support two or three centers that advance fundamental knowledge about Environmental Social and Behavioral Science. Activity in these centers will build on groundwork laid by the Human Dimensions of Global Change centers. The Request also provides increases totaling $6.09 million for a number of mathematical and physical science centers, including: Chemistry Centers, Materials Centers, Mathematical Sciences Research Institutes and Physics Frontiers Centers. NSF investments in Engineering Research Centers continue to focus on next-generation advances in complex engineered systems.

Fundamental Research to Enhance Homeland Security. The FY 2005 Request includes investments in fundamental research that will address new homeland security challenges facing the nation. The Ecology of Infectious Diseases program, jointly sponsored by NSF and the National Institutes of Health, and the Microbial Genome Sequencing program, jointly sponsored by NSF and the U.S. Department of Agriculture, will contribute to a better understanding of potential bioterrorism threats and how to combat them. The Scholarship for Service program, which supports the education of students in information security and assurance in exchange for service in federal government agencies, will increase the nation's capacity to protect vital information infrastructure. The Critical Infrastructure Protection program will support research to identify potential vulnerabilities and strengthen protection for the nation's infrastructure, including power grids, transportation networks and water supply systems. National Security-Related Information Technology research supports leading-edge approaches to securing IT systems and networks.

Climate Change Research Initiative (CCRI). As part of the Administration's Climate Change Research Initiative, NSF will support research to reduce uncertainty related to climate variability and change, with the objective of improving decision making and informing the policy process. In FY 2005, NSF will continue to support the interdisciplinary centers being established in FY 2004 to explore Decision-Making Under Uncertainty. These Centers will improve understanding of risk management, risk communication and decision making in relation to climate change. These investigations complement

NSF's ongoing programs in climate change science. The FY 2005 Request also supports improved climate modeling through investments in the Community Climate Science Model.

Plant Genome Research Program. The FY 2005 budget provides $89.47 million to support ongoing research on the genomics of plants of major economic importance. Multi-disciplinary, multi-investigator teams will explore the functional genomics of plants, conduct large-scale genome sequencing and develop tools for studies of plant genomes.

Innovation Fund. Funding of $5.0 million in FY 2005 will initiate a new Innovation Fund. The Fund provides an opportunity for the Foundation to respond quickly to rapidly emerging activities at the frontiers of learning and discovery.

International Science and Engineering. Discoveries emerge from across the globe and it is essential that American scientists and engineers have opportunities to engage with the world's top researchers, to lead major international collaborations, and to have access to the best research facilities throughout the globe and across all the frontiers of science and engineering. In November 2001, the National Science Board called on the Foundation to make international leadership a high priority for NSF and a much stronger programmatic focus both in core disciplines and in NSF-wide activities. The FY 2005 Budget Request to carry out these activities is $34.04 million, an increase of $5.92 million, or 21.1 percent, over the FY 2004 Estimate of $28.12 million.

Scientific Research in Education. The Research on Learning and Education (ROLE) program seeks to build a strong interdisciplinary approach to research on learning and education within the context of the nation's schools, colleges and universities. The FY 2005 funding increase is to support the increased emphasis on funding evidence-based, rigorous STEM education research. ROLE and related research funding totals $47.46 million in FY 2005, an increase of $8.13 million over the FY 2004 level of $39.33 million. These investments build the capacity to go to larger scale in other NSF programs such as the Science of Learning Centers and Centers for Learning and Teaching.

EPSCoR. The Experimental Program to Stimulate Competitive Research (EPSCoR) builds capacity in educational institutions to participate more fully in NSF research activities. Funding in FY 2005 totals $84.0 million from the Education and Human Resources account, with an additional investment of approximately $30 million provided through the Research and Related Activities account.

Priority Areas. In partnership with the science and engineering community, NSF identifies emerging areas of research that offer exceptional promise to advance knowledge. A sustained level of investment builds research momentum and educates a critical mass of scientists and engineers. In FY 2005, NSF will continue to support five priority areas with promising research horizons.

NSF Funding by Priority Area
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biocomplexity in the Environment	70.28	99.83	99.83	0.00	0.0%
Human and Social Dynamics	4.46	24.24	23.25	-0.99	-4.1%
Mathematical Sciences	60.42	89.09	89.11	0.02	0.0%
Nanoscale Science and Engineering	222.46	253.51	305.06	51.55	20.3%
Workforce for the 21st Century	N/A	N/A	20.00	20.00	N/A
Total, Priority Areas	$357.62	$466.67	$537.25	$70.58	15.1%

Totals may not add due to rounding.

- **Biocomplexity in the Environment (BE).** BE explores the complex interactions among organisms and their environment at all scales and through space and time. This fundamental research on complex environmental systems will help us better understand and, in time, predict environmental change. Research on the complex interactions between freshwater and the rest of the environment will be encouraged in FY 2005.

- **Human and Social Dynamics (HSD).** How we learn, make decisions, assess risk and adapt to change; how institutions are shaped by us and how we, in turn, are shaped by our decisions and institutions are central questions in an era marked by rapid and complex change. HSD will fund research on a range of topics from individual decision-making and risk, to the dynamics of human behavior, to global agents of change such as democratization, globalization and war. Support will also be provided for methodological capabilities in spatial social science and for instrumentation and data resources infrastructure.

- **Mathematical Sciences.** Mathematics is the language of science and a powerful tool of discovery. The Mathematical Sciences priority areas will focus on fundamental research in mathematical and statistical sciences, interdisciplinary research connecting the mathematical sciences with science and engineering and targeted investments in mathematical sciences training activities.

- **Nanoscale Science and Engineering.** NSF's investment in Nanoscale Science and Engineering targets the fundamental research that underlies nanotechnology, likely to be the next transformational" technology. Investments in this priority area will emphasize research on nanoscale structures and phenomena and quantum control. NSF is the lead agency for the government-wide National Nanotechnology Initiative.

- **Workforce for the 21st Century (W21).** The FY 2005 Request provides $20.0 million for the Workforce for the 21st Century priority area, which aims to strengthen the nation's capability to produce world-class scientists and engineers and a general workforce with the science, engineering, mathematics and technology skills to thrive in the 21st Century workplace. This investment will support innovations to improve education at all levels, from K-12 through postdoctoral, as well as attract more U.S. students to science and engineering fields and broaden participation. Workforce for the 21st Century will capitalize on NSF's experience with a variety of successful investments in education and broadening participation by encouraging institutions and partnerships to integrate them into broader, innovative programs. The priority area will also support research that explores the issue of attracting and retaining students in science and engineering.

NSF's Information Technology Research (ITR) priority area, initiated in FY 2000 and funded through FY 2004, is an example of how fostering an emerging area creates a new landscape for research and education. ITR pioneered major advances in fundamental IT research and also opened new vistas at the interface between IT and other fields. Beginning in FY 2005, activities funded through ITR investments will be merged into new and ongoing research programs across NSF.

TOOLS: Getting the Job Done

"Broadly accessible, state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation."

The FY 2005 request for Tools totals $1.47 billion, an increase of $104.19 million over the FY 2004 Estimate. Consistent with the recent recommendations of the National Science Board, the increase continues an accelerated program to revitalize and upgrade the nation's aging infrastructure through broadly distributed investments in small, mid-sized and major research instruments and tools. Progress in research and education frequently depends upon the development and use of tools that expand experimental and observational limits. Researchers need access to cutting-edge tools to tackle today's complex and radically different research tasks, and students who are not trained in their use are at a disadvantage in today's technology-intensive workplace.

Cyberinfrastructure. In FY 2005, a total of nearly $400 million supports the expansion of state-of-the-art cyberinfrastructure. Exponential growth in computing power, communication bandwidth and data storage capacity will continue into the foreseeable future, profoundly transforming research and education practices. Providing access to moderate-cost computation, storage, analysis, visualization and communication for every researcher will help to stimulate robust innovation and an even more creative and productive national research enterprise and broaden research vistas. NSF will invest in research to develop new generations of cyberinfrastructure and new capabilities for cyber-science.

A centerpiece of NSF's investment in Cyberinfrastructure, NSF's Extensible Terascale Facility now encompasses data, computing and instrumentation resources at ten sites connected by networks operating at ten gigabits-per-second or greater through network hubs in Los Angeles, Chicago, and soon Atlanta. *Credit: NSF*

Major Research Equipment and Facilities Construction. In FY 2005, NSF's Major Research Equipment and Facilities Construction (MREFC) Account totals $213.27 million. Funding supports three continuing projects: Atacama Large Millimeter Array (ALMA) Construction ($49.67 million); IceCube Neutrino Observatory ($33.40 million); and EarthScope ($47.35 million). Three new projects will be initiated in FY 2005.

- **National Ecological Observatory Network (NEON).** Funding of $12.0 million in FY 2005 will launch the National Ecological Observatory Network (NEON), a continental scale research instrument with geographically distributed infrastructure, linked by state-of-the-art networking and communications technology. NEON will encompass cutting-edge lab and field instrumentation, site-based experimental infrastructure, natural history archive facilities and computational, analytical and modeling capabilities. NEON will facilitate studies on major environmental challenges at regional to continental scales and will provide a virtual laboratory for research to obtain a predictive understanding of the environment. Disciplinary and multidisciplinary programs will support NEON research projects and educational activities. Data from standard measurements made using NEON will be publicly available.

- **Scientific Ocean Drilling Vessel (SODV).** FY 2005 funding of $40.85 million supports the conversion and scientific outfitting of a state-of-the-art drill ship to be used by the newly constituted Integrated Ocean Drilling Program (IODP), an international collaboration that strengthens U.S. scientific ocean drilling activities through cooperation with Japan and other nations. The IODP program will use measurements as well as cores of sediment and rock from the ocean floor to study the geologic processes that modify our planet, the history of those changes in oceans and climate and the extent and depth of the planet's biosphere. The U.S. operated vessel will be used to obtain high-resolution cores to address climate, environmental and sea-floor observatory objectives, and it will complement the Japanese-operated *Chikyu*, a heavier vessel for drilling deep sedimentary and crustal holes up to 10,000 meters below sea surface. Both ships are accessible to the international scientific community.

- **Rare Symmetry Violating Processes (RSVP).** The FY 2005 budget provides funding of $30.0 million for RSVP, a project to mount two highly sensitive experiments to study fundamental symmetries of nature. The standard model of particle physics accounts for the existence of both matter and antimatter, but does not fully explain the ``asymmetry'' between them in the laws of physics or the absence of antimatter in the observable universe. The two RSVP experiments will search for extremely rare decays of elementary particles that can shed on these puzzles. In so doing, RSVP could uncover evidence for a new symmetry of nature (``supersymmetry''), which predicts a doubling of the number of fundamental particles and could answer questions ranging from the origins of our universe to the nature of dark matter and dark energy. The experiments will be performed at the existing Brookhaven National Laboratory Alternating Gradient Synchrotron.

ORGANIZATIONAL EXCELLENCE: Meeting the Highest Standards for Stewardship
"An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."

With activities that involve over 200,000 scientists, engineers, educators and students and over 40,000 proposals to process each year, NSF relies on efficient operations and state-of-the-art business practices to provide quality services and responsible monitoring and stewardship of the agency's investments. NSF's Request includes $363.05 million to support Organizational Excellence (OE). This represents an increase in the share of the total NSF budget for OE from 5 percent in FY 2004 to 6 percent in FY 2005.

A number of considerations have elevated the Organizational Excellence portfolio in NSF's FY 2005 Request. For the past two decades, NSF staffing has remained level as the total budget and workload increased significantly. Proposals increasingly involve large, multidisciplinary and interdisciplinary projects and require sophisticated monitoring and evaluation. NSF is also committed to maintaining its traditional high standards for stewardship, innovation and customer service, in keeping with the broad set of challenges identified in the President's Management Agenda (PMA), the NSF business analysis and by GAO and other organizations. Key priorities for FY 2005 include award monitoring and oversight, human capital management and IT system improvements necessary for leadership in eGovernment, security upgrades and world class customer service.

NSF has a history of adopting state-of-the-art management approaches, maintaining a learning environment and providing leadership in both policy and e-business innovation. The agency has received two "greens" on the PMA scorecard and received the President's 2003 Award for Management Excellence, in recognition of the success of NSF's FastLane system for handling grant applications 100 percent electronically.

It is central to NSF's mission to provide effective stewardship of public funds, to realize maximum benefits at minimum cost and to ensure public trust in the quality of the process. The FY 2005 investment in Organizational Excellence will streamline and update NSF operations and management by enhancing cutting edge business processes and tools. It will also fund the addition of 25 new permanent employees (bringing the total increase to 75 over the past three years) to address mounting workplace pressure, add new skills to the workforce and improve the quality and responsiveness of customer service. NSF also continues to foster close ties to the research and education community through the use of "rotators" - scientists, engineers and educators from academic and other nongovernmental institutions who work at NSF for 1-2 years on average and then return to their home institutions. Rotators represent nearly 10 percent of NSF's total staffing, and they help provide a continuous inflow of up-to-date information and fresh, invigorating viewpoints on needs and opportunities across all of research and education.

NSF INVESTMENTS AND STRATEGIC GOALS

NSF Investments and Strategic Goals

The National Science Foundation's FY 2005 funding request supports the agency's investment in *People*, *Ideas*, *Tools,* and *Organizational Excellence* – the Foundation's four strategic outcome goals. These goals flow from NSF's statutory mission, "to promote the progress of science.…" and they form the basis for the many activities of the Foundation. These goals, along with their associated investment categories and objectives, provide a results-oriented focus for NSF's investments, and a framework for assessing overall program performance. NSF's investments in *People, Ideas*, and *Tools* work in concert to promote progress in all aspects of science and engineering research and education, and are underpinned by investments in *Organizational Excellence*.

- *People* - A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.
- *Ideas* - Discovery across the frontier of science and engineering, connected to learning, innovation and service to society.
- *Tools* - Broadly accessible, state-of-the-art science and engineering facilities, tools and other infrastructure that enable discovery, learning and innovation.
- *Organizational Excellence* - An agile, innovative organization that fulfills its mission through leadership and state-of-the-art business practices.

NSF Budget by Strategic Goal
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	1,117	1,134	1,065	-69	-6.1%
Ideas	2,689	2,789	2,845	56	2.0%
Tools	1,313	1,368	1,472	104	7.6%
Organizational Excellence	251	287	363	76	26.4%
Total, NSF[1]	$5,369	$5,578	$5,745	$167	3.0%

Totals may not add due to rounding.

[1]Total does not include $46.57 million in FY 2003 from H-1B Nonimmigrant Petitioner Fees. Legislation for this activity expired in FY 2003 and was not reauthorized.

The NSF Strategic Plan identifies management of the investment process as a critical factor in achieving the agency's goals. NSF strategies for meeting new challenges and carrying out agency goals and mission include:

- Commitment to Organizational Excellence;
- Adequate funding of the Major Research Equipment and Facilities Construction Account;
- Investments in Priority Areas;
- Continued funding to sustain an efficient and enabled research and education community;
- Sustaining a capable and well-trained science and engineering workforce by attracting top U.S. students and broadening participation across science and engineering;
- Supporting Investments in Innovation; and
- Expanded collaborations with international partners.

In addition to investments based on NSF's four Strategic Outcome Goals, the FY 2005 budget is aligned to reflect funding levels associated with the Foundation's ten investment categories. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

NSF Budget by Strategic Outcome Goal and Investment Categories
(Dollars in Millions)

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	Individuals	471.53	477.39	498.85	21.46	4.5%
	Institutions	182.54	180.15	172.35	-7.80	-4.3%
	Collaborations	462.93	476.23	393.62	-82.61	-17.3%
		1,117.00	1,133.77	1,064.82	-68.95	-6.1%
Ideas	Fundamental Science and Engineering	2,095.56	2,124.25	2,150.44	26.19	1.2%
	Centers Programs	364.23	413.02	457.26	44.24	10.7%
	Capability Enhancement	229.21	251.72	237.35	-14.37	-5.7%
		2,689.00	2,788.99	2,845.05	56.06	2.0%
Tools	Facilities	538.17	580.21	685.57	105.36	18.2%
	Infrastructure and Instrumentation	336.66	341.52	344.93	3.41	1.0%
	Polar Tools, Facilities and Logistics	252.96	250.24	254.15	3.91	1.6%
	Federally-Funded R&D Centers	184.92	195.92	187.43	-8.49	-4.3%
		1,312.71	1,367.89	1,472.08	104.19	7.6%
Organizational Excellence		250.63	287.18	363.05	75.87	26.4%
Total, NSF		$5,369.33	$5,577.83	$5,745.00	$167.17	3.0%

Totals may not add due to rounding.

Additionally, in FY 2005, NSF resources will support the Administration's five interagency research and development (R&D) investment priorities: Research and Development (R&D) for Combating Terrorism; Nanotechnology; Networking and Information Technology Research and Development; Molecular-level Understanding of Life Processes; and Environment and Energy. Many of NSF's investments map to these important existing and emerging priorities.

Core Research and Education Activities

NSF investments in core research and education activities are targeted to disciplinary and multidisciplinary programs that support the best ideas generated by the academic community. These funds support single investigator and small group awards and also provide primary support for junior faculty and students. They are extremely important in invigorating the research and education community since they promote emergence of new ideas and fields, especially where the defining borders of disciplines are blurring and new technologies are emerging. Investments in the core activities ensure the vitality of scientific and engineering fields in interdisciplinary research and discovery. If the nation is to maintain the health, security, and vitality of its citizens, it must continue to have access to the best science and engineering talent. The National Science Foundation has a critical role in providing this balance for U.S. science and engineering.

Investments in Selected Priority Areas

In addition to investments in core research and education, NSF funding for selected priority areas provides key, agency-wide opportunities for pursuing the strategic outcome goals. Through these priority areas, NSF identifies and accelerates progress in areas of emerging opportunity that hold exceptional promise for advancing knowledge and addressing national interests. Each requires appropriate attention to developing people with new skills and new perspectives; seeking new approaches to knowledge generation across the frontiers of science and engineering; and creating the tools that enable rapid advances.

The FY 2005 Request emphasizes investments in five interdependent priority areas – Biocomplexity in the Environment; Nanoscale Science and Engineering; Mathematical Sciences; Human and Social Dynamics; and Workforce for the 21st Century. In addition, NSF continues to give high priority to Information Technology Research investments, which will be merged in FY 2005 into ongoing research programs across NSF. As a previous NSF priority area, ITR created unprecedented new possibilities for advancing IT knowledge and supported investments that provided state-of-the-art supercomputing resources to U.S. researchers and expanded into new fields of research such as cyberinfrastructure. Within the priority areas, there is a rich mix of activity that integrates areas of fundamental research with elements of practice in related fields. This synergy characterizes the interdependence of the priority areas. For example, concepts and techniques from the mathematical sciences priority area may influence the development of our understanding of biocomplexity or nanoscale science and engineering and vice versa.

NSF Priority Area Investments
(Dollars in Millions)

Priority Area	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	70.28	99.83	99.83	0.00	0.0%
Nanoscale Science and Engineering	222.46	253.51	305.06	51.55	20.3%
Mathematical Sciences	60.42	89.09	89.11	0.02	0.0%
Human and Social Dynamics	4.46	24.24	23.25	-0.99	-4.1%
Workforce for the 21st Century	N/A	N/A	20.00	20.00	N/A
Total, Priority Areas	$357.62	$466.67	$537.25	$70.58	15.1%

Totals may not add due to rounding.

Biocomplexity in the Environment

The world is facing significant scientific and societal challenges, including the prospect of rapid environmental and climatic change, the threat of biological warfare, and the complicated question of long-term environmental security. The integrity of local, regional and global ecosystems is inextricably linked to human well-being while environmental and human health issues often intertwine. Fundamental study of complex environmental systems is therefore a key element of local, national, and global security and critical to the development of new scientific and technological capabilities that will significantly advance our ability to anticipate environmental conditions and thus improve environmental decision-making.

The *Biocomplexity in the Environment* (BE) priority area is designed to give NSF the capability to respond to the demand for new approaches to investigating the interactivity of biota and the environment. Investigations must be highly interdisciplinary, consider non-human biota and/or humans explicitly, and examine challenging systems that have high potential for exhibiting nonlinear or highly-coupled behaviors. Advanced computational strategies and technologies must be developed and utilized. The term "biocomplexity" is used to stress the requirement that research questions must address the dynamic web of interrelationships that arise when living things at all levels – from their molecular structures to genes to organisms to ecosystems to urban centers – interact with their environment. This priority area will result in more complete and synthetic understanding of natural processes, of human behaviors and decisions in the natural world, and ways to use new technology effectively to sustain life on earth.

An important new emphasis in the BE priority area beginning in FY 2005 will be research on biocomplexity in aqueous systems. These systems may be at small scales, such as aquatic organisms and their effect on water flow and safety, or at large scales, such as interactions between the climate variability and aquatic ecosystem function and diversity. Processes that occur at interfaces are particularly attractive topics for investigation. For example, surface studies of molecular processes of sediments or ice may elucidate the interplay among microbes, nutrients, and substrate and also enlarge understanding of transport in aqueous environments. Other interfacial regions such as estuaries, coastal zones, and large rivers offer many scientific and engineering challenges. Here, the complex interactions among terrestrial, aquatic, microclimatic, and human systems have important implications for water quantity and quality. Studying the complexity of a river system, for example, may require integrated investigation of natural and physical features as well as the relationships of social groups that place different values on water use.

Biocomplexity in the Environment Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biological Sciences	26.00	39.86	39.86	0.00	0.00%
Computer and Information Science and Engineering	7.36	8.00	8.00	0.00	0.00%
Engineering	6.00	6.00	6.00	0.00	0.00%
Geosciences	23.00	37.22	37.22	0.00	0.00%
Mathematical and Physical Sciences	5.21	4.70	4.70	0.00	0.00%
Social, Behavioral and Economic Sciences	0.95	2.00	2.00	0.00	0.00%
Office of International Science and Engineering	0.35	0.50	0.50	0.00	0.00%
Office of Polar Programs	1.41	1.55	1.55	0.00	0.00%
Total, Biocomplexity in the Environment	$70.28	$99.83	$99.83	0.00	0.00%

Totals may not add due to rounding.

Long-term Goals: This year NSF will continue to emphasize research and education on the role of Biocomplexity in the Environment. This priority area is part of the investments and accomplishments within NSF's FY 2005 environmental investment portfolio of approximately $1.0 billion. The intellectual goals of the effort are to:

- Synthesize environmental knowledge across disciplines, subsystems, time and space;
- Discover new methods, models, theories, and conceptual and computational strategies for understanding complex environmental systems;
- Develop new tools and innovative applications of new and existing technologies for cross-disciplinary environmental research;
- Integrate human and societal and ecological factors into investigations of the physical environment and environmental engineering;

- Improve science-based forecasting capabilities and enhance research on decision-making and human environmental behaviors; and
- Advance a broad range of infrastructure to support interdisciplinary environmental activities: collaboratory networks, information systems, research platforms, international partnerships, and education activities that enhance and diversify the future environmental workforce.

Long-term Funding for Biocomplexity in the Environment
(Dollars in Millions)

FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$50.00	$54.88	$58.96	$70.28	$99.83	$99.83	$101.83	$103.86

FY 2005 Topical Areas: In FY 2005, NSF plans to invest $99.83 million in the interdisciplinary Biocomplexity in the Environment activities described below. The first two areas listed are relevant to enhanced fundamental understanding of microorganisms important in nature and to humans, including some microbes that are potentially harmful.

- **Microbial Genome Sequencing** – use of high throughput sequencing of microorganisms of fundamental biological interest, importance to agriculture, forestry, food and water quality, or value in understanding potential agents of bioterrorism. Genome sequence information will provide the basis for understanding the physiology, pathology, and ecology of these organisms. This knowledge can be applied to detection and economic uses of organisms and to understanding microbial adaptation to extreme environments. Emphasis will also be placed on sequencing of microbes and their associations with other organisms – plant, animal, and other microbes. This is an interagency activity with the U.S. Department of Agriculture.

- **Ecology of Infectious Diseases** – development of predictive models and discovery of principles for relationships between environmental factors and transmission of infectious agents. Potential benefits include the development of disease transmission models, understanding of unintended health effects of environmental change, and improved prediction of disease outbreaks, emergence, and reemergence. Examples of environmental factors include habitat transformation, biological invasion, biodiversity loss, and contamination. This activity involves an interagency partnership with the National Institutes of Health.

- **Dynamics of Coupled Natural and Human Systems** – quantitative, interdisciplinary analyses of relevant human and natural system processes and the complex interactions among human and natural systems at diverse scales, with special emphasis given to studies of natural capital; landscapes and land use; and uncertainty, resilience, and vulnerability.

- **Coupled Biogeochemical Cycles** – the interrelation of biological, geochemical, geological, and physical processes at all temporal and spatial scales, with particular emphasis on understanding linkages between chemical and physical cycles (for example, the carbon, oxygen, nitrogen, phosphorus and sulfur cycles) and the influence of human and other biotic factors on those cycles.

- **Genome-Enabled Environmental Sciences and Engineering** – the integrated use of genomic and information technology approaches to gain novel insights into environmental questions and problems.
- **Instrumentation Development for Environmental Activities** – the development of instrumentation and software that takes advantage of microelectronics, photonics, telemetry, robotics, sensing systems, modeling, data mining, and analysis techniques to bring recent

laboratory instrumentation advances to bear on the full spectrum of environmental biocomplexity questions.

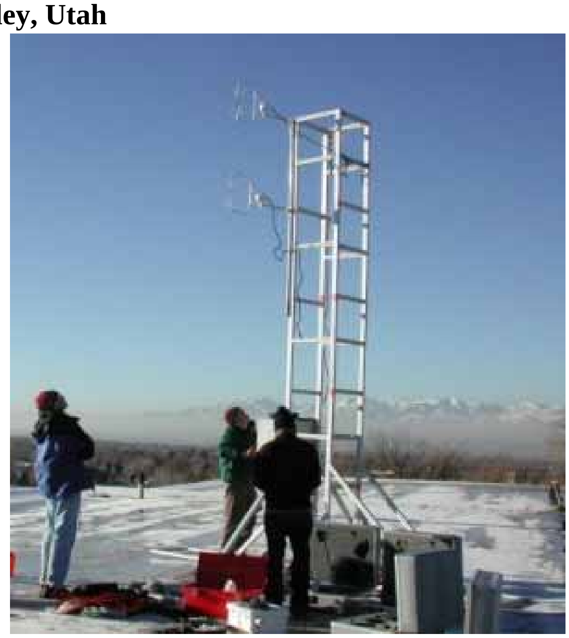
- **Materials Use: Science, Engineering and Society** – studies directed toward reducing adverse human impact on the total, interactive system of resource use; the design and synthesis of new materials with environmentally benign impacts on biocomplex systems; as well as maximizing the efficient use of individual materials throughout their life cycles.

In addition to these primary areas, other multidisciplinary research and education activities will be supported. These include:

- Water Cycle and Freshwater Resources – complex human, biological, and physical processes that influence water cycle variability, hydrologic reservoirs, and geochemical functions
- Carbon Cycle and Geomicrobiology – research on mediation of carbon distribution, transformation and transport among terrestrial, atmospheric, and ocean environments by biota
- Social and Behavioral Processes – scientific understanding of social and behavioral processes associated with materials use and adaptation to environmental change
- "Tree of Life" – exploration of genealogical relationships of extant species using new algorithmic methods and genomic technologies
- Synthesis – capacity-building activities to support novel partnerships that will integrate knowledge and information about complex environmental systems
- Educational Activities – biocomplexity-oriented projects in workforce development, including underrepresented minorities, and development of science teachers and curricular materials
- International Partnerships - collaborations with research partners in other countries that expand the scope of biocomplexity research activities and broaden the experience of U.S. students

Recent Research Highlight

Urban Trace-gas Emissions Study (UTES): Interactions Among Canopy Processes, Anthropogenic Emissions, and Social Institutions in the Salt Lake Valley, Utah



The majority of greenhouse gases and other atmospheric pollutants originate in cities, generated both by human activities and vegetation. For this reason, it is important to understand the complex social, physical, and biological processes at play in the urban airshed. To study the influences of urban land cover and emissions, an interdisciplinary team of researchers selected the Salt Lake Valley, a region with excellent historical records, an extensive urban forest relative to the surrounding desert ecosystem, and a rapid rate of urban growth. Using the results of atmospheric and energy use measurements, traffic monitoring, and remote sensing, they are developing a quantitative model of this dynamic system. The user-friendly model is being used as a tool to explore the factors affecting air quality and the impact of future scenarios of urban growth. Decision-makers from city, county, and state governments are participating in the project, and a social science team has been assigned to evaluate the effectiveness of the partnership between university researchers and decision-makers. The long-term goal of the project is to evaluate possible ways to reduce greenhouse gas emissions, maintain high air quality standards, and improve the quality of life of urban residents.

Nanoscale Science and Engineering

The Nanoscale Science and Engineering (NS&E) priority area encompasses the systematic organization, manipulation and control of matter at atomic, molecular and supramolecular levels. Novel materials, devices, and systems – with their building blocks on the scale of nanometers – shift and expand possibilities in science, engineering and technology. A nanometer (one-billionth of a meter) is to an inch what an inch is to 400 miles. With the capacity to manipulate matter at this scale, science, engineering and technology are realizing revolutionary advances, in areas such as individualized pharmaceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry and order-of-magnitude faster computer chips.

Nanoscale science and engineering research promises a better understanding of nature, a new world of products beyond what it is now possible, high efficiency in manufacturing, sustainable development, better healthcare and improved human performance.

Nanoscale Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biological Sciences	2.98	5.31	5.85	0.54	10.2%
Computer and Information Science and Engineering	11.14	15.79	19.40	3.61	22.9%
Engineering	94.35	108.88	133.81	24.93	22.9%
Geosciences	7.53	7.94	7.94	0.00	0.0%
Mathematical and Physical Sciences	103.92	111.48	132.14	20.66	18.5%
Social, Behavioral and Economic Sciences	2.32	1.56	1.50	-0.06	-3.8%
Office of International Science and Engineering	N/A	N/A	0.26	0.26	N/A
Subtotal, Research and Related Activities	222.24	250.96	300.90	49.94	19.9%
Education and Human Resources	0.22	2.55	4.16	1.61	63.1%
Total, Nanoscale Science and Engineering	$222.46	$253.51	$305.06	$51.55	20.3%

Totals may not add due to rounding.

The National Nanotechnology Initiative (NNI) began in FY 2001 (http://www.nano.gov). NSF's role in NNI emphasizes long-term, fundamental research aimed at discovering novel phenomena, processes, and tools; addressing NNI Grand Challenges; supporting new interdisciplinary centers and networks of excellence; supporting research infrastructure, including shared user facilities; and addressing research and educational activities on the societal implications of advances in nanoscience and nanotechnology.

NSF has been a pioneer among federal agencies in fostering the development of nanoscale science, engineering and technology. In FY 2004, an estimated $253.51 million supports research in a wide range of research and education activities, including approximately 20 nanotechnology research and education centers, which focus on electronics, biology, optoelectronics, modeling and simulation, advanced materials and engineering.

This investment will expand by 20.3 percent in FY 2005 to $305.06 million to develop and strengthen critical fields (including nanobiotechnology, manufacturing and catalysis at the nanoscale, instrumentation, and education) to further establish the science and engineering infrastructure and a workforce to exploit opportunities presented by these new capabilities. Support will encompass single investigator research, interdisciplinary research and education teams, national science and engineering centers, exploratory research and education projects, and education and training.

Long-term objectives include building a foundation of fundamental research for understanding and applying novel principles and phenomena for nanoscale manufacturing and other NNI Grand Challenges; ensuring that U.S. institutions have access to a full range of nano-facilities; enabling access to nanotechnology education for the public through informal education, and for students in U.S. middle schools, secondary schools, colleges and universities; and catalyzing the creation of new commercial markets that depend on three-dimensional nanostructures. These goals will enable development of revolutionary technologies that contribute to improved human health, agricultural advancements, material and energy conservation, and sustainability in the environment.

Long-term Funding for Nanoscale Science and Engineering
(Dollars in Millions)

FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$149.68	$192.28	$222.46	$253.51	$305.06	$315.00	$325.00

FY 2005 Areas of Emphasis: NSF's five programmatic focus areas are:

- **Fundamental Research and Education.** The FY 2005 Request level includes $174.0 million for fundamental research and education, with special emphasis on:

  - *Biosystems at the Nanoscale* – Approximately $24.5 million to support study of biologically-based or -inspired systems that exhibit novel properties and potential applications. Potential applications include improved drug delivery, biocompatible nanostructured materials for implantation, exploiting of functions of cellular organelles, devices for research in genomics, proteomics and cell biology, and nanoscale sensory systems, such as miniature sensors for early detection of cancer.
  - *Nanoscale Structures, Novel Phenomena and Quantum Control* – Approximately $65.8 million to discover and understand phenomena specific at the nanoscale, including new phenomena in nanoelectronics and advanced silicon technology, create new materials and functional nanoscale structures and to exploit their novel properties. Potential applications include quantum computing and new devices and processes for advanced communications and information technologies.
  - *Device and System Architecture* – Approximately $32.0 million to develop new concepts to understand interactions among nanoscale devices in complex systems, including the physical, chemical, and biological interactions between nanostructures and device components. Interdisciplinary teams will investigate methods for design of systems composed of nanodevices.
  - *Nanoscale Processes in the Environment* – Approximately $11.5 million to support studies on nanoscale physical and chemical processes related to the trapping and release of nutrients and contaminants in the natural environment. Potential benefits include artificial photosynthesis for clean energy and pollution control, and nanoscale environmental sensors and other instrumentation.
  - *Multi-scale, Multi-phenomena Theory, Modeling and Simulation at the Nanoscale* – Approximately $22.2 million to support theory, modeling, large-scale computer simulation and new design tools and infrastructure in order to understand, control and accelerate development in new nanoscale regimes and systems.
  - *Manufacturing Processes at the Nanoscale* - Approximately $14.0 million to support new concepts for high rate synthesis and processing of nanostructures, nanostructured catalysts, fabrication methods for devices, and assembling them into nanosystems and then into larger scale structures of relevance in industry and in the medical field.

- *Converging Technologies from the Nanoscale* – Approximately $4.0 million. The convergence of nanotechnology with information technology, modern biology and social sciences will reinvigorate discoveries and innovation in almost all areas of the economy. This new theme includes investments in:
  - Nano-biology interface and improving human performance; and
  - Nano-information interface research.

- **Grand Challenges.** Approximately $11.9 million will fund interdisciplinary activities to focus on major long-term challenges: nanostructured materials 'by design,' nanoscale electronics, optoelectronics and magnetics, nanoscale-based manufacturing, catalysts, chemical manufacturing, biological-chemical detection and protection, environment and healthcare.

- **Centers and Networks of Excellence.** Approximately $57.5 million will support five new research and education centers with a focus on converging science and technology from the nanoscale, and a multidisciplinary, multi-sectoral network for modeling and simulation at the nanoscale.

- **Research Infrastructure.** Approximately $36.9 million will support instrumentation and facilities for improved measurements, processing and manipulation at nanoscale, and equipment and software for modeling and simulation. University-industry-national laboratory and international collaborations will be encouraged, particularly for costly instrumentation and facilities. Support for the National Nanofabrication Infrastructure Network (NNIN), established in FY 2004, is also included.

- **Societal and Educational Implications of Science and Technology Advances.** Approximately $24.7 million will support student assistantships, fellowships and traineeships, curriculum development on nanoscience and engineering and development of new teaching tools. The implications of nanotechnology on society will be analyzed from social, behavioral, legal, ethical, and economic perspectives. Factors that stimulate scientific discovery at the nanoscale ensure the responsible development of nanotechnology, and converging technologies to improve human performance will be investigated. The development and use of nanoscale technologies is likely to change the design, production and use of many goods and services, ranging from vaccines to computers to automobile tires.

FY 2005 will likely see accelerated transition from scientific discoveries to technological innovation, due to the increased rate of discoveries over the past several years. Funding priority will be given to: (1) research enabling the nanoscale as the most efficient manufacturing domain including fabrication of nanostructured materials, nanosystems and nanoscale catalysis, (2) nanobiotechnology, and nanobiology for improving human performance, (3) innovative nanotechnology solutions to biological-chemical-radiological-explosive detection and protection, (4) discovery, understanding and potential application of phenomena specific to the nanoscale, (5) development of new instrumentation and standards, and in particular for imaging, characterization and manipulation of materials and systems in three dimensions at the nanoscale, (6) education and training of a new generation for future industries, including high school, undergraduate, graduate and informal education through the Nanoscale Science and Engineering Education program solicitation, and (7) the National Nanotechnology Infrastructure Network (NNIN) for user facilities, development of new instrumentation, and training.

Program Assessment Rating Tool (PART) Evaluation: A PART on the Nanoscale Science and Engineering (NS&E) priority area was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found NS&E to be an "effective" program. With respect to program purpose and design, the PART review found that the program's purpose, to "support fundamental knowledge creation across disciplinary principles, phenomena, and tools at the nanoscale, and to catalyze synergistic science and engineering research and education in emerging areas of nanoscale science and technology," is clear. The program addresses the need to develop a knowledge base, workforce and infrastructure to advance nanotechnology. The program relies on the competitive merit review process, an NSF working group that has representation from each participating directorate, Program Officers in their oversight capacity, and independent reviews by external entities such as the National Research Council to provide scrutiny of the program goals, ensuring effectiveness and efficiency.

With respect to strategic planning, the program was found to have a limited number of long-term performance measures with ambitious targets and timeframes that promote continuous improvement. These encompass development of a capable interdisciplinary research community, provision of the necessary research infrastructure, development of educational curricula, and building a knowledge base that enables the next industrial revolution. NS&E has annual performance measures that provide confidence that the program is moving toward accomplishment of its long-term goals. Evaluations are conducted regularly in order to inform program improvements and influence program planning. The National Nanotechnology Initiative (NNI) as a whole has been comprehensively evaluated by the National Research Council and will continue to receive annual evaluation. An NS&E-wide Committee of Visitors (COV) is planned for FY 2004. Performance information is incorporated into NSF's budget decisions and NSF's budget requests to the Congress. The budget also clearly presents the resource request for each program and outlines the activities that will be supported with the funds.

With respect to program management, NS&E was found to collect timely and credible performance information and to use it to manage the program and improve performance. NS&E grant recipients are required to submit annual and final project reports. NSF program managers conduct site visits and NS&E awards are included in COV reviews. Quantitative goals are monitored based on data in NSF's corporate systems. NS&E was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner. In order to assure sufficient knowledge of grantee activities, among other mechanisms, NS&E conducts an annual grantees workshop to highlight major accomplishments.

To a large extent, NS&E has demonstrated adequate progress in achieving its long-term goals. A number of important discoveries and their applications of nanoscale materials and devices that are impacting the economy or close to commercialization can be tied to NNI, for which NSF plays the lead federal role. NSF's participation is pivotal to the success of the overall NNI program goals. NS&E is a relatively young, robust priority area at NSF, for which internal assessment tools (such as the NS&E-wide COV) are under development. Contributing theme elements, such as nanomanufacturing, Materials Research Science and Engineering Centers and Nanoscale Science and Engineering Centers, are evaluated periodically by COVs. The complete PART for Nanoscale Science and Engineering and other assessed NSF programs may be found on the OMB Website.

FY 2005 Annual Performance Goal – Award Size: The average annualized new research grant award size funded via the NS&E solicitation will be at least $330,000.

Average annualized award size for research grants funded via the NS&E solicitation					
	FY 2001	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal			$330,000	$330,000	$330,000
Result	$363,000	$323,000	$315,000	&	&

& = Data not yet available

An average annualized award size of $330,000 is an ambitious target; significantly greater than NSF's FY 2003 average annualized award size of $136,000, and even larger than NSF's long-term goal of $250,000.

<u>**Means and Strategies for Success:**</u>
- Use electronic monitoring systems to keep track of average award size and duration and to modify funding strategies as needed.
- Communicate with the research and education community about the proposal duration and budget size using the dedicated NSE websites and professional meetings.

<u>**Resources Required:**</u> This goal can be achieved with the resources requested in FY 2005.

FY 2005 Annual Performance Goal – Access to Infrastructure – At least four thousand users will access National Nanofabrication Users Network/National Nanotechnology Infrastructure Network (NNUN/NNIN) and Network for Computational Nanotechnology (NCN) sites.

	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
Goal			3,000	4,000	4,000	4,500	5,000
Result	1,300	1,700	3,000	&	&	&	&

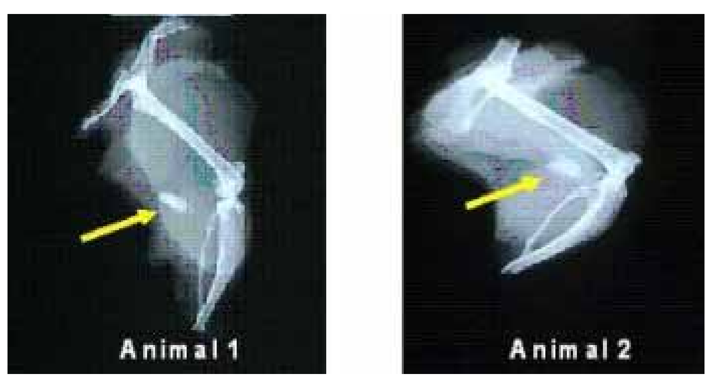
& = Data not yet available.

<u>**Means and Strategies for Success:**</u>
- Expand the number of involved universities and other partners within the networks.
- Offer long-distance education programs and remote use of facilities.
- Conduct annual reviews of the research and education topics to address national needs.

<u>**Resources Required:**</u> This goal can be achieved with the resources requested in FY 2005.

Recent Research Highlight

Ink-Jet Production of Nanostructured Matrices and Particles for Controlled Gene Delivery.
Gene therapy has great potential in engineering new tissue to replace defective organs and tissue while also being useful for the treatment of many genetically transferred diseases such as muscular dystrophy and cystic fibrosis. Gene delivery now uses viral therapy, where a virus is used to insert a gene into a target cell. This approach carries the risk of unknown diseases being transferred or the possibility of cancerous mutations associated with the manipulation of the virus to deactivate its active forms. Non-viral gene delivery may avoid many of these risks.



X-ray images of two animal subjects in which the nanoscopic DNA carriers have demonstrated bone formation at a muscle site.

A research group at Carnegie Mellon University and the University of Pittsburgh has demonstrated a mechanical method of introducing genes using ceramic particles that carry non-viral DNA. They have synthesized nanosize particles that have been incorporated into a matrix composed of materials that are naturally found in the body, to ensure compatibility. One such material is calcium phosphate – a material found in the bones – and the other is fibrin-a biopolymer that is involved in clotting as part of the body's wound-healing response. A fibrin matrix containing calcium phosphate nanoparticles with bone-forming DNA has been inserted into the tissue of laboratory rats. This matrix has been demonstrated to promote bone formation where there previously was no bone.

Small drops containing the DNA-particle complex and matrix material are deposited in layers inside the body in locations where bone is missing. Ink jet printing makes it possible to create unique three-dimensional shapes, tailoring the matrices (scaffolds for bone growth) to the desired bone reconstruction within the organism. This automated technique could enable large-scale commercialization of controlled gene delivery once the robotic ink jet printing technique has been fully developed. This could lead to significantly improved bone reconstruction therapy and possibly enhanced therapy to repair other tissues as well.

Mathematical Sciences

Today's discoveries in science, engineering and technology are intertwined with advances across the mathematical sciences. New mathematical tools disentangle the complex processes that drive the climate system; mathematics illuminates the interaction of magnetic fields and fluid flows in the hot plasmas within stars; and mathematical modeling plays a key role in research on micro-, nano-, and optical devices. Innovative optimization methods form the core of computational algorithms that provide decision-making tools for Internet-based business information systems.

The fundamental mathematical sciences – embracing mathematics and statistics – are essential not only for the progress of research across disciplines, they are also critical to training a mathematically literate workforce for the future. Technology-based industries that help fuel the growth of the U.S. economy and increasing dependence on computer control systems, electronic data management, and business forecasting models, demand a workforce with effective mathematical and statistical skills, well-versed in science and engineering.

It is vital for mathematicians and statisticians to collaborate with engineers and scientists to extend the frontiers of discovery where science and mathematics meet, both in research and in educating a new generation for careers in academia, industry, and government. For the United States to remain competitive among other nations with strong traditions in mathematical sciences education, we must attract more young Americans to careers in the mathematical sciences. These efforts are essential for the continued health of the nation's science and engineering enterprise.

The role of mathematics has expanded in science and society, but the nation’s scientific, technical, and commercial enterprises depend on three key areas: fundamental mathematical and statistical research, interdisciplinary collaboration between the mathematical sciences and other disciplines, and mathematics education. To strengthen the mathematical foundations of science and society, the NSF will continue to support the priority area, focused on the mathematical sciences, encompassing interdisciplinary efforts in all areas of science, engineering, and education supported by the Foundation.

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences	0.91	2.21	2.21	0.00	0.0%
Computer and Information Science and Engineering	2.29	2.29	2.29	0.00	0.0%
Engineering	0.91	2.91	2.91	0.00	0.0%
Geosciences	4.57	7.07	7.07	0.00	0.0%
Mathematical and Physical Sciences	47.39	70.19	70.19	0.00	0.0%
Social, Behavioral and Economic Sciences	1.43	1.50	1.50	0.00	0.0%
Office of Polar Programs	0.18	0.18	0.20	0.02	11.1%
Subtotal, Research and Related Activities	$57.68	$86.35	$86.37	0.02	0.0%
Education and Human Resources	$2.74	$2.74	$2.74	0.00	0.0%
Total, Mathematical Sciences	$60.42	$89.09	$89.11	$0.02	0.0%

Totals may not add due to rounding.

Long-term Goals: The goal of this priority area is to advance frontiers in three interlinked areas: (1) fundamental mathematical and statistical sciences, (2) interdisciplinary research involving the mathematical sciences with science and engineering, and focusing on selected themes, and (3) critical investments in mathematical sciences education. The investment plan (FY 2002 – FY 2007) will allow efforts in research and education to take root and begin a transformation in the way mathematics, science, and education interact. The long-term goals of the investments in the priority area are to:

- Foster significant advances in fundamental mathematics and statistics with important benefits for the mathematical and other sciences and engineering;
- Bring support for researchers in the mathematical sciences to a level competitive with other sciences and recognize mathematicians and statisticians as full partners in research, by increasing award size and duration;
- Integrate the most appropriate, state-of-the-art, statistical principles and mathematical tools and concepts into all NSF sponsored research;
- Foster interdisciplinary research partnerships that integrate the mathematical sciences with other science and engineering disciplines;
- Train a new generation of researchers in interdisciplinary approaches to future science and engineering challenges;
- Increase the numbers and diversity of U.S. students trained in the mathematical and statistical sciences to meet the increasing demands of scientific research, engineering, and technology in academic institutions, industry, and government laboratories; and
- Develop a framework to significantly advance the image and understanding of mathematics in the general population.

Long-term funding for the Mathematical Sciences
(Dollars in Millions)

FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007
$30.00	$60.42	$89.09	$89.11	$90.00	$92.00

FY 2005 Areas of Emphasis: NSF plans to invest $89.11 million in the Mathematical Sciences activities described below.

- **Fundamental Mathematical and Statistical Sciences:** Fundamental research areas include themes such as dynamical systems and partial differential equations, geometry and topology, stochasticity, number theory, algebraic and quantum structures, the mathematics of computation, statistics, and multi-scale and multi-resolution analysis. To enhance research in these areas, the NSF will provide improved support for mathematical sciences through research groups and individual investigator grants, as well as through institute and undergraduate, graduate, and postdoctoral training activities.

- **Advancing Interdisciplinary Science and Engineering:** The concepts and structures developed by fundamental mathematics often provide just the right framework for the formulation and study of applications in other disciplines. Mathematics and statistics have yielded new analytical, statistical, computational, and experimental tools to tackle a broad range of scientific and technological challenges long considered intractable. This success has fueled a demand both for further development of new mathematical and statistical techniques and for research teams capable of applying these sophisticated techniques to the problems of science and engineering. A new breed of researchers, broadly trained in both mathematics and science or engineering disciplines, is needed to tackle the increasingly complex multidisciplinary research topics that confront society. Three broad, interdisciplinary research themes are being emphasized in the mathematical sciences priority area:

  - ♦ **Mathematical and statistical challenges posed by large data sets** – Much of modern science and engineering involves working with enormous data sets. Major challenges include: the identification and recovery of meaningful relationships between data; the identification and validation of the structure of large data sets, which require novel mathematical and statistical methods; and improvement of theories of control and decision-making based on large data streams, with new statistical techniques to assess complicated data sets. These challenges arise in such diverse arenas as: large genetic databases; the explosion of data gathered from satellite observation systems, seismic networks, and global oceanic and atmospheric observational networks; situations in which privacy and missing data are major concerns; the massive data streams generated by automated physical science instruments, which must be compressed, stored and accessed for analysis; and data produced by modern engineering systems that place networked sensors and actuators on scalable networks to support dynamic interactions.

  - ♦ **Managing and modeling uncertainty** – Predictions and forecasts of phenomena – bracketed by measures of uncertainty – are critical for making better decisions, whether in public policy or in research. Improved methods for assessing uncertainty will increase the utility of models across the sciences and engineering and result in better predictions of phenomena. Improving the ability to forecast extreme or singular events will improve safety and reliability in such systems as power grids, the Internet, and air traffic control. Advancing techniques to assess uncertainty has applications ranging from forecasting the spread of an invasive species, to predicting genetic change and evaluating the likelihood of complex climate change scenarios. In the social sciences, methods for assessing uncertainty will improve the utility of forecasts of market behavior.

  - ♦ **Modeling complex nonlinear systems** – Advances in mathematics are necessary for a fundamental understanding of the mechanisms underlying interacting complex systems and will be essential to the further development of modern physical theories of the structure of the universe at the smallest and largest scales. Across the sciences, there is a great need to analyze and predict emergent complex properties and understand multi-scale phenomena, from social behaviors to brain function, and from communication networks to multi-scale business information systems to complex engineering systems. The development of new mathematical and statistical ideas and tools for understanding complex systems in the environment will be a particular area of interest, building on efforts initiated in FY 2004.

To enhance research in these areas of science and engineering, which depend on cross-cutting themes in the mathematical sciences, NSF support will build on existing efforts and create new opportunities to encompass interdisciplinary research groups, interdisciplinary centers, interdisciplinary cross-training programs, and partnership activities with other federal agencies. Training activities will cover interdisciplinary professional development at many levels and those that link highly innovative training activities with research. International activities, especially those involving students, will be included.

- **Advancing Mathematical Sciences Education:** This effort will support innovative educational activities, centered on the research priorities highlighted above. Activities which foster closer connections between research and education will include: curriculum development both in the mathematical sciences and in incorporating sophisticated mathematics into other disciplines; introducing new ideas across the K-16 spectrum; and research on how mathematics is learned, particularly in light of new learning technologies and emerging mathematical fields. Investments include support for undergraduate and graduate education and postdoctoral training coupled with curriculum reform. One particular emphasis will be to enhance undergraduate research experiences at the interface between the mathematical sciences and other science and technical disciplines, building on activities between the mathematical and biological sciences initiated in FY 2003 and continued in FY 2004.

Recent Research Highlight

Transport Processes in Geophysical Systems. The exchange of heat, gases, and fluids between the ocean and atmosphere through the sea ice packs are among the most fundamental processes driving the earth's climate and polar biological activity. However, little is known about the effective fluid and transport properties of sea ice, a porous composite material. Researchers at the University of Utah, supported through NSF's Collaborations in the Mathematical Geosciences competition, together with a collaborator at the University of Alaska, are developing new theories for the fluid permeability of sea ice and for effective thermal transport through sea ice, as well as modeling life sustaining, diffusive processes in the brine microstructure, necessary for the survival and growth of sea ice bacterial populations. In particular, progress has been made in seeing how different length scales interact in different situations and how theory, field, and laboratory work are inter-related. This project has a significant component of undergraduate research, involving three students who have engaged in field and laboratory work on Arctic sea ice.

Human and Social Dynamics

The twentieth century saw an unprecedented growth in our understanding of the physical and biological worlds. New technologies transformed everyday life and enabled the development of a more closely linked global economy. Our understanding of human and social functioning, however, has not kept pace. The arrival of the twenty-first century has brought with it new hopes and possibilities for better living, but also change, uncertainty and disruption.

Research into human and social phenomena is increasingly characterized by a focus on "dynamics," that is on how the behavior of individuals, formal and informal organizations, and societies evolve and changes over time. New methods, data and technologies have invigorated the social and behavioral sciences, as have findings in other disciplines. Today, scientific understanding of the dynamics of individual behavior and social activity increasingly builds on partnerships that span the scientific and engineering communities. For example, the convergence of research in biology, engineering, nanotechnology, information technology, and cognitive science is crucial for understanding the dynamics of mind, brain and behavior and also offers new possibilities for studying group and organizational behavior. Geographic information systems (GIS) and other technologies, together with mathematically rooted advances in multilevel modeling and network analysis, have opened new frontiers for understanding such diverse subjects as crime, environmental management, epidemics and patterns of linguistic behavior.

We know that social and knowledge systems do not develop independently. Humans develop new knowledge that leads to new technologies. Social institutions shape what knowledge is produced and influence new markets and products. Because people and institutions respond to and are influenced by new knowledge and technologies, understanding the human and social dynamics underlying these complex interdependencies is essential for our nation's progress and well-being. Multi-scaled, multi-disciplinary approaches, many of which have been made possible by recently acquired knowledge and new technologies, provide the tools and techniques needed to expand necessary understanding. The NSF priority area, *Human and Social Dynamics* (HSD), develops and applies these and other approaches.

Human and Social Dynamics Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biological Sciences		0.50	0.50	0.00	0.0%
Computer and Information Science and Engineering		3.00	3.00	0.00	0.0%
Engineering		2.00	2.00	0.00	0.0%
Geosciences		1.35	1.35	0.00	0.0%
Mathematical and Physical Sciences		0.50	0.50	0.00	0.0%
Social, Behavioral and Economic Sciences	4.46	15.90	15.90	0.00	0.0%
Subtotal, Research and Related Activities	$4.46	$23.25	$23.25	0.00	0.0%
Education and Human Resources		$0.99	$0.00	-0.99	-100.0%
Total, Human and Social Dynamics	$4.46	$24.24	$23.25	-$0.99	-4.1%

Totals may not add due to rounding.

Long-term Goals: This priority area began in FY 2003 and will continue for a period of five years. In the FY 2004 Budget Request to Congress, NSF emphasized research and education related to *Human and Social Dynamics*. The intellectual goals of the effort are to:

- Exploit the convergence in biology, engineering, information technology and cognition to advance our understanding of human behavior and performance at the individual, social, and population levels;

- Refine our knowledge of decision-making, risk, and uncertainty, and to learn how to translate this knowledge into improved decision-making and risk communication;

- Develop a comprehensive, multi-disciplinary approach to understanding human and social dynamics, incorporating international, regional, and cross-cultural approaches;

- Create accessible large-scale data resources and advance methodological frontiers. Areas ripe for progress include: agent-based modeling, complex network analysis, non-linear dynamics, computer-assisted qualitative analysis, and multi-level, multi-scalar analysis and measurement research and technologies. Advances in these areas will provide the foundation for social and behavioral investigations for the next decade or more, and will create spillover effects that extend beyond the social sciences;

- Develop the broad range of infrastructure needed to support transformative interdisciplinary research. Examples include collaboratory research networks, large-scale data repositories and experimental laboratories, cognitive neuroimaging centers, national and international topic-focused research sites, and innovative research platforms such as real and modeled virtual communities and intelligent environments.

Long-term Funding for Human and Social Dynamics

(Dollars in Millions)

FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007	FY 2008
$4.46	$24.24	$23.25	$25.00	$30.00	$35.00

FY 2005 Areas of Emphasis: In FY 2005, NSF plans to invest $23.25 million in interdisciplinary research on *Human and Social Dynamics* with special attention to the priorities described below.

Agents of change – Research will focus on better understanding of large-scale transformations, such as globalization and democratization, and the role of education as an agent of change; the reciprocal relationship between individual and social action; the evolution of society and its interaction with climate, geography and environment; the implications of cultural change and variation for intergroup relations, including conflict, assimilation, diversity, and equality; and impacts, adaptation, and resistance to technological change and new science-based knowledge.

Dynamics of human behavior – Work in this area will support innovative research on cognitive, linguistic, developmental, social, organizational, cultural, biological and other processes essential to understanding individual and group behavior as structured phenomena that develop and change over time. This area of emphasis aims to stimulate research using state-of-the-art methods and cross-disciplinary approaches to better understand the dynamic processes that shape human behavior and action. Research might, for example, exploit the convergence in nanotechnology, biotechnology, information technology, and cognitive neuroscience to better understand the development of human communication. Other examples of relevant research are investigations into the cognitive requisites for effective human-machine interfaces and studies of the robustness of organizational forms to unexpected exogenous shocks. Support will also be available for educational activities related to the development and use of innovative approaches, tools and techniques.

Decision-making under uncertainty – Research will focus on decision-making in normal and crisis circumstances, the implications of distributed versus centralized decision-making systems; new approaches to risk analysis including risk assessment and risk management; and the development of databases, decision-support systems, and other tools and approaches to facilitate effective decision-making and risk communication. Especially important will be research on behavior in response to extreme events such as natural disasters and terrorist attacks. Approximately $5.0 million within the SBE Directorate supports a portion of NSF's $25.0 million investment in the Administration's Climate Change Research Initiative.

Spatial social science – Recent technological advances have the potential for qualitatively changing the nature of social science by providing tools and techniques for acquiring information about location that can be combined with demographic, political, health-related and other social data. Examples of such advances hold great promise for all facets of society and include the use of Global Positioning Systems for highly precise locational specification; the use of mobile devices, integrated sensors/transmitters; and the design of intelligent environments for information access and transmission. Investments in this area will lead to improvements in existing tools and technologies and will help to make them more accessible. Research in this area will use these and other technologies to explore and map the spatial aspects of human and social dynamics, including: neighborhood effects on social outcomes; the growth of virtual, regional, and global networks that defy traditional geographic and spatial boundaries; the geo-spatial dimensions of innovation and knowledge spillovers; and environmental spatial history, where studies of environmental history inform us about how humans have interacted with the natural landscape.

Modeling human and social dynamics – Research foci will include: (1) complex networks, such as social groups, large organizations, electrical distribution grids, and economic and cognitive systems across time and space, (2) the integration of formal modeling and empirical testing, and (3) group and societal behavior as a result of numerous individual, small group, or micro-cultural actions and decisions. Promising lines of inquiry include: stochastic agent-based modeling, social network analysis, multi-level models, non-linear dynamics, and the use of innovative information and engineering technologies in modeling human interaction and behavior.

Instrumentation and data resource development – The development of instrumentation and software that takes advantage of information technology, microelectronics, nanotechnology, photonics, robotics, sensing systems, modeling, data mining, and meta-analysis techniques promises to bring recent laboratory instrumentation advances to bear on the full spectrum of social and behavioral questions. New instruments include tools and techniques for genetic analysis and cognitive neuroimaging. Data resource needs include new and extended longitudinal databases such as those that capture organizational variables and changes in them over time. Tools are also needed for data-rich linguistic analysis and corpus linguistics, and databases with fail-safe privacy protections, that couple genetic information with behavioral and social information. Database related tools include systems and devices for more rigorously collecting and analyzing qualitative data; the integration of diverse data resources across multiple scales; advanced techniques for the analysis of information from diverse sources; and technologies for anonymizing sensitive data and efficiently analyzing these data.

Workforce for the 21st Century

The nation's economic vitality, security, and quality of life depend on a workforce that is scientifically and technologically literate and a science and engineering professional workforce that is world class at all levels. Our educational system has been and continues to be effective at the collegiate level and attracts those students globally. However, many K-12 graduates are ill-prepared to respond to the demands of today's world, fewer young Americans choose to pursue science and engineering careers, and fewer than half of those who do choose these career paths graduate, putting the nation's economy and security at peril.

This softening of the nation's science and engineering capacity is exacerbated by the slow progress in attracting, supporting, developing, and advancing underrepresented minorities, women and persons with disabilities to careers in science and engineering. This shortcoming must be overcome with both passion and strategic investment. It is unrealistic to imagine that the United States can persist in sustaining its freedom without long-term dedication to resolving this workforce conundrum. In the words of James Madison, "What spectacle can be more edifying or more seasonable than that of liberty and learning, each leaning on the other for their mutual and surest support?"

NSF's *Workforce for the 21st Century* priority investment will capitalize on its experience with programmatic investments made over the years by integrating the most effective of them; premising program designs on research findings bearing on science, technology, engineering, and mathematics learning; and broadening participation throughout. The objective is a highly synergistic and interconnected enterprise requiring active involvement of researchers and educators at all levels and from every science and engineering discipline.

NSF has a long tradition of innovation in science, technology, engineering, and mathematics education. From its initial 1952 investment in Graduate Research Fellowships (a story on the Class of '52 is posted at http://www.nsf.gov/od/lpa/nsf50/classof52.htm) to K-12 curriculum and faculty development to television programming for the public, NSF has promoted the preparation of high quality scientists and engineers, and scientifically literate citizens. Now, in the *Workforce for the 21st Century (Workforce 21)* priority area, these efforts will be brought together in distinct activities that build on what has been learned over half a century.

Workforce for the 21st Century Funding
(Dollars in Millions)

	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Computer and Information Science and Engineering	0.00	2.56	2.56	N/A
Engineering	0.00	1.03	1.03	N/A
Mathematical and Physical Sciences	0.00	1.03	1.03	N/A
Subtotal, Research and Related Activities	0.00	4.62	4.62	N/A
Education and Human Resources	0.00	15.38	15.38	N/A
Total, Workforce for the 21st Century	$0.00	$20.00	$20.00	N/A

Totals may not add due to rounding.

Long-term goal: For the next five years, all NSF directorates will partner in an integrated research and education effort to address science and engineering workforce needs. The elements of this goal are to:

- Prepare scientists, mathematicians, engineers, technologists and educators capable of meeting the challenges of the 21st Century;
- Attract more U.S. students to science and engineering fields; and
- Broaden participation in science and engineering fields.

To ensure quality of the process and achieve this goal, the following strategies will be pursued:

- Prepare and support K-12 teachers and higher education faculty who inspire and challenge students and provide this instructional workforce with effective materials, training, and methods to promote and assess learners;
- Integrate the linkages of elementary, middle, and high school and the transition to postsecondary education for a seamless K-12 experience for all learners;
- Improve coordination and vertical integration of NSF programs along career paths to ensure an educational pathway for all students;
- Focus on models that attract and retain U.S. students in science and engineering through the junctures along their career paths, from high school to college, from 2-year to 4-year institutions, from baccalaureate to graduate programs (both integrative master's degrees and doctoral research programs), and from graduate study to careers;
- Promote both institutional and multi-institutional networking, partnerships, alliances and collaborations, to achieve results of mutual benefit;

- Pursue research on those factors that influence career choices and evaluate the productivity of strategies for increasing and broadening participation in K-12 science and mathematics and careers in science and engineering; and
- Ensure individual and institutional participation in the nation's nascent cyberinfrastructure.

To achieve the goal of this priority area, three integrative investments that build on successful activities will be pursued over the next five years:

- **Integrative Institutional Collaborations:** Currently, NSF supports a number of effective programs designed to encourage U.S. students to participate in science and engineering fields, ranging from pre-college to postdoctoral study. NSF's investment in K-12 programs rests on attracting U.S. students to these fields in their early years; in addition, collaborations between K-12 and higher education promote alignment of secondary school and higher education by implementation of enriched mathematics and science curricula, and laboratory improvements. Institutions participating in the Louis Stokes Alliances for Minority Participation (LSAMP) program produce 70 percent of the underrepresented minority science and engineering baccalaureate degree recipients. The successful Research Experiences for Undergraduates (REU) investment impacts students across all sectors; REU awards support to individual investigators and site directors offer hands-on research experiences for undergraduates. The Alliances for Graduate Education and the Professoriate (AGEP) program has yielded a substantial increase in minority students earning graduate degrees and this was achieved in just a few years. Centers of Research Excellence in Science and Technology (CREST) develop research capacity in minority-serving institutions.

  Together, these programs advance pre-college students, undergraduates, and graduate students, and build research capacity. When coupled with support for Minority Serving Institutions (MSIs) and Graduate Teaching Fellowships in K-12 Education (GK-12), Major Research Instrumentation (MRI), NSF's investment in cyberinfrastructure to speed the connectivity of everyone to learning and research tools, and other programs, integrated sets of these capacity-building programs can have substantial impact within a campus and, more broadly, on advancement of U.S. students, over and above what is envisioned by any one of them alone. Additionally, NSF's outstanding research and education centers, such as the Science and Technology Centers, the Engineering Research Centers, the Centers for Learning and Teaching, and the Long-Term Ecological Research Program, can be important contributors to campus programs that encompass these many individual programs. Integrative Institutional Collaborations will enable institutions to craft activities that weave together, vertically integrate, and augment support for existing programs, thereby creating a seamless route of advancement for students from the K-12 through post-doctoral levels and beyond – a result that is greater than the sum of its parts.

- **Faculty for the Future.** This program is designed to enhance both preparation and professional development of K-12 teachers and the professoriate. Importantly, it is aimed at offering both K-12 and higher education faculty the opportunity to hone their skills to meet the challenges of today's fast-paced growth in knowledge and tools of knowledge transfer. One component supports development of innovative approaches to educating new K-12 and higher education faculty, i.e., the next generation of teachers, especially those teachers who will attract and retain members of underrepresented groups. These efforts may include development of new cost-effective tools to enhance learning, allow students and faculty to participate in research, including simulation and Internet access to specialized research environments, and to adapt research equipment to educational uses. A second component provides early and mid-career Minority Serving Institution (MSI) faculty with research-based faculty development opportunities in laboratories at research-intensive universities. The intent is to promote mutual partnerships and mentorships between host and visiting faculty members and to establish long-term relationships between individual faculty members, departments, and institutions in order to strengthen learning-through-research at MSIs.

- **Workforce Research**. As the educational environment increases in complexity, young people and adults have many options in the pursuit of a degree or for enhancing their employability and opportunity for advancement. While many programs and activities elicit interest in science and engineering, it is important to reinforce decisions to pursue careers in those fields. The decisive factors in career choices unfortunately remain elusive. Therefore, research is needed to determine what experiences, strategies, or practices are most effective in attracting and retaining students in careers that require fluency in mathematics, science, engineering, or technology. This program will complement the Centers for Learning and Teaching in promoting study of factors influencing career choices; analyzing the quality and productivity of the pathways that students use to prepare for science and engineering careers or advance in their careers; and evaluating programs designed to increase and broaden participation in science, mathematics, and engineering areas at all levels. The long-term outcome is to develop effective ways to meet the changing needs of the 21st Century workforce for knowledge and skills in science, technology, and engineering.

Long-term Funding for Workforce for the 21st Century
(Dollars in Millions)

FY 2004 Estimate	FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009
$0.00	$20.00	$22.00	$25.00	$30.00	$35.00

FY 2005 Investment: In FY 2005, NSF will begin investment in two of the three integrative investments. Integrative Institutional Collaborations will be supported at $13.43 million and Workforce Research to understand and scientifically validate practices that are deemed effective in attracting and retaining students in careers requiring mathematics and science fluency will be supported at $6.57 million.

Information Technology Research

Information Technology Research Funding
(Dollars in Millions)

	FY 2000 Actual	FY 2001 Actual	FY 2002 Actual	FY 2003 Actual	FY 2004 Estimate
Biological Sciences		5.19	6.08	6.80	7.50
Computer and Information Science and Engineering	90.00	155.48	173.51	215.17	218.11
Engineering		8.17	10.23	11.17	11.17
Geosciences		10.90	12.16	13.21	14.56
Mathematical and Physical Sciences		29.62	32.66	35.52	35.52
Social, Behavioral and Economic Sciences		3.82	4.36	4.60	5.15
Office of Polar Programs		1.09	1.22	1.33	1.55
Subtotal, Research and Related Activities	90.00	214.27	240.22	287.80	293.56
Education and Human Resources		2.00	2.00	2.48	9.53
Major Research Equipment and Facilities Construction	36.00	44.90	35.00	44.83	9.94
Total, Information Technology Research	$126.00	$261.17	$277.22	$335.11	$313.03

Totals may not add due to rounding.

From FY 2000 – FY 2004 NSF provided support for the Information Technology Research priority area. Information Technology (IT) has created unprecedented new possibilities for advancing knowledge across the spectrum of human endeavors, including fundamental scientific research, education, engineering design and manufacturing, environmental systems, health care, business, entertainment, and government operations. IT is essential in the growth of our economy and in solving critical problems facing our nation. NSF-supported research extends the frontiers of IT, improves our understanding of IT and its impacts on society, and helps prepare Americans for the Information Age. ITR has also supported Terascale computing investments that are providing state-of-the-art supercomputing resources to U.S. researchers and moving in new directions such as the Extensible Terascale Facility to prepare for cyberinfrastructure investment.

In FY 2000, the NSF Information Technology Research (ITR) program stressed fundamental research and education; in FY 2001, applications in science were added; in FY 2002, the program supported research to create and utilize cutting-edge cyberinfrastructure, enabling research and education in multidisciplinary areas and focusing on emerging opportunities at the interfaces between information technologies and other disciplines. In FY 2003, the ITR program continued its emphasis on interdisciplinary research opportunities, with the intent to stimulate broad research on the fundamental challenges facing the expansion and utilization of IT across science and engineering. In FY 2004, ITR continues to exploit and deepen the ongoing research and continues to expand research in multidisciplinary areas, focusing on fundamental research that will lead to novel and profound insights about our physical, biological, and social world. It continues to support research to enable the wide and secure deployment of pervasive IT through new classes of ubiquitous applications, the creation of new paradigms to achieve high-levels of trust in cyberspace, and the development of new tools and methods to enhance our national security and critical infrastructure protection. NSF priority areas tend to last no more than five years, in order to allow new priority areas to emerge. Consistent with this policy, the ITR priority area is being transitioned back into NSF's fundamental science and engineering core in FY 2005.

Program Assessment Rating Tool (PART) Evaluation: A Program Assessment Rating Tool (PART) on the Information Technology Research (ITR) priority area was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found ITR to be an "effective" program. With respect to program purpose and design, the PART review found that the program has a clear purpose. It responds to the President's Information Technology Advisory Committee (PITAC) Report of 1999 that recommended increased research on software, scalable information infrastructure, high-end computing and the socioeconomic impacts of IT, including IT workforce issues. PITAC also called for "acquisition of the most powerful high end computing systems to support science and engineering research." ITR supports long-term, basic, high-risk research in IT of the kind that is too speculative for industry to support. ITR relies on the competitive merit review process and NSF Program Officers to ensure program effectiveness and efficiency. A Committee of Visitors (COV) for ITR will also be convened to review the program.

With respect to strategic planning, the program was found to have a limited number of long-term and annual performance measures, with ambitious targets and timeframes that promote continuous improvement. Long-term measures have been chosen consonant with the PITAC recommendations and with other NSF performance measures to assure that the program is effective in terms of its own goals and its performance can be judged and compared to that of other NSF programs. Short-term goals provide evidence for long-term evaluation. The ITR program intends to make progress toward its long-term goals and to achieve substantial impact on the nation's IT capabilities and IT workforce by 2008. Performance information is incorporated into NSF's budget decisions and NSF's budget requests to the Congress. The budget also clearly presents the resources requested for each program and outlines the activities that will be supported with the funds.

With respect to program management, ITR was found to collect timely and credible performance information and to use it to manage the program and improve performance. Performance information is collected via interim, annual and final project reports as well as site visits to larger projects. COV reviews and recommendations are utilized to improve program performance. Process-related goals such as dwell time can be monitored via the agency's Enterprise Information System (EIS). ITR was also found to effectively coordinate and collaborate with related programs. ITR coordinates with programs in other agencies through the Interagency Working Group (IWG) on Information Technology Research and Development (ITR&D), which has six interagency "Coordinating Groups" for different aspects of the Networking and ITR&D (NITRD) Program. ITR was found to use strong financial management processes and obligate funds in a timely manner.

To a large extent, ITR has demonstrated adequate progress in achieving its long-term goals. The ITR program has stimulated a high level of research activity and resulted in the initiation of new research directions, institution of new interdisciplinary activities, and expansion of research communities. The FY 2002 Advisory Committee for GPRA Performance Assessment (AC/GPA) assessed ITR as an Area of Emphasis in NSF and reported that "The quality, creativity, importance and breadth of the projects in the ITR Emphasis Area are impressive...The portfolio demonstrates a good balance of risky, high potential benefit projects versus less risky research. Many of the projects are multidisciplinary." The complete PART for Information Technology Research and other assessed NSF programs may be found on the OMB website.

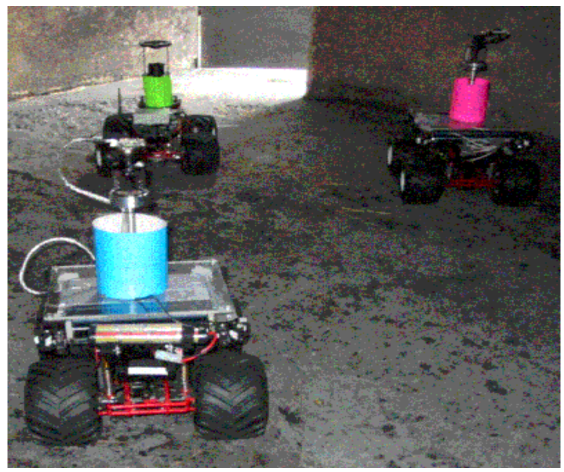
Recent Research Highlights

Tracking intruders on compromised computers. After a computer is broken into, it is imperative for the administrator to learn how the intruders broke into the system, what secrets they stole, what data they modified, and what further attacks they enabled or launched. Unfortunately, administrators currently rely on sketchy logs, guesswork, and luck when analyzing intrusions. Careful intruders can hide their tracks by disabling monitoring software, by encrypting their communication, or by performing non-deterministic actions that an administrator cannot reliably repeat.

An NSF-supported Principal Investigator and his students have developed a virtual-machine based system called ReVirt that can trace an intruder's every action. This tracing is performed at such a fine level of detail that an administrator can reenact every instruction an intruder executed to break into a computer, as well as every instruction the intruder performed after breaking into the computer. The tracing slows execution by only a few percent and can store a day of activity on $1 of disk storage. This research was presented at the Symposium on Operating Systems Design and Implementation.

The work represents a new approach to applying the concept of virtual machines that supports identifying and recovering from damage following penetration of a computer. The work is notably novel, effective, and practical.

Active sensor networks for emergency response. Researchers studying networked, sensor-carrying robots at the University of Pennsylvania recently engaged in on-site experiments at the Allegheny County (Pennsylvania) Fire Academy Test Facility. Robots were sent into a smoking building with various kinds of sensors onboard. Movies and photos of the experiments can be found on a University of Pennsylvania Web site for the Allegheny Fire Academy Tests.

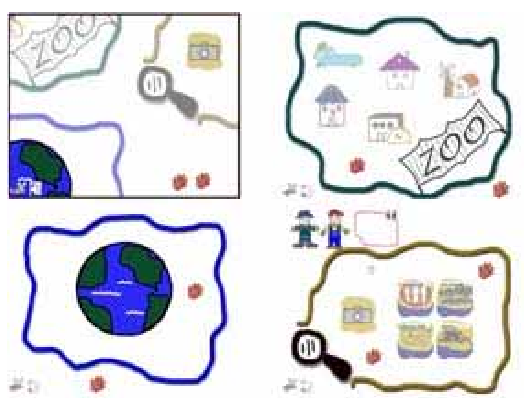


Researchers on this Information Technology Research project conduct both fundamental and applied embedded and hybrid systems research. In this project, results are deployed for experimentation using mobile robots. The project seeks to acquire and integrate various types of data from sensor networks (temperature, acoustics, range, visible and infrared imaging). These experiments are expected to provide a cost/benefit analysis of how these technologies and algorithms will be able to benefit fire fighters.

This project illustrates important concrete benefits for society of research in robotics, sensor nets, and embedded systems.

Digital Libraries for Children: Computation Tools that Support Children as Researchers.

Over the three years of the project, an NSF-supported team developed visual interfaces that support young children (age 7-9 years) in querying, browsing, and organizing multimedia information. In doing so, the team worked with children and teachers as "design partners" to develop new digital library technologies that support the learning challenges of young children. This demonstration project focused on multimedia resources of animal information donated by the Discovery Channel and the Patuxent Wildlife Research Center (Maryland). The outcomes of the project to date include:



- The development of a digital library prototype (SearchKids) where children can search for animals using a zoomable visual querying interface. Multiple children can use this tool at the same time thanks to a special interface that enables multiple pointing devices (mice) to be used simultaneously on one computer. This tool is linked to a zoomable presentation tool (KidPad), which enables children to use their animal resources to tell stories.

- The evaluation of the software with 120 2nd and 3rd grade children: The team has worked extensively in early elementary school classrooms to understand children's search strategies and approaches to collaboration. These studies have shown that young children not normally capable of complex Boolean searches can do so more efficiently and accurately given a visual interface. In addition, collaboratively navigating information necessitates various interface technologies that encourage cooperation and peer learning.

- The beginning of generalization of the interface on two fronts. The team has begun generalizing the technology infrastructure to work with other databases. They have begun generalization efforts by working with the University of Michigan's Bio Diversity animal database. In addition, the team has initiated a new research project with the Library of Congress and the Internet Archive to develop the largest international children's book digital library in the world.

Federal Crosscuts

NSF will continue its active participation in federal crosscut areas in FY 2005, supporting research and education in the Networking and Information Technology Research and Development program at $760.0 million, the National Nanotechnology Initiative at $305.06 million, and $210.02 million for Climate Change, including $185.0 million for the U.S. Global Change Research Program and $25.0 million for the Administration's Climate Change Research Initiative (CCRI), first proposed in FY 2003. The CCRI is a multiagency effort with a strong focus toward short-term outcomes and deliverables. NSF will participate in four specific areas: understanding the North American carbon cycle, research on climate change risk management, developing sensors to measure carbon dioxide and methane, and measuring and understanding the impact of black carbon.

People

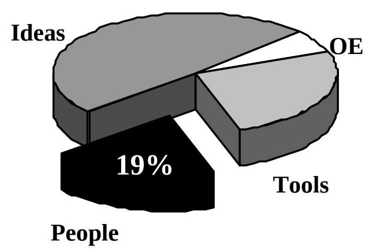
A diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.

People Funding by Investment Category
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	471.53	477.39	498.85	21.46	4.5%
Institutions	182.54	180.15	172.35	-7.80	-4.3%
Collaborations	462.93	476.23	393.62	-82.61	-17.3%
Total, People	$1,117.00	$1,133.77	$1,064.82	-$68.95	-6.1%

Totals may not add due to rounding.

PEOPLE = $1.06 B



Leadership in today's knowledge economy requires world-class scientists and engineers and a national workforce that is scientifically, technically and mathematically strong. Investments in People aim to improve the quality and reach of science, engineering, and mathematics education and enhance student achievement. Each year, NSF supports more than 200,000 people – teachers, students, and researchers at every educational level and across all disciplines in science and engineering – and provides support for public science-literacy projects. Embedded in all NSF programs are efforts to build a more inclusive and globally engaged workforce that fully reflects the strength of the nation's diverse population.

Within the constraints of the overall FY 2005 Request for People, it is not possible to accommodate the priority increases while increasing or even maintaining all programs in the portfolio at the FY 2004 Estimate. Increases requested for the highest priorities, the Integrative Graduate Education and Research Traineeships (IGERT), Graduate Research Fellowships (GRF) and Graduate Teaching Fellows in K-12 Education (GK-12) necessitated cuts in other programs. This required difficult decisions on where reductions could be taken while minimizing the adverse impact on program outcomes.

People Investment Categories: The three investment categories that support the People strategic outcome are Individuals, Institutions and Collaborations. They tie directly to NSF programs and budget resources and provide the framework for the Program Assessment Rating Tool (PART) analysis of NSF performance.

FY 2005 Annual Performance Goal for People: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the People outcome goal:

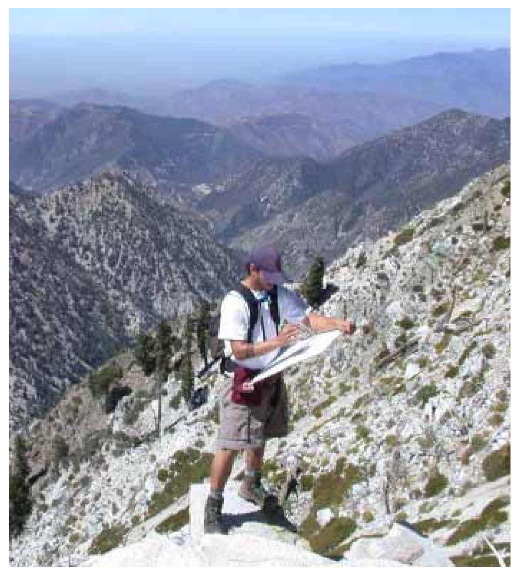
- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups in NSF activities.

- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and education that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

Baseline / Prior Year Results: FY 2001 was the first year that NSF had an annual performance goal with associated annual performance indicators for People. Each fiscal year's performance indicators may differ from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. NSF was successful in achieving the annual performance goal associated with the People strategic outcome in FY 2001, FY 2002 and FY 2003.

Means and Strategies for Success:

- Support, through merit-based grants and cooperative agreements, the most promising and capable individuals and groups throughout the U.S.
- Pay particular attention to development of people beginning careers in science and engineering.
- Use all aspects of NSF activity to embed diversity in the science and engineering workforce.
- Maintain existing partnerships and explore opportunities for developing new partnerships that focus on broadening participation. These include making presentations at national and regional meetings involving minority-serving organizations and at formal meetings of NSF programs (e.g., EPSCoR and LSAMP).
- Focus on (a) preparation and professional development of teachers of mathematics and science, and (b) alignment of standards, rigorous curricula and assessments.
- Support the production of well-trained researchers and educators by providing a variety of NSF activities (e.g., programs with industry; NSF centers) to afford interactive research and education opportunities for students, post-doctoral scientists and faculty at all career stages.



Student from the REU Program operated by the Association of American State Geologists and the California Geological Survey conducting field research in the San Gabriel Mountains. *Credit: Jonathan A. Nourse, California State Polytechnic University, Pomona.*

- Support approaches that integrate research and learning activities, encourage the partnering of the K-12 and higher education communities and develop intellectual capital.
- Encourage attendance at international meetings, faculty/student exchange opportunities, and research utilizing international facilities and field/logistics centers in order to further engage the NSF community in international activities.
- Promote increased linkages between formal programs and informal activities such as those involving museum and science center exhibits, public fora, or the Internet in order to communicate with the public.

INDIVIDUALS

Investments that ensure development of world-class scientists, engineers, mathematicians, technologists, and educators.

Individuals Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
CAREER	133.87	130.68	130.68	0.00	0.0%
Graduate Research Fellowships	85.02	97.27	103.30	6.03	6.2%
IGERT	57.85	67.00	81.74	14.74	22.0%
Postdocs	17.84	17.46	18.31	0.85	4.9%
REU Supplements	23.59	21.20	21.47	0.27	1.3%
Scholarships for Service	30.14	16.08	16.18	0.10	0.6%
Teacher Professional Continuum	66.65	62.16	62.16	0.00	0.0%
VIGRE	19.00	25.78	27.78	2.00	7.8%
Other	37.57	39.76	37.23	-2.53	-6.4%
Total, Individuals	$471.53	$477.39	$498.85	$21.46	4.5%

Request Level: $498.85 million (+$21.46 million)

- NSF is adding $14.74 million to Integrative Graduate Education and Research Traineeships (IGERT), for a total of $81.74 million and adding $6.03 million to Graduate Research Fellowships (GRF), for a total of $103.30 million. This supports approximately 450 additional graduate students. These awards are available to those graduate students who are U.S. citizens or nationals. The IGERT program is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries. It is also intended to facilitate greater diversity in student participation and preparation. GRF offer recognition and three years of support for advanced study to outstanding graduate students.

NCAR Undergraduate Leadership Workshop visiting the NSF C-130 aircraft. *Credit: University Corporation for Atmospheric Research.*

- Support for one of NSF's most prestigious programs, Faculty Early Career Development (CAREER), remains at the FY 2004 Estimate of $130.68 million. The Foundation-wide CAREER program recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century.
- Research Experiences for Undergraduates Supplements increase by $270,000 to a total of $21.47 million.

- The Teacher Professional Continuum program (TPC) is funded at $62.16 million, level with the FY 2004 Estimate, to support the development of master teachers with strong disciplinary and pedagogical content knowledge who will then serve as agents of change in their school districts. These projects will include an education research component to assess the impact on teacher learning and instructional skills, as well as strategies for effectively transferring professional development experiences back to classrooms. These leadership efforts will address particular needs of more advanced instructional materials, e.g., those associated with innovative science and mathematics.
- Support for Enhancing the Mathematical Sciences Workforce for the 21st Century (the broadening of Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE)) increases by $2.0 million to $27.78 million. This will provide support for additional postdoctoral fellowships, graduate traineeships, research experiences for undergraduates, and innovative programs to increase the number of students who pursue advanced education and training in the sciences.

Highlights of Other Individuals support include:

- NSF will expand support for research experiences for graduate students through an extension of the East Asia graduate research summer institute model to other countries. Currently this program exists in Japan, Taiwan, Korea, China, and Australia. This program will be increased by $550,000. The Foundation will also initiate a new $250,000 fellowship program for senior researchers pursuing collaborative research with scientists and engineers in developing countries.
- Support for the Opportunities to Enhance Diversity in the Geosciences (OEDG) program will be increased by $600,000 to a total of $4.60 million. This program seeks to increase participation in geosciences education and research by students from groups historically underrepresented in the geosciences.
- Support for the post-doctoral program Discovery Corps, which will be piloted in FY 2004, will increase by $500,000 to a total of $1.50 million. This program will enhance the research skills of the participants and contribute to the development of national research infrastructure.

Scientists from Michigan State (MSU) and Stanford universities, sponsored through CAREER, in a fresh look at world population dynamics, have revealed evidence that increased numbers of households, even where populations are declining, are having a vast impact on the world's biodiversity and environment. *Credit: Sue Nichols, Michigan State University.*

FY 2005 Annual Performance Goal within Individuals: Stipend level of $30,000 for students supported through the IGERT and GRF programs.

IGERT and GRF Stipend Level

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Goal	$15,000	$16,000	$18,000	$25,000	$30,000	$30,000
Result	$16,200	$16,800	$21,500	$27,500	N/A	N/A

N/A = Not Available

Program Assessment Rating Tool (PART) Evaluation: A PART on the Individuals investment category was completed to inform the FY 2005 budget decision-making process. Overall, the PART assessment found Individuals to be an “effective” program. With respect to program purpose and design, the PART review found that the program’s purpose, to "ensure development of world-class scientists, mathematicians, technologists and educators", is clear. The program addresses the need to prepare future generations of scientists, mathematicians, and engineers who will be necessary to ensure America's leadership in the global marketplace. The Individuals investment category addresses unique national STEM workforce needs that are not under the purview of mission-oriented federal, state or local agencies. The program relies on the competitive merit review process, the NSF Program Officers in their oversight capacity, and independent, external Committees of Visitors (COVs) to ensure effectiveness and efficiency.

With respect to strategic planning, Individuals was found to have a limited number of long-term performance measures with ambitious targets and timeframes, which focus on outcomes and meaningfully reflect the purpose of the program. These measures are significant achievement, as assessed by external experts, in 1) promoting diversity in the science and engineering workforce through increased participation of underrepresented groups in NSF activities and 2) attracting and preparing U.S. students to be highly qualified members of the global S&E workforce.

NSF is in the process of developing appropriate measures, baselines, and targets for its investments in Individuals. Until now, NSF's assessment processes have been based on qualitative evaluations (under the "alternative format" authorized by the Government Performance and Results Act). The agency has identified a number of potential quantitative annual measures that relate directly to the agency's strategic goals. These provide valuable indicators of progress, but further analysis is required before specific baselines and targets can be identified.

Evaluations are conducted regularly in order to inform program improvements and influence program planning. Each activity at NSF is reviewed once every three years by a COV. NSF's approach to evaluation was recently highlighted by GAO as an "evaluation culture–a commitment to self-examination, data quality, analytic expertise, and collaborative partnerships." Performance information informs NSF's budget decisions and is incorporated into NSF's budget requests to the Congress. For NSF's investments in Individuals, for example, the FY 2004 Budget Request highlighted the accomplishments of recipients of NSF graduate fellowships, noting that four former GRF recipients received the Nobel Prize in 2001 and two received the National Medal of Science. The budget also clearly presents the resource request for each program and outlines the activities that will be supported with the funds.

With respect to program management, Individuals was found to collect timely and credible performance information and to use it to manage the program and improve performance. Individuals was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner.

The investment category has demonstrated adequate progress in achieving its long-term goals, as qualitatively evaluated by external experts. Its performance compares favorably to other programs with similar purpose and goals. The complete PART can be found online at http://www.whitehouse.gov/omb/budget.

Means and Strategies for Success – Individuals:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.

INSTITUTIONS

Investments that enable colleges, universities and other institutions to attract increased numbers of students to S&E fields and enhance the quality of S&E education at all levels.

Institutions Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
ADVANCE	17.18	19.16	20.27	1.11	5.8%
Advanced Technological Education	42.33	45.23	38.16	-7.07	-15.6%
Course, Curriculum and Laboratory Improvement	54.20	44.99	50.97	5.98	13.3%
Instructional Materials and Assessment Development	27.36	28.82	29.45	0.63	2.2%
STEM Talent Expansion Program	21.29	24.85	15.00	-9.85	-39.6%
Other	20.18	17.10	18.50	1.40	8.2%
Total, Institutions	$182.54	$180.15	$172.35	-$7.80	-4.3%

Request Level: $172.35 million (-$7.80 million)

- ADVANCE totals $20.27 million, an increase of $1.11 million over the FY 2004 Estimate. The goal of ADVANCE is to increase the participation of women in the scientific and engineering workforce through the increased representation and advancement of women in academic science and engineering careers.
- Advanced Technological Education (ATE), funded at $38.16 million, a decrease of $7.07 million from the FY 2004 Estimate, supports improvement in technician education in science- and engineering-related fields that drive the nation's economy, particularly at two-year colleges and secondary schools, by supporting the design and implementation of new curricula, courses, laboratories, educational materials, opportunities for faculty and student development, and collaboration among educational institutions and partners from business, industry, and government.
- EHR increases its Course, Curriculum and Laboratory Improvement (CCLI) program by $6.12 million to $46.53 million, bringing the total number of awards to approximately 305 with a funding rate of about 21 percent. Emphasis will be on assessment and evaluation, modern instrumentation, and curriculum and program development in emerging areas. Other course, curriculum, and laboratory improvement related efforts total $4.44 million across NSF for a total of $50.97 million.
- The Instructional Materials and Assessment Development (IMD) program will increase by $630,000 to a total of $29.45 million with emphasis on applied research focused on the design and impact of new approaches to disciplinary content and its implications for student learning, the instructional workforce, and education policy.
- The STEM Talent Expansion Program (STEP) is funded in FY 2005 at $15.0 million, a decrease of $9.85 million from the FY 2004 Estimate, which allows support for approximately ten awards. STEP seeks to increase the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields within science, technology, engineering, and mathematics. The STEP decrease is due to the constraints of the overall People portfolio, in which it was not possible to maintain funding at the FY 2004 Estimate for all programs.

Highlights of Other Institutions support include:

- An additional $4.0 million will support Computer and Information Science and Engineering (CISE) demonstration projects that effectively link research and education and use best practices to attract more women and minorities; these projects will support recruiting and retaining students in computing science and engineering tracks along with improved outcomes for all students. These efforts will build on prior CISE awards that provide a research base to understand the reasons for low participation in computer science and engineering education and career paths.

- Support for the Engineering Education Reform program at $13.47 million, a decrease of $2.02 million from the FY 2004 Estimate. This level of support, while decreasing emphasis on unsolicited proposals, continues to enable engineering departments to develop innovative curricula, incorporating interdisciplinary knowledge and allowing engineering schools to develop active partnerships with schools of education, for their mutual benefit.

NSF will consider annual performance goals related to the Institutions investment category appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Means and Strategies for Success – Institutions:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

COLLABORATIONS

Investments that foster partnerships with colleges, universities, school districts, and other institutions – public, private, state, local, and federal – to strengthen S&E education at all levels and broaden participation in S&E fields.

Collaborations Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Centers for Learning and Teaching	26.58	28.84	28.84	0.00	0.0%
Evaluation	12.50	11.57	11.57	0.00	0.0%
GK-12	42.40	49.85	55.70	5.85	11.7%
HBCU-UP	18.71	23.86	19.98	-3.88	-16.3%
Informal Science Education	60.23	62.13	50.00	-12.13	-19.5%
LSAMP	31.81	34.30	34.30	0.00	0.0%
Math and Science Partnership	144.07	139.17	80.00	-59.17	-42.5%
Partnerships for Innovation	4.97	9.94	10.00	0.06	0.6%
REU Sites	30.49	31.58	31.58	0.00	0.0%
Other	91.17	84.99	71.65	-13.34	-15.7%
Total, Collaborations	$462.93	$476.23	$393.62	-$82.61	-17.3%

Request Level: $393.62 million (-$82.61 million)

- Centers for Learning and Teaching (CLTs) are funded at $28.84 million, level with the FY 2004 Estimate. CLTs address the need to enrich and diversify the national infrastructure for standards-based science, technology, engineering, and mathematics education. The goal is to increase the number of K-12 educators prepared in content, pedagogy, and assessment methodologies.
- The Evaluation program, funded level with the FY 2004 Estimate at $11.57 million, will support development of methodological state-of-the-art approaches and the training of evaluators, especially at the graduate level, to meet the needs of the STEM education community.
- The GK-12 program will increase by $5.85 million to $55.70 million, providing support for approximately 50 additional graduate students. Students receiving this support must be U.S. citizens or nationals. Stipend levels will be maintained at $30,000.
- Support for the LSAMP program will be sustained at the FY 2004 Estimate of $34.30 million and the Alliances for Graduate Education and the Professoriate (AGEP) program will be funded at $14.91 million, level with FY 2004, to allow for continuing alliances and integration between the programs.
- In FY 2005, NSF begins the process of phasing out the MSP program. Funding of $80 million will continue support for (a) out-year commitments to *Comprehensive* and *Targeted* awards made in the first and second competitions and (b) data collection and program evaluation. The MSP is being consolidated in the Department of Education to concentrate attention and resources in a single program.
- Partnerships for Innovation (PFI) are funded at $10.0 million, slightly above the FY 2004 Estimate of $9.94 million. PFI promotes innovation by bringing together colleges and universities, State and local governments, private sector firms, and nonprofit organizations. These organizations form partnerships that support innovation in their communities by developing the people, tools, and infrastructure needed to connect new scientific discoveries to practical uses.
- Funding for Research Experiences for Undergraduates Sites will remain at the FY 2004 Estimate of $31.58 million.
- The overall FY 2005 decrease reflects completion of the planned phase-out of the Urban Systemic and Rural Systemic programs and decreases in support for the Math and Science Partnership (MSP) and the Informal Science Education program.

Highlights of Other Collaborations support include:

- Support of $3.0 million for the MPS pilot program proposed to begin in FY 2004 for Undergraduate Research Centers that support faculty teams working with teams of first- and second-year college students to attract a larger and more diverse group of students into the technical workforce will be continued. Support for MPS Internships in Public Science Education (IPSE) program will increase $500,000 to total $3.0 million.
- Investment in research and training activities at the scientifically rich interface between the MPS disciplines and the biological sciences will be increased by $400,000 to total $1.0 million.
- GEO sustains support for the Centers for Ocean Science Education at $2.60 million. This program is putting in place a distributed

A University of Rhode Island GK-12 Fellow (Catalina Martinez) and a student hold a flounder during a field experiment. The GK-12 Fellows received extensive training and were paired with teachers in grades 4-8. Both the Fellows and teachers attended a summer institute focused on marine science content and on pedagogy. *Credit: University of Rhode Island.*

set of center-like groups to develop and implement innovative education activities utilizing the world's oceans as an integrating theme.

NSF will consider annual performance goals related to the Collaborations investment category appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Means and Strategies for Success – Collaborations:

- Promote greater diversity in the science and engineering workforce through increased participation of underrepresented groups and institutions in NSF activities. NSF promotes diversity by embedding it throughout its investment portfolio.
- Support programs that attract and prepare U.S. students to be highly qualified members of the global S&E workforce, including providing opportunities for international study, collaborations and partnerships.
- Develop the nation's capability to provide K-12 and higher education faculty with opportunities for continuous learning and career development in science, technology, engineering and mathematics.
- Promote public understanding and appreciation of science, technology, engineering, and mathematics, and build bridges between formal and informal science education.
- Support innovative research on learning, teaching and mentoring that provides a scientific basis for improving science, technology, engineering and mathematics education at all levels.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS – PEOPLE

Examples of accomplishments of NSF-supported education and training programs are described below.

Lake Ecosystem Critical to East African Food Supply Is Threatened by Climate Change. In an important new study directly linking climatic warming with the survival of lake organisms, researchers have found multiple lines of evidence showing that increasing air and water temperatures and related factors are shrinking fish and algae populations in Lake Tanganyika in Africa. The lake holds 18 percent of the world's liquid freshwater and is a critical food source in East Africa. Researchers have reported that climate change in the region is harming the lake's ecosystem, decreasing fish stocks by as much as 30 percent over the past 80 years. NSF supports this research through the Nyanza Project, an interdisciplinary research-training program for undergraduate and graduate students and secondary school teachers based at the University of Arizona in Tucson. This project, part of the NSF Research Experiences for Undergraduates (REU) Program, links U.S. researchers with African researchers supported by the United Nations Global Environmental Fund's Lake Tanganyika Biodiversity Project.

Deploying the Hedrick Marrs multicorer. *Credit: Andrew Cohen, University of Arizona at Tucson; NSF.*

NCAR Undergraduate Leadership Workshop. In June 2002, the National Center for Atmospheric Research (NCAR) hosted the first annual NCAR Undergraduate Leadership Workshop to inform students about the potential for exciting research and career opportunities in the atmospheric and related sciences. The five-day workshop established informal dialogues between students and research scientists as they explored laboratories, instrumentation, and computing facilities that support studies on weather, climate change, solar dynamics, the Sun-Earth system, and the impacts of severe weather and climate change on societies around the world. Students gained insight into the breadth of research topics in the atmospheric and related sciences, while they also learned about NCAR's collaborative role in university research. They were informed about opportunities for graduate and post-doctoral studies in the University Corporation for Atmospheric Research (UCAR) community of member and affiliate universities and colleges.

Center Aims to Bring More Women and Minorities into Engineering. To increase the number of women and minorities in the field of engineering, the Center for Wireless Integrated MicroSystems (WIMS), an Engineering Research Center (ERC) at the University of Michigan, has expanded its work into secondary schools. The Center sponsors four summer programs that use microsystems to excite students about using engineering to tackle important societal problems. The courses are designed to improve precollege students' skills in science, math, computer science, and communications. More than half of those enrolled were females, and one program targeted students from underrepresented groups (mainly African-Americans from urban schools). Some examples are:

- "*Legos to WIMS*" – a 5-day commuter program open to fifth through seventh grade students;
- The "*Detroit Area Pre-College Engineering Program (DAPCEP)/ WIMS Short Course*" – a 3-week residential program for students entering 11th and 12th grades, which is offered through the Diversity Programs Office at WIMS partner institution Michigan State University;
- "*WIMS for Women*" – a 6-day/5-night residential summer program; and
- "*WIMS for Teens*" – a 7-day/6-night residential summer program. The curriculum focuses on math integrated with science, Lego Mindstorm challenge activities, communication skills, and pre-engineering motivational activities.

Detroit: Improving Science and Math Education. The Detroit Urban Systemic Program (USP) assists the city's school district in implementing K-12 science and mathematics standards based on the Michigan Core Curriculum. Rigorous standards, cognitive engagement, personal relevance, pervasive technology, and capacity building are the five basic concepts that guide the constructivist approach to teaching and learning of the Core Curriculum in all 268 schools reaching the entire population of over 167,000 students. To increase the pool of qualified science and math teachers in the school district, the Detroit USP collaborated with Wayne State University to create an Alternative Pathway to Teaching program for teachers now under temporary certification who wish to work toward full certification. Likewise, the program collaborated with the University of Michigan to create a K-12 Masters of Arts with Certification that focuses on the preparation of science and math teachers in urban areas.

A Detroit math teacher provides guidance on the use of hand-held technology and real-world data to chart changes in the coordinates of a student as he changes position. *Credit: Detroit Public Schools.*

MLIAM: NESPOLE! - Negotiating Through Spoken Language in E-commerce. This research in the area of multi-lingual speech translation and communication has produced a prototype system that enables native users to connect with a "commercial" service provider that speaks a different language and receive detailed information via a live video-conferencing channel, in which speech-to-speech translation is seamlessly embedded. A simple and easy to use "whiteboard" application that allows the two parties to simultaneously view shared WebPages, maps, images, and annotated gestures complements the speech communication channel, significantly enhancing the effectiveness of communication. The speech-to-speech translation is accomplished via a unique server architecture distributed over the Internet. Very minimal software is required on the end users' standard personal computers (PCs). This technology opens the door to new global e-commerce applications that transcend language barriers. The project uses an "*interlingua*" to support multiple language pairs, and has managed to achieve successful speech recognition of relatively low quality speech taken from video conferencing equipment. The NESPOLE! Project is funded under the MLIAM program with one U.S. partner (Carnegie Mellon University) and three European research partners: University of Karlsruhe (Germany), Joseph Fourier University (France), and ITC-irst (Italy). Two European industrial partners are also involved: AETHRA (an Italian telecommunications company), and APT (the Trentino provincial government tourism bureau). The partners work together on overall system architecture, interlingua design, evaluation, user studies, and Human Language Technology (HLT) component design.

International Children's Digital Library. Researchers at the University of Maryland's Human-Computer Interaction Lab and at the Internet Archive, a public, non-profit organization, are engaged in a 5-year project to create a digital library of international children's books. The primary goal of the project is to create a collection of 10,000 books in at least 100 languages that is freely available via the Internet to children, teachers, librarians, parents, and scholars throughout the world. The project leaders are collaborating with children as design partners in the development of computer interface technologies that support children in searching, browsing, reading, and sharing books in electronic form. The primary audience is children ages 3-13. The researchers worked with children in grades two and three to understand children's search strategies and approaches to collaboration. Their studies showed that young children not normally capable of complex Boolean searches could do so more efficiently and accurately given a visual interface. The International Children's Digital Library aims to make "the largest bookmobile in history" available to children around the world.

Credit: International Children's Digital Library.

Number of People Involved in NSF Activities

Over 200,000 people are directly involved in NSF programs and activities, receiving salaries, stipends, or participant support. In addition, NSF programs indirectly impact many millions of people. These programs reach preK-12 students and preK-12 teachers, the general public and researchers through activities including workshops; informal science activities such as museums, television, videos, and journals; outreach efforts; and dissemination of improved curriculum and teaching methods. The FY 2005 decrease in the number of people involved in NSF activities reflects the phasing out of the Math and Science Partnership program and other reductions in the EHR budget, which will result in fewer K-12 students and teachers supported, and the overall decrease in the estimated number of awards, which will result in fewer senior researchers, other professionals, postdoctoral associates, and undergraduate students supported by NSF.

Number of People Involved in NSF Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	31,040	31,400	30,970
Other Professionals	14,340	14,500	12,680
Postdoctoral Associates	6,120	6,240	6,080
Graduate Students	27,620	28,640	28,870
Undergraduate Students	34,890	35,260	33,210
K-12 Students	13,310	14,320	10,820
K-12 Teachers	84,980	86,220	82,780
Total Number of People [1]	212,300	216,580	205,410

[1] Does not include individuals funded through H-1B Nonimmigrant Petitioner Receipts.

Senior Researchers include scientists, mathematicians, engineers, and educators receiving funding through NSF awards. These include both researchers who are principal or co-principal investigators on research and education projects, and researchers working at NSF-supported centers and facilities.

Other Professionals are individuals who may or may not hold doctoral degrees or its equivalent, who are considered professionals, but are not reported as senior researchers, postdoctoral associates, or students. Examples are technicians, systems experts, etc.

Postdoctoral Associates are individuals who have received Ph.D., M.D., D.Sc., or equivalent degrees and who are not members of the faculty of the performing institution. Most are supported through funds included in research projects, centers or facilities awards. The balances are recipients of postdoctoral fellowships.

Graduate Students include students compensated from NSF grant funds. Some of these students receive support through programs such as the NSF Graduate Research Fellowships, Integrative Graduate Education and Research Traineeship Program (IGERT), and NSF Graduate Teaching Fellowships in K-12 Education. The balance assists senior researchers or postdoctoral associates in performing research, and are supported through funds included in research projects, centers, or facilities awards. NSF provides support for approximately five percent of the science and engineering graduate students in the U.S.

Undergraduate Students include students enrolled in technical colleges or baccalaureate programs compensated from NSF grant funds. They may either be assisting senior researchers or postdoctoral associates in performing research, or participating in NSF programs specifically aimed at undergraduate students, such as Research Experiences for Undergraduates and the Louis Stokes Alliances for Minority Participation.

K-12 Students are those attending elementary, middle, and secondary schools. They are supported through program components that directly engage students in science and mathematics experiences such as teacher and student development projects.

K-12 Teachers include teachers at elementary, middle, and secondary schools. These individuals actively participate in intensive professional development experiences in sciences and mathematics.

Ideas

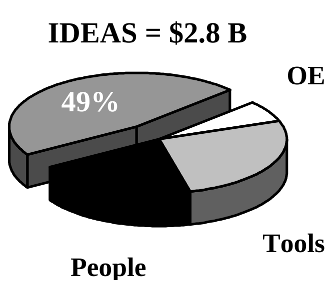
Discovery across the frontier of science and engineering, connected to learning, innovation, and service to society.

Investments in *Ideas* are aimed at the frontier of science, mathematics, and engineering. They build the intellectual capital and fundamental knowledge that drive technological innovation, spur economic growth, and increase national security and welfare. These investments also seek answers to the most fundamental questions about the origin and nature of the universe and life.

NSF's FY 2005 Request for Ideas totals $2,845.05 million, a $56.06 million increase from the FY 2004 Estimate of $2,788.99 million. This provides funding for research projects that support researchers and postdoctoral associates as well as undergraduate and graduate assistants. Funds are also provided for items necessary for performing research, such as instrumentation and supplies, and for related costs such as travel and conference support. Research in core disciplinary areas as well as studies within NSF's priority areas is included within funding for Ideas. Through outreach activities, NSF seeks out and supports excellent proposals from groups and regions that traditionally have not fully participated in science, mathematics, engineering, and education technology.

Ideas Funding by Investment Category
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Fundamental Science and Engineering	2,095.56	2,124.25	2,150.44	26.19	1.2%
Capability Enhancement	229.21	251.72	237.35	-14.37	-5.7%
Centers Programs	364.23	413.02	457.26	44.24	10.7%
Total, *Ideas*	$2,689.00	$2,788.99	$2,845.05	$56.06	2.0%



Ideas Long-Term Investment Categories: The three long-term investment categories that support the Ideas strategic outcome goal are Fundamental Science and Engineering, Capability Enhancement, and Centers Programs. They tie directly to NSF programs and budget resources, and provide the framework for analysis of NSF performance using the Program Assessment Rating Tool (PART).

FY 2005 Annual Performance Goal for *Ideas*: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Ideas* outcome goal:

- Enable people who work at the forefront of discovery to make important and significant contributions to science and engineering knowledge;
- Encourage collaborative research and education efforts – across organizations, disciplines, sectors and international boundaries;
- Foster connections between discoveries and their use in the service of society;
- Increase opportunities for individuals from underrepre-sented groups and institutions to conduct high quality, competitive research and education activities;

- Provide leadership in identifying and developing new research and education opportunities within and across science and engineering fields; and
- Accelerate progress in selected science and engineering areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.

NSF funded a study on the corona of the Sun, shown here in white light. Undergraduate students formed an integral component of the eclipse expedition and developed both interest and expertise in astronomy.

Means and Strategies for Success:

NSF utilizes the following means and strategies to achieve the strategic outcome goal of Ideas and its associated long-term investment categories and annual performance goals:

- Support the most promising ideas through merit-based grants and cooperative agreements to individual researchers and groups, in partnership with colleges, universities, and other institutions – public, private, state, local, and federal – throughout the U.S.;
- Encourage partnerships and cooperative research efforts – among disciplines, in different sectors, and across international boundaries;
- Take informed risks in emerging research areas where consensus on appropriate directions (e.g., theory, methodology, or knowledge) is just beginning to form;
- Partner with a diverse range of investigators (e.g., new, minority) and institutions (e.g., research universities, community colleges, EPSCoR states, minority-serving institutions);
- Identify and support major cross-disciplinary priority areas where U.S. and NSF leadership are important;
- Identify and provide support for new and emerging opportunities;
- Develop and support a high-quality, balanced award portfolio that considers disciplines and fields, interdisciplinary research areas, and emerging opportunities;
- Utilize the NSF core strategies of integrating research and education, promoting partnerships, and developing intellectual capital; and
- Provide grants of sufficient size and duration to improve the efficiency of the research process.

Baseline / Prior Year Results: FY 2001 was the first year that NSF defined an annual performance goal with associated annual performance indicators for Ideas. Each fiscal year's performance indicators differ slightly from those of prior years, but in all cases they serve as measures of progress toward achievement of NSF's strategic outcome goal. NSF was successful in achieving the annual performance goal associated with the Ideas strategic outcome in FY 2001, FY 2002, and FY 2003.

FY 2005 Annual Performance Goal – Award Size: NSF will increase the average annualized award size for research grants to $142,000.

Average annualized award size for research grants.								
	FY 1998	**FY 1999**	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Baseline	$90,000							
Goal				$110,000	$113,000	$135,000	$139,000	$142,000
Result		$94,000	$105,800	$113,601	$115,666	$136,000	&	&

& = Data not yet available

FY 2005 Annual Performance Goal – Award Duration: The average duration of awards for research grants will be 3.0 years.

Average duration of awards for research grants (in years).								
	FY 1998	**FY 1999**	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Baseline	2.7							
Goal		2.8	N/A	3.0	3.0	3.0	3.0	3.0
Result		2.8	2.8	2.9	2.9	2.9	&	&

& = Data not yet available

Means and Strategies for Success (Award Size and Duration):

- Use electronic monitoring systems to track average award size and duration and to modify funding strategies as needed.
- Increase award size for priority areas, focused competitions, and other programs.

Resources Required: Approximately $40.0 million is needed to increase average annualized award size from the FY 2004 goal of $139,000 to $142,000 in FY 2005, assuming that there is a slight decrease from the FY 2004 number of awards and that the FY 2005 average award duration continues at approximately 3.0 years as in FY 2004.

FUNDAMENTAL SCIENCE AND ENGINEERING

This investment category provides funds to support the best new ideas generated by scientists and engineers working at the forefront of discovery. These funds support single investigators and small groups, and provide the primary support for early career faculty and students. They are extremely important in invigorating the research community since they promote emergence of new ideas and fields, especially in areas where disciplines are blurred and new technologies merge. Investments in these activities ensure the vitality of a broad array of scientific and engineering fields needed to maintain U.S. leadership in science and engineering.

NSF relies on a competitive, merit-based process to identify the most promising research directions in established fields, and increasingly, to open new frontiers across a broad front of disciplines through multidisciplinary investigations. The continuing vitality of core disciplines is the lifeblood of the research and education enterprise.

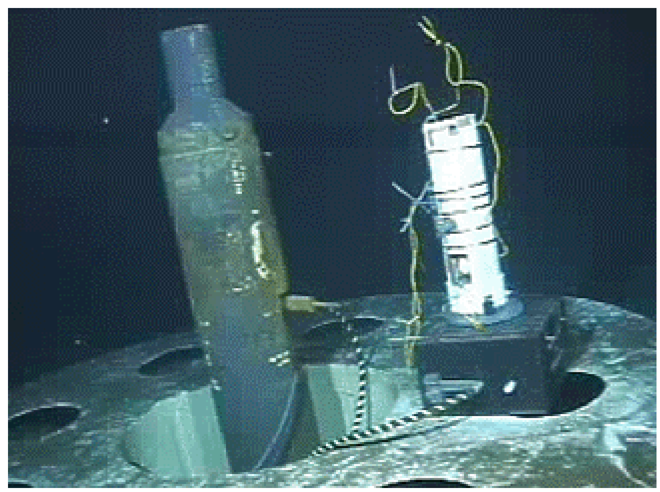
It is particularly important in today's research climate, where advances in one field can rapidly lead to new insights in others. The accelerating pace of discovery, combined with new information and communication tools, has produced unprecedented opportunities for these synergies. Information research and technology, for example, have enabled rapid progress in virtually every discipline from molecular biology to astronomy, and from particle physics to the social and behavioral sciences.

Fundamental Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Disciplinary Research	2,058.33	2,082.20	2,103.39	21.19	1.0%
Arctic Research Commission	1.08	1.19	1.19	0.00	0.0%
Innovation Fund	N/A	N/A	5.00	5.00	n/a
Interagency Education Research Initiative (IERI)	24.85	24.54	24.54	0.00	0.0%
Plant Genome Research	11.30	16.32	16.32	0.00	0.0%
Total, Fundamental Science and Engineering	$2,095.56	$2,124.25	$2,150.44	$26.19	1.2%

Highlights include:

- The NSF average annualized research grant award size will increase to approximately $142,000 and research award duration will continue at approximately 3.0 years.
- NSF's investments in cyberinfrastructure research represent the integration of state-of-the-art computing, communications and information technologies, tools and services in an infrastructure framework designed to radically empower the Nation's science and engineering research and education community.
- The new Innovation Fund, initiated at $5.0 million, will enable investment in strategic, community-driven, frontier activities.
- The 'core' of biological sciences research will increase, bringing the average award size to $190,750 per year. Focus areas include Frontiers in Biological Research, environmental genomics, molecular level understanding of life processes, and cyber-tools and services that will enable biological research and education.



With awards from the Ocean Technology and Interdisciplinary Program and the Biological Oceanography Program, researchers at the University of Hawaii have succeeded in developing methods to sample deep within the environment of oceanic crust. The research indicates that crustal fluids support a diversity of microbial life. Pictured here is the BioColumn sampling device used to sample crustal fluids.

- Computer and information science and engineering will increase award size to $165,000 and duration to 3.1 years with an emphasis on new IT technologies for cyberinfrastructure and science of design, along with strengthening 'cybertrust' – moving networking and computing to a state in which people justifiably rely on computer-based systems' performance. Other priorities include programs in Understanding, Inference and Data, Data Driven Science, Formal and Mathematical Foundations Program, Foundations of Computing Processes and Artifacts, Emerging Models and Technologies for Computation, Next Generation Systems, and Next Generation Networks.
- Engineering investments will be focused on emerging technologies – nanotechnology, cyberinfrastructure and biotechnology. Added support will be distributed among: Sensor and Sensor Networks, to increase proposal funding rates; a cross-directorate linkage of molecular structure with all levels of function in biological and non-biological membrane systems; and the current portfolio of

energy investments focused in the areas of novel energy sources, resource recovery, energy infrastructure and energy conversion and utilization.

- Research in the geosciences will support initial science projects utilizing EarthScope, fund a new Biogeoscience program enabling additional projects to examine processes at the interface between the living and non-living environment, and provide added support of targeted interdisciplinary research into carbon and water cycles.
- Fundamental Science and Engineering levels in the mathematical and physical sciences will initiate support for understanding the newly emerging area of physics of the universe, linking the very smallest and very largest of spatial and temporal scales; enhance the understanding of the physical and chemical bases of life processes, with an emphasis on the molecular level; increase the NSF priority area in Nanoscale Science and Engineering with an emphasis on structures, phenomena, and quantum control at the nanoscale; enhance support for cyberinfrastructure through new algorithms that enable the exploration of previously inaccessible science; as well as continue efforts in NSF's Mathematical Sciences priority area.
- Special emphases in social, behavioral and economic sciences will include research on cognition, the disparate involvement of members of different groups on the nation's science and technology workforce, human interaction with the natural environment over space and time, and an expansion of research on organizations.
- Polar research will expand frontiers in polar genomics, cyberinfrastructure, environmental observatories, and sensors.
- Expanded international activities will include new partnerships involving U.S. and international collaborators working at promising fundamental research frontiers. Efforts in global networking to facilitate communication and collaboration between the U.S. and the international science and engineering community will also be supported.

NSF will consider annual performance goals related to the Fundamental Science and Engineering subgoal appropriate for inclusion in a future performance budget at the time the PART assessment for this program is completed.

CAPABILITY ENHANCEMENT

These investments enhance the capability of individuals and institutions to conduct high quality, competitive research, education, and technological innovation. For example, the Small Business Innovation Research (SBIR) program, pioneered by NSF, stimulates technological innovation in the private sector by strengthening the role of small business concerns in conducting high quality science and engineering research. The Experimental Program to Stimulate Competitive Research (EPSCoR) promotes the development of state-level science and technology resources through partnerships involving a state's universities, industry, and government.

Capability Enhancement Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
CREST	8.66	14.91	10.88	-4.03	-27.0%
EPSCoR	89.21	94.44	84.00	-10.44	-11.1%
ROA	0.83	1.29	1.29	0.00	0.0%
RUI	33.43	31.19	31.09	-0.10	-0.3%
SBIR/STTR	90.92	103.59	104.09	0.50	0.5%
Industry/Univ Coop Research, and State/IUCRC	6.16	6.30	6.00	-0.30	-4.8%
Total, Capability Enhancement	$229.21	$251.72	$237.35	-$14.37	-5.7%

Request Level: $237.35 million (-$14.37 million)

- The Small Business Innovative Research (SBIR) program increases by $450,000 to a total of $93.16 million, consistent with statutory requirements.
- The Small Business Technology Transfer (STTR) program, providing funding at the mandated level, will increase by $50,000 to $10.93 million.
- EPSCoR decreases by $10.44 million to a total of $84.0 million in FY 2005. EPSCoR will be supplemented in FY 2005 by approximately $30.0 million in co-funding from the Research and Related Activities Account, bringing total EPSCoR support to approximately $114.0 million.
- Research at Undergraduate Institutions (RUI) decreases by $100,000 to a total of $31.09 million.

NSF will consider annual performance goals related to the Capability Enhancement investment category appropriate for inclusion in a future performance budget at the time the PART assessment for this program is completed.

CENTERS PROGRAMS

NSF supports a variety of individual centers and centers programs, which contribute to NSF's investment in *Ideas*. The centers play a key role in furthering the advancement of science and engineering in the U.S., particularly through their encouragement of interdisciplinary research and the integration of research and education. While the programs are diverse, the centers generally share common commitments to coordination and team-based cross-disciplinary research.

Centers Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Centers for Analysis and Synthesis	2.86	6.15	6.47	0.32	5.2%
Chemistry Centers	13.39	16.85	18.90	2.05	12.2%
Earthquake Engineering Research Centers	6.00	6.00	6.00	0.00	0.0%
Engineering Research Centers and Groups	65.72	65.55	63.49	-2.06	-3.1%
Information Technology Centers	76.46	74.00	75.00	1.00	1.4%
Long-Term Ecological Research Program	18.06	20.52	22.82	2.30	11.2%
Materials Centers	54.65	56.56	58.90	2.34	4.1%
Mathematical Sciences Research Institutes	14.77	15.10	16.60	1.50	9.9%
Nanoscale Science and Engineering Centers	12.08	30.69	33.79	3.10	10.1%
Physics Frontiers Centers	12.25	15.20	15.40	0.20	1.3%
Plant Genome Virtual Centers	36.00	36.00	36.00	0.00	0.0%
Science and Technology Centers	44.07	42.52	72.39	29.87	70.2%
Science of Learning Centers	2.19	19.88	20.00	0.12	0.6%
SBE Centers	5.73	8.00	11.50	3.50	43.8%
Total, Centers	$364.23	$413.02	$457.26	$44.24	10.7%

Request Level: $457.26 million (+$44.24 million)

- In FY 2005, a new competition for the next class of Science and Technology Centers will be supported with $30.0 million.
- Funding for on-going awards and approximately 20 new catalyst awards for Science of Learning Centers (SLCs) totals $20.0 million.
- The Long Term Ecological Research (LTER) investment increases by $2.30 million, to a total across NSF of $22.82 million. Increased funding responds to computational advances and the increasing complexity of research questions being addressed at each LTER site.
- Centers receiving funding from the mathematical and physical sciences are enhanced by an additional $6.09 million to a total of $109.80 million, spread across Chemistry Centers (+$2.05 million), Materials Centers (+$2.34 million), Mathematical Sciences Research Institutes (+$1.50 million), and Physics Frontiers Centers (+$200,000).
- Nanoscale Science and Engineering Centers (NSECs) receive an additional $3.10 million, to a total of $33.79 million. These additional funds will support two new nanotechnology centers with needed new multidisciplinary capabilities, and will enhance award size of some existing centers.

NSF will consider annual performance goals related to the Centers Programs subgoal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Description of NSF Centers

Center for Ecological Analysis and Synthesis

The Center for Ecological Analysis and Synthesis (CEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. The goals of the center are to advance the state of ecological knowledge through the search for universal patterns and principles and to organize and synthesize ecological information so that it will be useful to researchers, policy makers and resource managers addressing important environmental issues. NSF's FY 2005 support for the CEAS program is $3.47 million.

Center for the Synthesis of Biological Evolution

Initial funding of approximately $3.0 million in FY 2004 will support the Center for the Synthesis of Biological Evolution. The Center will provide mechanisms to foster synthetic, collaborative, cross-disciplinary studies in evolutionary biology. It will play a pivotal role in the further unification of the biological sciences as it draws together knowledge from disparate biological fields to increase our general understanding of biological design and function. Finally, the Center will play a critical role in organizing and synthesizing evolutionary knowledge that will be useful to policy makers, government agencies, educators and society. FY 2005 funding will be maintained at the FY 2004 Estimate of $3.0 million.

Chemistry Centers

Chemistry Centers include the Environmental Molecular Science Institutes (EMSIs), Collaborative Research in Chemistry (CRC), and the Laboratory for Molecular Sciences (LMS). In addition, new centers, Chemical Bonding Centers (CBCs), were proposed in FY 2004 to attack grand challenges in our understanding of the nature of the chemical bond. CBCs will investigate such problems as the molecular basis of life processes, the molecular origins of life, the rational design of catalytic systems, and the control of chemical reactions by lasers. In FY 2005, NSF will provide $18.90 million, an increase of $2.05 million (12.2 percent) over the FY 2004 Estimate of $16.85 million, to support 11 new centers, bringing the total to 40 centers.

Children's Research Initiative Centers

The Children's Research Initiative (CRI) supports a variety of research activities, including small research centers, individual investigator awards, collaborative proposals, and workshops. Together, the research centers represent a new thrust in the field of integrative developmental science; individually, they support leading-edge research about children and media, developmental science, and the integration and dissemination of developmental science to inform both research and policy. Centers established from FY 2001 through FY 2003 are located at the University of North Carolina-Chapel Hill, Cornell University, New York University, and the University of Michigan. A fifth center is a collaboration among four universities: Georgetown University, Northwestern University, University of Texas-Austin, and University of California-Los Angeles. No additional centers will be established in FY 2004 or FY 2005. Annual commitments to these centers total $2.50 million.

Climate Change Research Initiative Centers

Support will continue in FY 2005 for three to five centers focusing on Decision Making Under Uncertainty related to climate variability and change as part of the government-wide Climate Change Research Initiative. The centers will involve interdisciplinary teams that will advance understanding of all facets of decision-making processes related to climate change and other problems for which information exists but uncertainty remains. Centers also will increase knowledge of the content and form of information needed by decision makers, develop tools to support decision makers and increase their ability to make sound decisions over multiple time scales, and facilitate interaction among researchers and decision makers, thereby enhancing fundamental research and increasing the speed with which new research findings are adopted and used by decision makers. The FY 2005 investment in these centers will total $4.50 million, with the expectation that continuing support at this level will be provided annually through FY 2007.

Earthquake Engineering Research Centers

The three Earthquake Engineering Research Centers (EERCs) focus on reducing earthquake losses, integrating research and education, and developing partnerships with industry and the public agencies responsible for earthquake hazard mitigation at the local, state and federal levels. The EERCs link geological information about the nature of earthquake hazards in different regions of the country with geotechnical and structural engineering knowledge to provide state-of-the-art structural design methodologies. They provide the knowledge and technology base for industry and public agencies to build and retrofit buildings, bridges, and other infrastructure to better withstand the impacts of earthquakes. Because these centers involve partnerships among social scientists and engineers, they are developing a new generation of decision tools to improve public service agencies' planning for earthquake hazard mitigation and their responses during earthquake emergencies.

EERCs are rapidly becoming major contributors in the field both in the U.S. and internationally. In FY 2003, NSF provided nearly $6.0 million to three EERCs, which leveraged this support with $14 million from universities, three states, and industry. FY 2005 support is maintained at the FY 2004 level of $6.0 million.

Engineering Research Centers and Groups

The Engineering Research Centers (ERC) program stands as a landmark in federal support for university research and education in partnership with industry. These centers provide an environment where academe and industry can focus together on advances in the complex engineered systems that transform industrial processing systems and product lines most important for the Nation's future. ERCs bring diverse engineering and scientific disciplines together to address fundamental research issues at the interface between the discovery-driven culture of science and the innovation-driven culture of engineering. They provide the intellectual foundation for industry collaboration with faculty and students to resolve generic, long-range challenges, producing the knowledge needed to ensure steady advances in technology, speed their transition to the marketplace, and train graduates who are effective in applying them in industry.

ERCs are also devoted to the integration of research and education by creating team environments for learning and research and producing curricula and course materials for bioengineering, multimedia information systems, manufacturing, electronic packaging, and particle science and technology, among others. In addition, all ERCs have active programs to stimulate interest in engineering with pre-college students and their teachers and several have sites at local museums to educate the general public about engineering and technology.

An additional $53 million in support from industry, other federal agencies, universities, and ten states leveraged NSF support of $65.72 million in FY 2003. There were 383 non-industry organizations from the U.S. and abroad and 522 firms involved in partnerships and collaborations in research and education in these centers. In FY 2005, NSF will provide a total of $63.49 million, a decrease of $2.06 million from the FY 2004 Estimate. This funding supports 16 ongoing ERCs across a broad range of technologies.

Environmental Social and Behavioral Science Centers

From FY 1995 though FY 2003, NSF supported a consortium of Research Centers on the Human Dimensions of Global Change (HDGC). No such centers will be supported in FY 2004; however, following a new competition in FY 2005, NSF intends to continue providing support for centers that advance fundamental knowledge about environmental social and behavioral science, promote education and training at levels ranging from undergraduate to postdoctoral, and foster interdisciplinary and multidisciplinary research collaborations. NSF's FY 2005 support for three new Environmental Social and Behavioral Science Centers is expected to total $3.50 million, a $1.20 million increase (52.2 percent) from the level of $2.30 million that supported the HDGC Centers in FY 2003 during their final year of funding.

Information Technology Centers

As part of the Information Technology Research (ITR) program begun in FY 2000, NSF began support for 33 new center projects. These focus on major challenges for information technology research and often address interdisciplinary themes. In FY 2001, the number of center projects doubled to 66. In support of their long-term mission, some centers develop testbeds and include education and outreach components. Other centers are virtual centers that link, by high-performance networks, geographically separate investigators with individualized expertise or instrumentation. Some of these virtual centers foster research on distributed computing and applications. In FY 2005, NSF will fund approximately 80 ITR Centers at the level of $75.0 million, an increase of $1.0 million over the FY 2004 Estimate of $74.0 million for enhancements to existing centers.

Long Term Ecological Research Program

The Long Term Ecological Research (LTER) program is an NSF-wide Centers program that supports long-term analysis of ecological phenomena, both natural and human influenced; comparisons of observations across diverse ecosystems; integration of information from multiple sites and multidisciplinary projects through cross-site syntheses; and provision of large, secure, ecologically diverse sites with well-developed support capabilities. Extensive computer networking facilitated by the LTER Network Office, enables regional, national and international synthesis.

In FY 2004 NSF is supporting 24 LTER sites that are representative of major ecosystems, including two sites in Antarctica. A significant development planned for FY 2005 is the expansion of the LTER network through the addition of up to threee new near-coastal marine sites, for a total of 27 sites in FY 2005. The LTER program has also led the development of the international long-term ecological research network (ILTER), enabling worldwide research collaborations among the U.S. sites and sites abroad.

NSF's FY 2005 Request for the LTER program is $22.82 million, an increase of $2.30 million over the FY 2004 Estimate.

Materials Centers

Materials Centers support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance. MRSECs include broad-based centers with diverse research agendas as well as more focused centers. The MRSECs feature cutting-edge materials research in areas such as polymers, biomimetic and biomolecular materials, nanoscale materials, electronic and photonic materials, and superconducting and superhard materials. Annual NSF support for individual centers ranges from less than $1.0 million to more than $4.0 million. Additional support from non-NSF sources for these centers totaled $70 million in FY 2003. Approximately 28 MRSECs will be supported in FY 2005 at a total of $52.50 million. They include Materials Research Science and Engineering Centers (MRSECs) and International Materials Institutes (IMIs); beginning in FY 2004 they will include Partnerships for Research and Education in Materials (PREMs). IMIs are five-year awards aimed at supporting and stimulating cooperative activities in various areas of materials research and education between U.S. investigators and their colleagues worldwide. Three new IMIs were established in FY 2003, increasing to five or six in FY 2004 for a total of up to $3.60 million annually. This level of support will be maintained in FY 2005. In FY 2004, up to four Partnerships for Research and Education in Materials are proposed to be established at a total of about $2.40 million for 5 years. This level of support will be maintained in FY 2005. PREMs link minority-serving institutions with focused research groups, centers, and user facilities in materials research and support collaborations among them. The MRSECs have strong links to industry and other sectors; MRSECs, IMIs and PREMs all support research and educational partnerships with other institutions.

NSF's FY 2005 support for the Materials Centers totals $58.90 million, an increase of $2.34 million (4.1 percent) over the FY 2004 Estimate of $56.56 million.

Mathematical Sciences Research Institutes

The institutes provide a national resource for in-depth research in the mathematical sciences and for multidisciplinary research between mathematical scientists and other scientists and engineers from academia, industry, and government laboratories. Significant postdoctoral experiences are nurtured through mentoring with world-class mathematical scientists and through opportunities with partner universities, industries, and government laboratories. In FY 2005, NSF will provide $16.60 million, an increase of $1.50 million (9.9 percent) over the FY 2004 Estimate of $15.10 million.

Nanoscale Science and Engineering Centers

As part of the multiagency National Nanotechnology Initiative, NSF funded six centers in FY 2001 and two centers focused on manufacturing at the nanoscale were established in FY 2003; an additional six centers are planned for FY 2004. Research at the nanoscale aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science and many other fields. Each center has a long-term vision for research, and together they will provide coherence and a long-term outlook to U.S. nanotechnology research and education. Support will be provided for education and outreach programs from the graduate to the K-12 level designed to develop a highly skilled workforce, advance pre-college training, and advance the public understanding of nanoscale science and engineering. The centers have strong partnerships with industry, national laboratories and international centers of excellence. In FY 2005, NSF will provide continuing support to the eight centers at $33.79 million, an increase of $3.10 million (10.1 percent) over the FY 2004 level of $30.69 million.

National Consortium on Violence Research

The National Consortium on Violence Research (NCOVR), based at Carnegie Mellon University, is engaged in a program of capacity building in the violence research community. The Consortium's activities focus on training the next generation of researchers in interdisciplinary approaches to understanding interpersonal violence and on increasing the participation of underrepresented groups in research on violence. NCOVR also seeks to facilitate collaborative methodological research and the promotion of intellectual exchanges that cut across disciplines. NSF is providing about $1.0 million in support for the Consortium in FY 2005, unchanged from FY 2004.

Physics Frontiers Centers

The Physics Frontiers Centers program was initiated in FY 2001. These centers provide critical resources and needed infrastructure to exceptionally promising new areas of physics. They serve as focal points to help catalyze new fields, with the resources and infrastructure to enable development of the new tools and techniques needed, and facilitate exploration of new directions in a way that is not practical in individual investigator awards. Areas such as atom lasers, quantum information science, computational physics, biological physics, and astrophysics are particularly promising for such an investment. Interdisciplinary research is a key element of this program, and each center is expected to have a significant outreach and infrastructure component. In FY 2005, NSF will provide a total of $15.40 million for support of eight centers, an increase of $200,000 above FY 2004.

Plant Genome Virtual Centers

The Plant Genome Research subactivity supported twenty-nine Plant Genome Virtual Centers in FY 2003. These are multi-institutional networks where coordinated, multi-disciplinary teams pursue comprehensive, interdisciplinary research on the structure, organization and function of plant genomes relevant to economically important plants or plant processes.

Of the 29 centers supported in FY 2003, 18 were continuations or renewals of virtual centers created in previous years; 11 were newly established centers. The 29 centers involve 167 scientists as key personnel with a large number of postdoctoral fellows, graduate students, undergraduate students, technical personnel, and others involved. Key participants are located at 53 institutions in 28 States. International collaborators in 10 centers are involved in a number of areas of research including the potato, wheat, and model legume projects. NSF support for Plant Genome Virtual Centers in FY 2004 and FY 2005 will total $36.0 million each year.

Research Centers on the Human Dimensions of Global Change

NSF supported a consortium of Research Centers on the Human Dimensions of Global Change from FY 1995 through FY 2003. The goals of these centers were to facilitate the progress of Human Dimensions of Global Change (HDGC) research; promote the education and training of researchers ranging from undergraduate to postdoctoral levels; and foster interdisciplinary and multidisciplinary research collaborations on HDGC issues. FY 2003 was the final year of support for the two HDGC centers.

Science and Technology Centers

NSF's Science and Technology Centers (STC) Integrative Partnerships Program supports innovation in the integrated conduct of research, education, and knowledge transfer in fields of basic science, mathematics, and engineering. STCs foster partnerships that build a new collaborative culture among researchers and educators at all levels in academia, industry, government laboratories, and other public and private organizations. The Centers provide opportunities to explore challenging and complex research problems that often require interdisciplinary expertise and high-risk approaches, access to state-of-the-art instrumentation and facilities, and a commitment of high levels of support for sustained periods of time. It is estimated that STC funding from other sources totaled approximately $23 million in FY 2003.

STCs have an impressive record of research accomplishments, research training, contributions to K-12 education, and timely transfer of knowledge and technology from the laboratory to industry and other sectors. Traditional barriers among disciplines and among university, governmental, and industrial laboratories have been reduced, creating a new mode of leadership and management in research and education. STCs have engaged the nation's intellectual talent, robustly drawn from its full human diversity, in the conduct of research and education activities; enabled the training of undergraduate students, graduate students, and postdoctoral fellows; involved scores of industrial researchers in basic research; and spawned new companies, products, and jobs.

STCs also create partnerships and programs that transfer knowledge in service to society with respect to new research areas, promising new instrumentation, and potential new technologies. NSF's FY 2005 Request for the STC program is $42.39 million for continuing support of eleven ongoing STCs and $30.0 million for support to establish six additional STCs from the most recent competition – for a total Request of $72.39 million.

Science of Learning Centers

NSF's investment in Science of Learning Centers (SLC), begun in FY 2003, builds on the Foundation's support for learning research in multiple disciplines including biology, psychology, education, neuroscience, cognitive science, linguistics, computer and information science, robotics, mathematics and statistics, engineering, the physical sciences, and the social and behavioral sciences. SLCs are organized around an integrated, unifying, multidisciplinary research focus or one that significantly advances disciplinary frontiers and is connected to educational, scientific, technological, and/or workforce challenges; consist of diverse teams at all organizational levels of the center; and establish partnerships with schools, industry, international collaborators, professional societies and/or other appropriate partners.

SLCs demonstrate an effective implementation strategy that aims to accomplish three principal goals: (1) advance the understanding of learning, through research on the learning process, the context of learning, and/or learning technologies; (2) strengthening the connections between science of learning research and educational and workforce development, in a manner that mutually advances both; and (3) building effective collaborative research communities with sufficient resources and organizational capacity to respond to new educational and workforce challenges, and capitalize on new research opportunities and discoveries. FY 2005 support requested for the SLCs totals $20.0 million, up $120,000 over FY 2004, to support ongoing centers and about 20 new catalyst awards.

FY 2003 Estimates for Selected Centers
(Dollars in Millions)

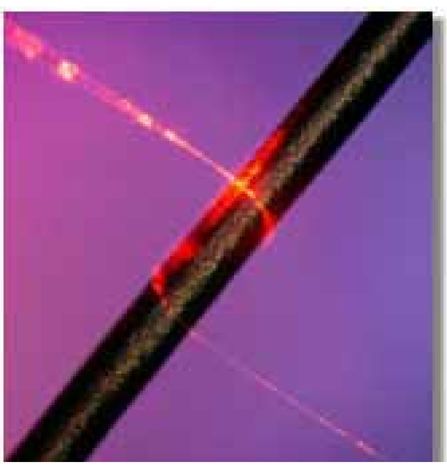
	FY 2003 Number of Participating Institutions	Number of Partners	Total NSF Support	Total Leveraged Support	Number of Participants
Chemistry Centers	47	15	$13	$1	610
Earthquake Engineering Research Centers	126	79	$6	$14	1,037
Engineering Research Centers and Groups	471	448	$66	$53	9,828
Long-Term Ecological Research Program	178	117	$18	$59	2,578
Materials Centers	83	330	$55	$70	4,950
Plant Genome Virtual Centers	53	9	$36	$6	2,160
Physics Frontiers Centers	14	12	$12	$2	328
Science and Technology Centers	79	211	$44	$23	2,140

Number of Participating Institutions: all academic institutions that participate in activities at the centers.
Number of Partners: the total number of non-academic participants, including industry, states, and other federal agencies at the centers.
Total Leveraged Support: funding for centers from sources other than NSF.
Number of Participants: the total number of people who utilize center facilities, not just persons directly supported by NSF.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS - IDEAS

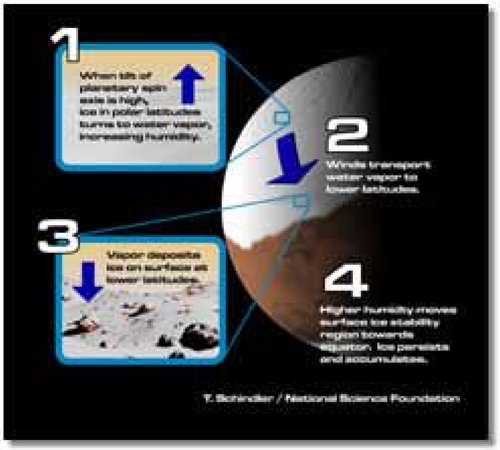
NSF investments in fundamental research provide support for cutting-edge research and education in many fields and help to maintain the nation’s capacity to conduct research in science and engineering. Selected examples of accomplishments of NSF-supported investments are described below.

Researchers Develop Nanoscale Fibers That are Thinner Than the Wavelengths of Light They Carry. Researchers have developed a process to create wires only 50 nanometers (billionths of a meter) thick. Made from silica, the same mineral found in quartz, the wires carry light in an unusual way. Because the wires are thinner than the wavelengths of light they transport, the material serves as a guide around which light waves flow. In addition, because the researchers can fabricate the wires with a uniform diameter and smooth surfaces down to the atomic level, the light waves remain coherent as they travel. The smaller fibers will allow devices to transmit more information while using less space. The new material may have applications in ever-shrinking medical products and tiny photonics equipment such as nanoscale laser systems, tools for communications and sensors. Size is of critical importance to sensing – with more, smaller-diameter fibers packed into the same area, sensors could detect many toxins, for example, at once and with greater precision and accuracy.



A light-conducting silica nanowire wraps a beam of light around a strand of human hair. The nanowires are flexible and can be as slender as 50 nanometers in width, about one-thousandth the width of a hair. *Credit: L.Tong/Harvard Univ.*

Landscapes on Buried Glaciers in Antarctica's Dry Valleys Help Decipher Recent Ice Ages on Mars. Studies of the unique landscape in the Dry Valleys of Antarctica provide new insights into the origin of similar features on Mars and provide one line of evidence that suggests the Red Planet has recently experienced an ice age, according to a paper in the December, 2003 issue of the journal *Nature*. The distribution of hexagonal mounds and other features on the Martian surface at mid-latitudes similar to

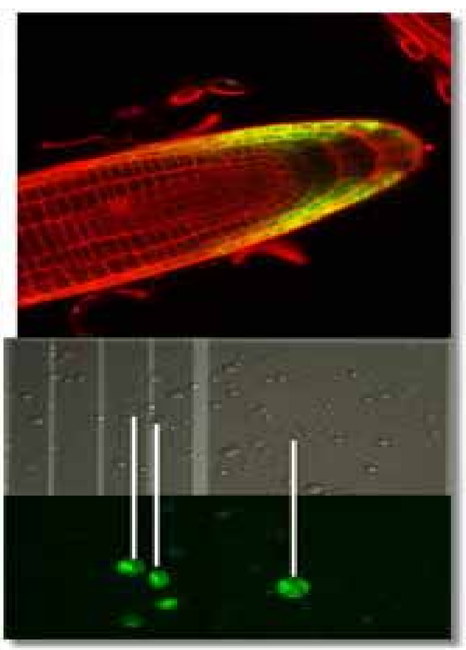


those in the Dry Valleys also supports previous scientific assertions that a significant amount of ice lies trapped beneath the Red Planet's surface.

This image describes how ice ages begin on Mars. (1) During periods of high obliquity (tilt of the planet's axis) the poles receive more direct sunlight, causing water vapor to evaporate from ice trapped there, increasing humidity. (2) Global winds transport the more humid air from polar latitudes to lower latitudes. (3) The water vapor is deposited on the surface as snow and frost. 4) Higher humidity at the surface makes ice more stable at lower latitudes, allowing it to accumulate, causing glaciation. *Credit: Trent L. Schindler / NSF*

Carbon nanotube tips for very high resolution Atomic Force Microscope (AFM) probes. The field of nanotechnology requires the development of new tools to probe devices on the nanometer scale. One of the few tools that is able to do this is the atomic force microscope (AFM). A critical factor that determines the resolution of such the AFM is the sharpness of the cantilever tip. An AFM cannot image surfaces at size scales smaller than the dimensions of the cantilever tip. Even the best tips currently available commercially have radii on the order of 20 nm. A natural candidate for making sharper AFM tips is a carbon nanotube. In addition to being extremely narrow (1.4 nm for single-walled nanotubes), nanotubes can be extremely long, so that surfaces with high relief features can be successfully imaged. Carbon nanotubes have been successfully mounted on commercial cantilever tips to obtain ultrasharp scanning probes. Images taken with this nanotube tip show substantial improvements in lateral resolution over images taken with a bare AFM tip. Other techniques are being developed to make ultrasharp tips with specific electronic and magnetic properties that will enable the study of a variety of surfaces with similar resolution.

Mustard-Root Map Breaks New Ground Tracking Gene Expression New 'global' technique a dividend of NSF's Arabidopsis 2010 effort. A new "gene expression" map is helping scientists track how a complex tissue ultimately arises from the blueprint of thousands of genes. Focusing on the root of a small flowering mustard plant, *Arabidopsis thaliana*, a research team led by Duke University biologist Philip Benfey created a detailed mosaic of cells showing where and when about 22,000 of the plant's roughly 28,000 genes are activated within growing root tissue. The results, announced in a recent issue of the journal *Science*, are the first to demonstrate "this level of resolution of gene expression on a global basis for any organism," said Benfey. The work, he said, serves as "a proof of principle" that similar approaches can be applied to other plant organs and other organisms.



The photos illustrate the first step in the root expression map technique. In the top photo, lateral root cap cells glow green because they share a common gene being expressed, one that has been marked with a gene that creates green fluorescent protein. In the middle micrograph, the plant cells have been treated with an enzyme that breaks down cell walls and disconnects the cells from each other. The bottom micrograph shows the same cells as in the middle micrograph, but with ultraviolet light applied to reveal only those with the GFP-marked genes active. These constitute the cell population glowing green in the top photo of the intact root. *All photos by Ken Birnbaum, New York University. Plant line shown in top photo created in lab of J. Hasseloff.*

The researchers collected hundreds of thousands of these specific cells. Using whole genome microarrays, also known as "gene chips," they then determined the genes expressed in these cells. The researchers typically detected about 10,000 genes in each cell population, and they reconstructed the gene-expression profile of the entire Arabidopsis root by repeating the process on virtually all cell types within it.

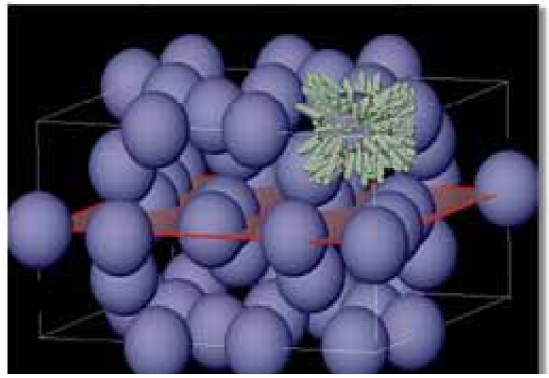
Chemists Crack Secrets of Nature's Super Glue. Researchers have discovered that iron in seawater is the key binding agent in the super-strong glues of the common blue mussel, *Mytilus edulis*. In addition to using the knowledge to develop safer alternatives for surgical and household glues, the researchers are looking at how to combat the glue to prevent damage to shipping vessels and the accidental transport of invasive species, such as the zebra mussel that has ravaged the Midwestern United States. National Science Foundation CAREER awardee Jonathan Wilker, Mary Sever and their colleagues at Purdue University announced their discovery in the January 12, 2004 issue of *Angewandte Chemie*.

Common blue mussel (*Mytilus edulis*) hangs tough after a night adhering to otherwise "non-stick" Teflon®. *Credit: Jonathan Wilker of Purdue University*

Outcrop photograph of a melt-enhanced shear zone that developed along the base of an intruding batholith (shown in yellow in crustal column). *Credit: Photo courtesy of Keith Klepeis, University of Vermont*

Earth Scientists Forge New Understanding of Mountain-Building Dynamics. Understanding how mountains form is critically important – from volcanic eruptions to earthquakes to catastrophic mudslides, the geologic processes active in mountain belts affect human societies every day. Yet, even though mountains are on all continents and in all ocean basins, scientists still understand relatively little about the forces that interact to form and destroy mountains, how mountains change over time, and the relationship between mountains and Earth's climate. To better understand these dynamics, earth scientists are now integrating studies across traditional disciplinary boundaries. In research funded by NSF and recently published in the *GSA Today*, scientists have demonstrated a new way to integrate results from observations collected in the field with laboratory and experimental techniques. The team studied a mountain belt located in Fiordland, South Island, New Zealand.

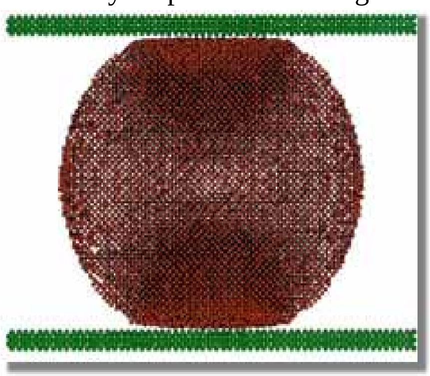
5-D Vision: Most useful metallic and ceramic materials are made up of many small crystals held together by grain boundaries. In many cases, these grain boundaries influence or even determine the performance of the material. To tell one type of grain boundary from another, the values of five distinct parameters must be specified. In other words, the space of boundary types is five-dimensional (5-D). In the past, "seeing" this 5-D space involved the accumulation of many tedious measurements. Because of this difficulty, researchers were forced to rely on simplified descriptions based on one or, at best, three parameters. The Materials Research Science and Engineering Center at Carnegie Mellon University has developed a statistical procedure for extracting 5-D information from fully automated observations of two-dimensional sections of grain boundary networks. This new characterization tool will facilitate the rapid analysis of grain boundaries in metals and ceramics and is expected to accelerate the design of a wide range of improved engineering materials.



The spherical dendrimers form a liquid crystal material that has an unexpectedly complex lattice structure. The lattice has a repetitive unit cell of 30 spheres – more than 250,000 atoms – in a rectangular volume nearly 20 nanometers by 10 nanometers. C*redit: V.Percec, Univ. of Pennsylvania*

New Molecular Self-Assembly Technique May Mimic How Cells Assemble Themselves. Researchers from the University of Pennsylvania and the University of Sheffield report in the February 21, 2003 issue of *Science* that they have created tree-like molecules that assemble themselves into precisely structured building blocks of a quarter-million atoms. Such building blocks may be precursors to designing nanostructures for molecular electronics or photonics materials, which "steer" light in the same way computer chips steer electrons.
electrons.

New Measurements Show Silicon Nanospheres Rank Among Hardest Known Materials. University of Minnesota researchers have made the first-ever hardness measurements on individual silicon nanospheres and shown that the nanospheres' hardness falls between the conventional hardness of sapphire and diamond, which are among the hardest known materials. Being able to measure such nanoparticle properties may eventually help scientists design low-cost superhard materials from these nanoscale building blocks. Up to four times harder than typical silicon – a principal ingredient of computer chips, glass and sand – the nanospheres demonstrate that other materials at the nanoscale, including sapphire, may also have vastly improved mechanical properties.



A 12-nm diameter silicon nanosphere, deformed by 2.3 nanometers in an atomistic simulation conducted by Mike Baskes of Los Alamos National Laboratory. At the top and the bottom the atoms are transformed into an amorphous state with no dislocations detected. Such simulations supported the hardness results measured experimentally by Bill Gerberich's team at Minnesota. *Credit: M.I. Baskes, Los Alamos National Laboratory*

Crystals on a Ball. Researchers have attacked a 100-year-old puzzle, and learned how a single layer of particles can pack on the surface of a sphere. In a discovery that is likely to impact fields as diverse as medicine and nanomanufacture, researchers have determined how nature arranges charged particles in a thin layer around a sphere. The leap forward in understanding this theoretical problem may help reveal structural chinks in the outer armor of viruses and bacteria (revealing potential drug targets) and guide engineers designing new molecules. On a flat surface, particles that repel each other will arrange themselves to create a stable energy state, eventually settling at vertices within a lattice of identical triangles much like billiard balls at the start of a game. Yet, for nearly a century, researchers studying spherical structures have known that a flat lattice cannot be simply wrapped around a sphere because the lattice of perfect triangles breaks down.

Since as early as 1904, when Nobel prize-winning physicist J.J. Thomson theorized about electron shells in atoms, researchers have wondered what structure the thin web of particles would choose, from among myriad possibilities, if wrapped around a sphere. In the March 14, 2003 issue of the journal *Science*, NSF researchers describe a major breakthrough in the puzzle, supported by experiments with water droplets and tiny, self-assembling beads. The researchers demonstrate how spherical crystals compensate for the curved surface on which they exist by developing "scars," defects that allow the beads to pack into place.

A rendered image of the protein shell that surrounds monkey cancer virus Simian Virus SV40 (the image is based on cryo-electronmicroscopy data). *Image Credit: VIrus Particle ExploreR*

Boundary Between Earth's Magnetic Field and Sun's Solar Wind Riddled with "Swiss Cheese" Holes. Magnetic fields explosively release energy in events throughout the universe, from experiments conducted in laboratories to huge outbursts within galaxies. On the Sun, these magnetic explosions are responsible for solar flares and ejections of material from the Sun's corona. Scientists have long debated whether the fast release of energy that occurs during "magnetic reconnection" is a smooth or turbulent process. Scientists funded by NSF have now used large-scale computer simulations, combined with direct observations from satellites, to show that the energy release is likely the result of turbulent processes. This knowledge may explain the effect of solar storms on Earth, from interruptions of satellite orbits to electrical outages in cities and towns. Satellite observations have shown that the boundary between Earth's magnetic field and the solar wind (known as the magnetopause) is riddled like Swiss cheese, with holes that may reach several miles in diameter. The holes move in the opposite direction of the prevailing electric current at speeds that can be faster than 1,000 miles per second, or 4 million miles per hour.

Aurora Australis--the Southern Lights--over the geodesic dome at the National Science Foundation's Amundsen-Scott South Pole Station. Like its more familiar counterpart, the Aurora Borealis--or Northern Lights, the phenomenon is caused by the solar wind passing through the upper atmosphere. *Photo Credit: Jonathan Berry, NSF*

"Raft" Down Sabino Canyon, an Ephemeral Stream in Arizona. Called Sabino Creek, this canyon stream in the Arizona desert exists for only part of every year. The canyon receives more than one million visitors each year from countries around the world who come to see a lush desert landscape fostered by the water that periodically courses through. Through the NSF-funded Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA), the U.S. Geological Survey and U.S. Forest Service, anyone with access to the Internet can visit Sabino Creek and learn about its unique attributes. To wend your way along this on-again, off-again watercourse, travel to: www.sabinocanyon.arizona.edu. The web site takes visitors to where Sabino Creek originates, floats them to where its water eventually ends, and shows what happens to the creek through the seasons – Sabino Creek flows only 293 days a year.

Sabino Creek, AZ: An ephemeral creek at its wettest. *Photo Credit: University of Arizona.*

Liberty Bell Web Portal Unites History and Technology. NSF website showcases all aspects of the Liberty Bell's move to its new home. The National Science Foundation (NSF), in collaboration with the National Park Service's Independence National Historical Park and MicroStrain, Inc., of Williston, Vermont, has created a new web portal to feature the history and technology surrounding the Liberty Bell's journey to its new home on October 9, 2003. Combining images, videos, and easy-to-read text, the website shows visitors details about the new sensor technology that will alert engineers and movers if the Bell's famous crack shows signs of spreading. Entitled "The Liberty Bell: Protecting an American Icon," the site also features the stories and legends that have made the Bell famous, and reveals the facts behind its crack and iconic symbolism.

African Ice Cores Reveal Prolonged Tropical Droughts. Ohio State University professors Lonnie Thompson and Ellen Mosley-Thompson led an international team of researchers to the summit of Mt. Kilimanjaro in 2000 to collect ice cores from glaciers at the summit in order to study tropical climate and the African monsoon system. What they discovered was completely astonishing. Through careful analyses, the team of researchers recreated an unprecedented and highly detailed record of three catastrophic droughts that plagued the region 8,300, 5,200 and 4,000 years ago. Glaciers at the top of Mt. Kilimanjaro in Tanzania began forming 11,700 years ago. Data from Kilimanjaro's ice cores reveal a wetter landscape in the region some 9,500 years ago than compared to today. Lake Chad, now the fourth largest body of water on the African continent with an area of 17,000 square kilometers, covered 350,000 square kilometers – an area larger than the modern day Caspian Sea. But beginning around 8,300 years ago, the ice cores reveal a climate of recurring and prolonged droughts, some lasting 300 years. While the causes of such climatic events are under active study by the Thompsons and colleagues, their recurrence is of major concern because seventy percent of the world's population now lives in the tropics and social systems can be dramatically stressed by climate events of the magnitude recorded in the ice.

Tools

Broadly accessible, state-of-the-art S&E facilities, tools, and other infrastructure that enable discovery, learning and innovation.

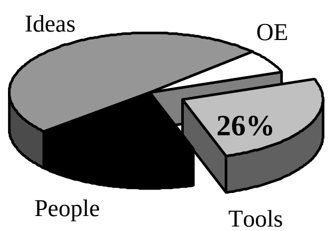
The FY 2005 Request for Tools totals $1,472.08 million, a $104.19 million increase over the FY 2004 Estimate of $1,367.89 million. Operations and maintenance of multi-user facilities and research resources are funded through the Research and Related Activities (R&RA) and the Education and Human Resources (EHR) Accounts; major construction projects are funded through the Major Research Equipment and Facilities Construction (MREFC) Account.

NSF investments provide state-of-the-art tools for research and education, such as laboratory instrumentation and equipment, multi-user research facilities, distributed instrumentation networks and arrays, accelerators, telescopes, research vessels, aircraft, and earthquake simulators. In addition, investments in Internet-based and distributed user facilities, advanced computing resources, research networks, digital libraries, and large databases are increasing as a result of rapid advances in computer, information, and communication technologies. NSF's investments are coordinated with those of other organizations, agencies and countries to ensure complementarity and integration.

Tools Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Facilities	$538.17	$580.21	$685.57	$105.36	18.2%
Infrastructure & Instrumentation	336.66	341.52	344.93	3.41	1.0%
Polar Tools, Facilities and Logistics	252.96	250.24	254.15	3.91	1.6%
Federally-Funded R&D Centers	184.92	195.92	187.43	-8.49	-4.3%
Total, Tools Support	$1,312.70	$1,367.89	$1,472.08	$104.19	7.6%

TOOLS = $1.47 B



Tools Long-Term Investment Categories: The four long-term investment goals that support the *Tools* strategic outcome are Facilities; Infrastructure and Instrumentation; Polar Tools, Facilities, and Logistics; and Federally-Funded Research and Development Centers (FFRDCs). They tie directly to NSF programs and budget resources and provide the framework for Program Assessment Rating Tool (PART) analysis of NSF performance.

FY 2005 Annual Performance Goal for Tools: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Tools* outcome goal:

- Expand opportunities for U.S. researchers, educators, and students at all levels to access state-of-the-art S&E facilities, tools, databases, and other infrastructure.

- Provide leadership in the development, construction, and operation of major, next-generation facilities and other large research and education platforms.
- Develop and deploy an advanced cyberinfrastructure to enable all fields of science and engineering to fully utilize state-of-the-art computation.
- Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation.
- Support research that advances instrument technology and leads to the development of next-generation research and education tools.

Means and Strategies for Success:

NSF utilizes the following means and strategies to achieve the strategic outcome goal of Tools and its associated long-term investment goals and annual performance goals.

- Support, through merit-based grants and cooperative agreements of sufficient size and duration, the most promising projects proposed by individual researchers and groups throughout the U.S.;
- Partner with other federal agencies, states, private organizations, national laboratories, or other nations to develop infrastructure by capitalizing on and leveraging the human and financial resources of each group;
- Operate an internal NSF capital planning process that encourages the development of innovative capabilities and meets the infrastructure needs of the U.S. community served by NSF;
- Develop and implement improvements for selecting, managing and overseeing large facility projects (cf. NSF Large Facility Projects Management and Oversight Plan, September 2001);
- Ensure that the breadth of infrastructure needs of the scientific community are examined regularly through workshops, panels, advisory groups, or other mechanisms;
- Provide broad support to the information technology community and others involved in innovative applications of cutting-edge IT tools for science and engineering;
- Upgrade the computation and computing infrastructure for all fields of science and engineering;
- Provide information on the status of the domestic / foreign science and engineering enterprise to inform science policy and priority setting;
- Develop and support a high-quality, balanced portfolio that invests in disciplines and fields, interdisciplinary research areas, and emerging opportunities; and
- Utilize the NSF core strategies of integrating research and education, promoting partnerships, and developing intellectual capital.

FACILITIES

Investments in the development, construction, and operation of state-of-the-art facilities and platforms that enable communities of researchers and educators to work at the S&E frontier.

To describe the life-cycle of a facility, the Foundation has adopted a set of distinct stages in its Facilities Management and Oversight Guide, found at http://www.nsf.gov/bfa/lfp/start.htm. These stages are: 1) Concept/Development – the phase during which the idea of a facility is articulated and project planning and design begins and is completed; 2) Implementation – including construction and/or acquisition, system integration, commissioning, testing, acceptance, transition to operations, and management of these efforts; 3) Operations and Maintenance – including the day-to-day work required to support and conduct research and education activities, to ensure that the facility is operating efficiently and cost-effectively, and to provide small- and intermediate-scale technical enhancements when needed to maintain state-of-the-art research capabilities; and 4) Renewal or Termination – the stage in which decisions regarding continued support of a facility are made. The information learned during the Operations and Maintenance stage and through various reviews of the results of research and education activities and facility management is used to determine whether the facility will be renewed, upgraded, re-competed or terminated.

Facilities Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Academic Research Fleet	$65.20	$76.50	$83.20	$6.70	8.8%
Advanced Modular Incoherent Scatter Radar	14.00	11.00	12.30	1.30	11.8%
Cornell Electron Storage Ring	19.49	18.00	19.70	1.70	9.4%
Gemini	13.48	14.12	14.93	0.81	5.7%
Incorporated Research Institutions for Seismology	13.20	13.00	13.00	0.00	0.0%
Laser Interferometer Gravitational Wave Observatory	33.00	33.00	33.00	0.00	0.0%
Major Research Equipment & Facilities Construction[1]	184.82	189.88	278.22	88.34	46.5%
Atacama Large Millimeter Array Construction	29.81	50.70	49.67	-1.03	-2.0%
EarthScope: USArray, SAFOD, PBO	30.21	44.94	50.80	5.86	13.0%
High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER)	13.00	0.00	0.00	N/A	N/A
IceCube Neutrino Observatory	25.75	41.75	33.40	-8.35	-20.0%
Large Hadron Collider	14.69	7.00	9.00	N/A	N/A
Network for Earthquake Engineering Simulation (NEES)	13.47	8.05	20.00	11.95	148.4%
Terascale Computing Systems	56.00	19.94	25.00	5.06	25.4%
National Ecological Observatory Network	0.00	4.00	16.00	12.00	N/A
Rare Symmetry Violating Processes		6.00	30.00	24.00	N/A
Scientific Ocean Drilling Vessel	1.90	2.10	41.35	39.25	N/A
Ocean Observatories Initiative		5.00	3.00	-2.00	-40.0%
Alaska Regional Research Vessel		0.40	0.00	-0.40	-100.0%
Nanofabrication (NNUN/NNIN)	6.05	12.45	13.86	1.41	11.3%
National High Magnetic Field Laboratory[2]	25.10	24.61	25.61	1.00	4.1%
National Superconducting Cyclotron Laboratory	15.65	15.65	16.65	1.00	6.4%
Ocean Drilling Program/Integrated Ocean Drilling Pgm	30.00	37.50	35.60	-1.90	-5.1%
Partnerships for Advanced Computational Infrastructure[3]	73.24	87.00	90.00	3.00	3.4%
Other Facilities[4]	44.94	47.50	49.50	2.00	4.2%
Total, Facilities Support	**$538.17**	**$580.21**	**$685.57**	**$105.36**	**18.2%**

[1]All MREFC projects are included in Facilities, except South Pole Station, which can be found under Polar Tools, Facilities and Logistics. Funding levels for MREFC projects in this table include initial support for operations and maintenance funded through R&RA as well as construction, acquisition and commissioning costs funded through MREFC. Information on all construction funds and activities for all MREFC projects can be found in the MREFC chapter.

[2]Support for the National High Field Mass Spectrometry Facility will be integrated into the National High Magnetic Field Laboratory in FY 2004, and has been included in the FY 2003 Actual.

[3]PACI includes cyberinfrastructure investment, which was previously listed as a separate item, in the amount of $20.0 million in FY 2004.

[4]Other Facilities includes support for the Network for Computational Nanotechnology, and other physics, materials research, ocean sciences, atmospheric sciences, and earth sciences facilities.

Program Assessment Rating Tool (PART) Evaluation: A PART on the Facilities program was completed to inform the FY 2005 budget decision-making process. Overall, PART assessment found Facilities to be an effective program. With respect to program purpose and design, the PART review found that the program has a clear purpose and addresses a specific need. NSF's Facilities program supports large, multi-user facilities, which allow researchers access to unique, state-of-the-art facilities that are necessary to advance U.S. capabilities required for world-class research. It also includes small facilities. This program addresses a critical need for tools to support basic research at universities and colleges. The program's design is free of major flaws that would limit its effectiveness or efficiency. NSF relies on the competitive merit review process, the NSF Program Officers in their oversight capacity, and independent, external Committees of Visitors (COVs) to ensure that facilities are effectively serving their intended communities, and to recommend changes to improve program effectiveness and efficiency. These measures ensure that supporting the acquisition and operation of infrastructure is the most efficient method of facilitating the science in question.

With respect to strategic planning, the program was found to have a limited number of long-term performance measures, with ambitious targets and timeframes, that focus on outcomes and meaningfully reflect the purpose of the program. It also has a limited number of annual performance measures, with ambitious targets, that demonstrate progress toward achievement of the long-term goals. Long-term outcomes for the Facilities program are external advisory committee (AC/GPA) findings of "significant achievement" that facilities enable discoveries or enhance productivity of NSF research or education communities and that NSF has partnerships to support and enable development of large facilities. Evaluations are conducted regularly at multiple levels in order to inform program improvements and influence program planning.

With respect to program management, Facilities was found to collect timely and credible performance information and to use it to manage the program and improve performance. Facilities was also found to effectively coordinate and collaborate with related programs, use strong financial management processes and obligate funds in a timely manner.

The program has demonstrated adequate progress in achieving its long-term goals, as qualitatively evaluated by external experts. Its performance compares favorably to other programs with similar purpose and goals.

The complete PART for Facilities and other assessed NSF programs may be found at the OMB website.

Annual Performance Goals for Facilities

FY 2005 Annual Performance Goal within Facilities – Facility Construction: For ninety percent of construction, acquisition and upgrade projects, keep any negative cost and schedule variances to less than 10 percent of the approved project plan. (This goal applies to all ongoing projects and those to be completed in FY 2005 that have a total project cost of at least $5.0 million.)

FY 2005 Annual Performance Goal within Facilities – Facility Operations: For ninety percent of operational facilities, keep scheduled operating time lost to less than 10 percent. (This goal applies to all NSF-supported facilities that received greater than $1.0 million in annual operations and maintenance support.) Results for the Facility Operations goal are shown below.

Results from Prior Years: FY 2003 was the first year for the construction goal.

Comparison with scheduled operating time.							
	FY 1999	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**
Goal	Keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	Keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of facilities, keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of facilities, keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.	For 90 percent of operational facilities, keep scheduled operating time lost to less than 10 percent.
Result	Majority of facilities met goal. Inconclusive.	22 of 26 (85%) facilities met goal. Not achieved.	25 of 29 (86%) facilities met goal. Not achieved.	26 of 31 (84%) facilities met goal. Not achieved.	26 of 30 (87%) facilities met goal. Not achieved.	& &	& &

& = Data not yet available.

MAJOR MULTI-USER RESEARCH FACILITIES

A brief summary of Major Research and Equipment Facilities Construction (MREFC) projects can be found at the end of the Tools chapter. For a full discussion of these projects, please refer to the MREFC chapter.

Academic Research Fleet

Project Description: The Academic Research Fleet consists of 27 vessels in the University-National Oceanographic Laboratory System (UNOLS). These vessels range in size, endurance, and capabilities, providing NSF and other federally-funded scientists with a diverse fleet capable of operating in coastal and open ocean waters to conduct ocean science research. This project includes funding for ship operations, shipboard scientific support equipment, oceanographic instrumentation and technical services, ship acquisition and upgrade, and submersible support.

Principal Scientific Goals: The Academic Research Fleet serves as the main platform for the collection of data and testing of hypotheses in oceanography. Through use of these facilities, scientists contribute to advances made in such areas as climate, fisheries, and marine research.

Principal Education Goals: Vessels in the Academic Research Fleet permit shipboard training of future oceanographers. Through cruise participation, graduate and undergraduate students interact with scientists and marine technicians, enabling them to gain first-hand exposure to ocean science field research. Through recent technological innovations, research conducted at sea can be transmitted remotely back to the classroom, broadening the educational impact of the vessels to a wider audience, including K-12 students.

Partnerships and Connections to Industry: The Academic Research Fleet is supported through an interagency partnership, principally with the National Oceanic and Atmospheric Administration (NOAA) and the Office of Naval Research (ONR) via a Memorandum of Understanding (MOU). NSF provides approximately 65 percent of the operating funds for the Fleet, while the remaining operating costs are divided proportionally among the other vessel users. NSF also coordinates with ship-operating and non-operating academic institutions through its connection with UNOLS.

Management and Oversight: NSF provides oversight to the Academic Research Fleet through cooperative agreements with each ship-operating institution and the UNOLS Office. In addition, NSF oversees the fleet through external review of proposals, site visits, ship inspections, and participation at UNOLS Council and subcommittee meetings by program managers. Several program managers within the Division of Ocean Sciences (GEO) are involved in the activities and overall oversight of the academic research fleet.

Management of an individual institution's ship-operating facilities varies with the size of the operation, but the core responsibility typically resides with the Director of the Institution, the Marine Superintendent (for all aspects of the facility), and the Ship's Captain (for at-sea operations). For larger multi-ship-operating facilities, a chief of marine technicians, schedulers and finance administrators may also be involved in facility management.

Current Project Status: NSF has supported this project for many years. Based on projected science requirements identified in recent reports and workshops, a fleet of vessels to support ocean science research will be needed far into the future. In coordination with the ocean science community, the Federal Oceanographic Facilities Committee (FOFC) recently developed and published a report on the long-range plan for renewal of the academic fleet. The FY 2005 Request for the Academic Research Fleet totals $83.20 million, an increase of $6.7 million over FY 2004 Estimate of $76.50 million. This increase will support the continued operation and implementation of the U.S. Academic Research Fleet. Also included are funds to continue planning for acquisition of a new deep submergence capability to replace the pioneering submersible ALVIN, and anticipated acquisition of a seismic research vessel to replace the aging R/V Maurice Ewing, which is in need of a significant refit. These new investments will open significant expanses of the deepest ocean to exploration, and bring greatly enhanced capability to map structures under the sea floor to U.S. researchers.

Funding Profile: All funding for the Academic Research Fleet to date has been provided through the R&RA Account.

Academic Research Fleet Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$2.13	$44.84	$46.97
FY 1995	0.60	45.69	46.29
FY 1996	1.51	41.52	43.04
FY 1997	0.02	40.86	40.88
FY 1998	0.37	40.23	40.61
FY 1999	0.00	43.28	43.28
FY 2000	0.26	45.11	45.36
FY 2001	2.30	56.60	58.90
FY 2002	2.30	59.60	61.90
FY 2003	3.00	62.20	65.20
FY 2004 Estimate	6.59	69.90	76.49
FY 2005 Request	13.23	70.00	83.23
FY 2006 Estimate	25.80	71.00	96.80
FY 2007 Estimate	18.80	72.00	90.80
FY 2008 Estimate	19.80	73.00	92.80
FY 2009 Estimate	20.80	74.00	94.80

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: From time to time, vessels require conversions or upgrades that go beyond the normal maintenance supported by operating costs. Funding decisions for conversions and upgrades are based on strong evidence of a scientific need. In recent years, the funding has provided for the conversion or upgrade of ships already in service whose age, configuration, or operating costs have impaired their usefulness. Planning for future years includes the replacement of ships that have reached the end of their useful life and replacing the capability for studies in the deep ocean as the aging ALVIN submersible reaches the end of its useful life. In December 2001, the FOFC of the National Oceanographic Partnership Program (NOPP) prepared a report titled *Charting the Future for the National Academic Research Fleet*, which defines a federal interagency renewal strategy for the national academic research fleet. Major upgrade expenditures indicated in implementation estimates in FY 2005 and out-years are for development of a new deep submergence vehicle, replacement of Regional Class ships and acquisition and reconfiguration of a seismic research vessel, consistent with community, National Research Council and FOFC reports.

- Operations and Maintenance: This includes funds for operating and maintaining the fleet, shipboard scientific support equipment, oceanographic instrumentation and technical services, and submersible support.

Renewal or Termination: Participation of each ship in the research fleet is through a cooperative agreement and is governed by the existence of an efficient schedule of scientific research cruises for that ship, assessments of the continued fitness of the ship to conduct research at sea (as defined through the FOFC report above), and the ability of the operating institution to maintain cost effective operations.

Associated Research and Education Activities: NSF-funded researchers utilizing the fleet are supported through NSF's research programs and are subject to NSF's standard merit review process. The fleet supports approximately 2,500 users per year, which is based on the total number of individual researchers, postdoctoral candidates, graduate and undergraduate students, teachers, K-12 students and observers who have participated in cruises.

ARF Educational Participation

Year	K12	Undergrad	Graduate	Teachers[b]
FY 1994	12	194	503	12
FY 1995	0	228	596	5
FY 1996	1	179	454	6
FY 1997	0	177	453	0
FY 1998	1	193	550	29
FY 1999	0	331	476	7
FY 2000	0	251	389	8
FY 2001[a]	2	222	489	10

[a] Estimated number based on recent year average.

[b] Teachers include those participating in Teacher-At-Sea programs.

Science Support: NSF-supported researchers with grants totaling approximately $60.0 million in FY 2003 used the academic research fleet. Because of its collaborative nature and the interagency cooperation, which enables the operation of the academic fleet, NSF only pays for ship time used by NSF researchers.

Advanced Modular Incoherent Scatter Radar (AMISR)

Project Description: The Advanced Modular Incoherent Scatter Radar (AMISR) is a phased array incoherent scatter radar with unique features that allow efficient and cost-effective dismantling, shipping, and re-assembly. The radar comprises three identical antenna faces, each with approximately three times the sensitivity of the incoherent scatter radar currently operating in Sondre Stromfjord, Greenland. Each of the three fixed antenna faces is approximately 35 meters square with 4,096 radiating elements located on 128 separate panels. In addition to being relocatable, AMISR will provide the means for unique scientific observations via two significant features that have not been technically feasible in the past and that will greatly enhance the way observations and experimental campaigns are conducted. First, the phased-array concept will allow pulse-to-pulse beam steering, thus enabling three-dimensional "imaging" of electron density features in high signal-to-noise environments. Second, an incoherent scatter radar with a solid-state transmitter and no moving parts will permit both extended operating periods and true remote internet operation with virtual "control rooms" at universities world-wide.

Principal Scientific Goals: Long-term measurements of atmospheric parameters will help understand the processes influencing global change, and observations during solar storms will help understand and predict space weather, the primary goal of the multi-agency National Space Weather Program. There will also be strong synergy between AMISR scientific activities and the Center for Integrated Space Weather Modeling (CISM), one of six new NSF-funded Science and Technology Centers selected in FY 2002.

The AMISR systems at Poker Flat, Alaska, and Resolute Bay, Canada, will enable researchers to investigate fundamental issues of solar-terrestrial science including how the Earth is magnetically and electrically coupled to the Sun; what the structure and dynamics of the magnetosphere, ionosphere, and upper atmosphere are; and how the global energy flowing into the upper atmosphere at the pole flows to the equator. The scientific goals will change in the future as AMISR is deployed at other locations.

<u>Principal Education Goals</u>: The design for the AMISR is at the forefront of current radar, electronics, and signal processing technology. It uses advanced solid-state amplifiers that can be computer-controlled for maximum flexibility and ease of use. It will provide outstanding opportunities for students and young scientists and engineers to be involved with the development of the project and the operation of the instrument. The AMISR will be the first incoherent scatter radar designed for remote usage, allowing students and scientists to plan and configure experiments, and watch in real-time as the data is returned from remote sites. The web-based tools to be developed will make AMISR an excellent means to train the next generation of incoherent scatter radar specialists. The possibilities for new discoveries, combined with the ease of operation, will inspire hundreds of scientists from all over the globe to use the facility.

<u>Partnerships and Connections to Industry</u>: Manufacturing of the 12000 antenna element units is being done by Sanmina SCI, a global electronics contract manufacturing firm with headquarters in San Jose. The solid-state power amplifier for each of the units is being manufactured by Comtech PST, a company based in Melville, New York, that specializes in the production of amplifiers for commercial and military uses. The construction of the AMISR support structure and the foundation work at the sites in Alaska and Canada is being performed by VECO Corp., an Alaska-based company that specializes in management, engineering design and construction for the oil and power industries.

<u>Management and Oversight</u>: Overall project management and oversight is the responsibility of the program manager for Upper Atmospheric Facilities within the Division of Atmospheric Sciences. An Internal Management Team will be appointed with representatives from the Geosciences Directorate, Office of Polar Program, Budget, Finance and Award Management, and the Office of the General Council. As required in the cooperative agreement for the AMISR construction, SRI International has assembled a Technical Advisory Committee to provide technical oversight in the design and development of the AMISR system. SRI International has also written a Project Execution Plan that describes the AMISR work breakdown structure, management structure, project milestones, and final test and acceptance plan.

<u>Current Project Status</u>: The cooperative agreement for AMISR construction was approved on August 1, 2003, during the design for manufacturing phase of the project funded as a separate award for AMISR prototype development. As of the end of 2003, the design for manufacturing phase was completed and a pilot manufacturing run of 40 antenna element units was begun. The Technical Advisory Committee is scheduled to meet at SRI International in January to review the testing and performance of the 40 units. SRI International has begun environmental impact assessments for the site in Alaska and has submitted a formal request for frequency allocation from the National Telecommunications and Information Administration.

The AMISR is being developed in three stages. The first stage includes design and vendor selection based on experience SRI International has gained under previous NSF support to develop a working prototype. The second stage is the assembly of the first AMISR antenna face at the Poker Flat Research Range in Alaska, a site that is both scientifically interesting and logistically advantageous. The second and third antenna faces will then be assembled at the Resolute Bay Observatory in the Canadian Arctic. Future deployments will be determined on the basis of recommendations of a committee from the broader space science research community.

Milestones for the project are outlined below:

FY 2004 Milestones:
- Select SSPA Vendor
- Submit NTIA forms to NSF Spectrum Management Office
- Pilot run
- Final Design Verification
- Initiate panel and AEU manufacturing
- Poker Flat Activities:
  - Submit Poker Flat environmental assessment
  - Complete 48 panels with AEUs
  - Poker Flat site prep
  - Complete 40 panels with AEUs
  - Poker Flat foundation installation

FY 2005 Milestones:
- Poker Flat Activities
  - Complete 40 panels with AEUs
  - Poker Flat (1 face) constructed
  - Poker Flat system test complete and operational
- Resolute Bay Activities:
  - Face 1 and 2 foundation materials, support scaffolding and distribution shelters shipped to Resolute Bay via sealift
  - Complete 32 Panels with AEUs
  - Face 1 and 2 foundation constructed
  - Face 1 – 128 panels with AEUs shipped via sealift

FY 2006 Milestones:

Resolute Bay Activities:
- Face 1 erected
- Face 1 system complete and operational
- Complete 32 panels with AEUs
- Face 2 – 128 panels with AEUs shipped via sealift

FY 2007 Milestones:
- Resolute Bay Activities:
  - Face 2 constructed
  - AMISR system test complete
- Full operations begin

Funding Profile: The implementation phase of AMISR began late in FY 2003 with an initial allocation of $14.0 million. Additional implementation funding of $10.0 million per year for the next three years will be provided for a total of $44.0 million. Operations and maintenance will be initially funded at $1.0 million in FY 2004, increasing to $2.30 million in FY 2005. Funds allocated in previous fiscal years for prototype development are also shown in the table below.

AMISR Funding Profile
(Dollars in Millions)

	Planning, Design, Development	Acquisition, Construction, Commissioning	Management, Operations & Maintenance	Totals
FY 1999 & Earlier	$1.30			$1.30
FY 2000	1.30			1.30
FY 2001	1.00			1.00
FY 2002	3.40			3.40
FY 2003		$14.00		14.00
FY 2004 Estimate		10.00	$1.00	11.00
FY 2005 Request		10.00	2.30	12.30
FY 2006 Estimate		10.00	2.40	12.40
FY 2007 Estimate			2.50	2.50
FY 2008 Estimate			2.60	2.60
FY 2009 Estimate			2.70	2.70
Totals	**$7.00**	**$44.00**	**$13.50**	**$64.50**

NOTE: A steady state of about $2.4 million in operations support is expected to occur in or about FY 2008. The expected operational lifespan of this project is at least 20 years, beginning in FY 2007. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Concept/Development: Initial R&RA funding for AMISR began in 1999 with an award to SRI International to develop the design of the antenna element units. Subsequent funding was provided for building 32 engineering prototype units that were assembled into a panel for testing at the SRI field site near Stanford University and the U. S. Air Force antenna test facility in Ipswich, Massachusetts. The Concept/Development phase concluded with the competitive source selection of Sanmina SCI and two years of design for manufacturing activities involving close interaction between Sanmina and SRI engineers.

- Implementation: FY 2004 funding in the amount of $10.0 million is being used to build the first AMISR face at Poker Flat, Alaska. The 4,000 antenna element units will be manufactured over the next twelve months. Site preparation at Poker Flat will begin late spring 2004. The antenna elements will be assembled onto panels by SRI International as they are received from the manufacturer. The assembled panels will be shipped to Alaska early in 2005 for integration and testing. This schedule will repeat for the two remaining faces to be deployed at Resolute Bay—the first in 2006 and the second in 2007.

- Operations and Maintenance: SRI is currently preparing a proposal for the initial operation and maintenance of the AMISR systems at Poker Flat and Resolute Bay. Operation and maintenance of the face at Poker Flat will be accomplished in collaboration with personnel at the Geophysical Institute, University of Alaska. Other participating institutions include Stanford University, MIT, and the University of Saskatchewan. Additional instrumentation for the two facilities will be funded through the R&RA grants programs within ATM.

Future Science Support: In addition to the operations support indicated above, AMISR research and education programs will be funded through the Aeronomy, Magnetospheric Physics, and Upper Atmospheric Facilities core programs within the Upper Atmospheric Research Section. The combined annual support level for this research is estimated to be about $5.0 million.

Cornell Electron Storage Ring (CESR)

Project Description: The Cornell Electron Storage Ring (CESR) supports research in elementary particle physics as well as in accelerator physics and superconducting radio frequency (RF) applications. CESR is an electron-positron collider that has provided important knowledge of the properties of the b-quark. Cornell University is now modifying CESR and the associated particle detector (CLEO) for operation over the energy range 1.5 GeV to 5.6 GeV per beam, to address high-priority physics questions relating to the c-quark and possible gluon states that cannot be addressed elsewhere. The transformed collider and detector will be named CESR-c and CLEO-c, respectively.

The materials research community at the Cornell High Energy Synchrotron Source (CHESS) also uses the CESR facility. CHESS is a high-intensity high-energy X-ray source that uses the synchrotron light given off by the charged particles, both electrons and positrons, as they circulate at nearly the speed of light around CESR. As a user facility, CHESS provides state-of-the-art synchrotron radiation facilities for research in Physics, Chemistry, Biology, and Environmental and Materials Sciences.

Principal Scientific Goals: CESR-c and CLEO-c will explore a large set of critical weak and strong interaction phenomena, knowledge of which is either lacking or fragmentary. These in turn will drive theoretical advances that will both extend and enable the full program of physics targeted by many new-generation detectors, such as those at Stanford Linear Accelerator Center (SLAC**)**, Fermilab, and the Large Hadron Collider (LHC), and will lay the foundation for strong interaction theory to meet the requirements of future physics beyond the Standard Model.

Principal Education Goals: To support and enhance Ph.D. level graduate education, postdoctoral research experience, research experiences for undergraduates, and research experiences for K-12 science teachers. Engendering excitement in science among young children will be a focus for strengthening K-12 engagements. An important component of that effort will be the participation of CLEO and CESR graduate students in school science classrooms.

Partnerships and Connections to Industry: CESR staff is transferring CESR Superconducting RF (SRF) technology to industry. Two new industrially fabricated SRF cavity systems have been acquired in order to shorten CESR bunch length with higher voltage. Through a license arrangement with Cornell, the ACCEL Corporation has manufactured two superconducting RF sources to power synchrotron light sources. They have been tested and installed in CESR to replace two older, lower gradient modules. Also some of the CHESS users are from industry, including: pharmaceutical corporations (Rib-x Pharmaceuticals) and the research arms of Eastman Kodak, Xerox and General Motors. Some medical institutions also make use of CHESS (Dana Farber Cancer Institute, Boston Biomedical Research Institute, and Memorial Sloan-Kettering Institute).

Management and Oversight: CESR-c is managed by the Director of the Laboratory for Elementary Particle Physics (LEPP) at Cornell, an Assistant Director, and an Associate Director for Accelerator Physics. The CLEO-c experiment is the sole CESR-c experiment in particle physics, a collaboration consisting of users from about 20 U.S. institutions. CESR-c management interacts with the CLEO-c collaboration through the collaboration spokesperson and executive board as needed, and there are monthly meetings of the collaboration that include CESR-c management.

NSF oversight by Physics Division (MPS) staff occurs through annual site visits. Technical review of the award involved panel evaluation of the CESR-c proposal, and a site visit by NSF staff and external reviewers. The oversight process includes annual financial reports and program reports to the NSF and an annual review by a Program Advisory Committee of outside physicists reporting to the Laboratory Director and NSF. A comprehensive review will be held midway through year three of a five-year award.

Current Project Status: A five-year Cooperative Agreement was initiated in FY 2003. Cornell University will modify the CESR colliding beam accelerator and the CLEO particle detector as mentioned above. In addition to the particle physics program, a vigorous program of accelerator science and technology development for accelerator concepts for the future will continue. CESR-c will also provide intense X-ray beams for the program in X-ray science at CHESS. The particle physics program and X-ray science program will now begin to use different accelerator energies, requiring the two programs to operate in different time periods. CHESS is supported through the Materials Research Subactivity (MPS), the Biological Sciences Activity, and by the National Institutes of Health. The FY 2005 Request for CESR totals $19.70 million, an increase of $1.70 million from the FY 2004 Estimate of $18.0 million. It is expected that the CESR-c and CLEO-c projects will cease at the end of the five-year period.

Funding Profile: The FY 2003 – FY 2009 estimated funding for CESR-c and CLEO-c will ensure completion of the elementary particle physics program and provide sufficient time for the particle physics group and the CHESS facility to plan their future activities. All funding for CESR to date has been provided through the R&RA Account.

CESR Funding Profile

(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$17.40	$17.40
FY 1995	$10.90	12.50	23.40
FY 1996	8.70	14.90	23.60
FY 1997	6.50	14.00	20.50
FY 1998	6.20	12.40	18.60
FY 1999	3.20	16.30	19.50
FY 2000		19.49	19.49
FY 2001		19.49	19.49
FY 2002		19.49	19.49
FY 2003		19.49	19.49
FY 2004 Estimate		18.00	18.00
FY 2005 Request		19.70	19.70
FY 2006 Estimate		21.00	21.00
FY 2007 Estimate		20.50	20.50
FY 2008 Estimate		10.00	10.00
FY 2009 Estimate		0.00	0.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: These figures reflect an upgrade to CESR in the FY 1995 through FY 1999 time period to allow the accelerator to produce higher luminosity beams and to CLEO to allow the detector to operate and take data under the higher luminosity conditions.

- Management and Operations: The facility operates about 5,500 hours per year for CLEO research and for accelerator physics and development. Maintenance is provided through a weekly 8-hour shift and through two or three, 3-week shut-downs for maintenance of the accelerator, superconducting RF, helium refrigerator, vacuum system, beam lines for CHESS, power systems, and other ancillary systems. Approximately 30 percent of the CESR funding is directed toward in-house research (both experimental elementary particle physics and accelerator physics) with the remainder used to operate and maintain the facility. The funding profile above includes minor detector and accelerator changes that are essential to completion of the scientific program before FY 2009.

Associated Research and Education Activities: Cornell continues to be active in outreach:

- LEPP holds staff workshops in Diversity Awareness;
- LEPP has conducted "Expanding Your Horizons" workshops for ~100 middle school girls over the last three years, involving 7 female graduate students and 1 female faculty member. The most recent workshop, in April 2003, hosted 18 middle school girls;
- Approximately 200 high school physics teachers received tours, lesson plans, and/or presentation materials, along with educational videos on particle physics via outreach events from April to November 2003;
- Approximately 60 elementary school students, 45 middle school students and 185 high school students were involved in activities hosted by LEPP. Over 300 people toured the Wilson Laboratory facility during this time frame;
- LEPP hosted a three-day workshop in June 2003 entitled "Exploring Physics First". Workshop participants exchanged ideas and information about the philosophy of teaching physics first in the high school science sequence;
- In August, LEPP sponsored a science booth at the New York State Fair entitled "Electrifying Experiments!" Over 500 youths and adults stopped by to participate in hands-on physics activities;
- LEPP personnel participate in "Saturday Academy," a group of ~25 minority grade and high school students meeting monthly
- LEPP sponsors a monthly Visiting Scientist series at a rural elementary school where 36 percent of the children are eligible for free school lunches;
- LEPP conducts an "Atoms for Kids" program at two rural elementary schools where ~30 percent of the students are similarly eligible for free school lunches; and
- The laboratory trains graduate students in accelerator physics and has supported the development of superconducting radio frequency accelerating cavities.

Science Support: Approximately $3.0 million is provided annually by NSF in support of separate awards to external users of the CESR/CLEO facility. DOE provides a similar amount in support of awards to individual investigators and groups. In addition, $600,000 is provided in a separate award to Cornell in support of theoretical elementary particle physics research.

About 200 physicists from 22 universities have built and are operating the CLEO detector to study the products of the electron-positron collisions. CESR is a national user facility and the current CLEO-c collaboration includes more than 150 researchers from 25 U.S. and foreign institutions.

The CHESS facility is used by the materials research community, with typically 600-700 users per year.

Gemini

Project Description: The Gemini Observatory consists of two 8-meter telescopes, one in the northern hemisphere, in Hawaii, and one in the southern hemisphere, in Chile. The Hawaiian telescope is optimized for infrared observations and is located on Mauna Kea at an altitude of 4200 meters. The telescope in Chile is located on Cerro Pachon, an outstanding photometric site, at an altitude of 2700 meters. This siting of the two telescopes assures complete coverage of the sky to complement the observations from space-based observatories, and provides access to the center of our own Galaxy as well as the Magellanic Clouds, our nearest galactic neighbors. Both telescopes are designed to produce superb image quality and both use sophisticated adaptive optics technology to compensate for the blurring effects of the Earth's atmosphere. The Observatory is an international collaboration with the United Kingdom, Canada, Australia, Chile, Argentina and Brazil.

Principal Scientific Goals: Astronomers need to resolve important questions about the age and rate of expansion of the universe, its overall topology, the epoch of galaxy formation, the evolution of galaxies once they are formed, and the formation of stars and planetary systems. The new generation of optical/infrared telescopes with significantly larger aperture (8-meter diameter) than existing instruments provide better sensitivity and spectral and spatial resolution. Technological advances in a number of key areas of telescope construction and design allow these instruments to take advantage of the best performance the atmosphere will allow.

Principal Education Goals: The Gemini telescopes will play a central role in the education and training of U.S. astronomy and engineering students. An estimated 20% of the projected 400 users per year will be students from the partner countries. Gemini is also providing a focus for public outreach and high school student training in all the partner countries, including the development of "sister city" arrangements between Hilo, Hawaii and La Serena, Chile involving students and teachers at high school and elementary school levels.

Partnerships and Connections to Industry: Gemini is an international partnership with the United Kingdom, Canada, Australia, Chile, Argentina, and Brazil. Construction of the telescopes and their instrumentation has involved a large number of industrial concerns in a number of partner and non-partner countries. These have involved firms in large and/or complex optical systems, aerospace industries, electronics and engineering firms, etc. Continued involvement of such industries is part of the instrumentation and facilities renewal activities included in the operating budget of the Gemini Observatory.

Management and Oversight: The project is governed by the Gemini Board, which was established by the International Gemini Agreement signed by the participating agencies. NSF serves as the Executive Agency for the seven-nation partnership, carrying out the project on their behalf. Programmatic management has been the responsibility of the Staff Associate for Gemini in the Division of Astronomical Sciences (MPS), assisted by an internal Project Advisory Team with representation from Office of the General Counsel, Office of Legislative and Public Affairs, Budget, Finance and Award Management, Division of Financial Management, and the Office of International Science and Engineering. During construction and oversight, a committee of outside experts regularly reviewed progress and reported to the partnership. With the start of scientific operations, the Gemini Board has established an independent Visiting Committee that will advise on the operation of the Observatory. Gemini is managed by Associated Universities for Research in Astronomy (AURA), Inc on behalf of the partnership through a cooperative agreement with NSF. AURA conducts its own management reviews through standing oversight committees. The current cooperative agreement expires in FY 2005. Under the terms of the international agreement, the partnership will determine whether to compete the management of the Observatory at that time.

Current Project Status: Construction of both telescopes is complete and science operations have begun at both sites. Commissioning of facility instruments continues at both telescopes. The Chilean partner in Gemini, CONICYT, has had a perennial problem paying operations contributions, though they have completed the construction payments in full. The astronomical community in Chile feels a far greater need to develop astronomy within the country than a need for more observing time. Gemini South is on Chilean soil and the conditions of exemption from taxes and duties under which Gemini operates in Chile are very advantageous.

CONICYT proposed that the Gemini partners effectively return the equivalent of Chile's construction payment to CONICYT to be used as a fund whose proceeds would be used to develop astronomy. In a "cooperative agreement" CONICYT remains a partner and returns to the partnership the 5 percent observing time on both telescopes that they had been entitled to as a result of paying 5 percent of the capital and operating costs. This proposal has been accepted by the Gemini Board and has been discussed with the National Science Board's Committee on Programs and Plans. Within the partnership there is agreement that the U.S. will assume 52.5 percent of the Chilean share, Australia 30 percent, Canada 15 percent, and Brazil the remaining 2.5 percent. A schedule of payments has been constructed that results in the payment of the full capital return by the end of 2005.

The FY 2005 Request totals $14.93 million, an increase of $810,000 over the FY 2004 Estimate of $14.12 million. Included in this increase is $1.0 million for partial return of the U.S. share of Chilean capital.

Funding Profile: The total NSF contribution to the construction of the Gemini telescopes is $92.0 million, representing a 50% share of the total project cost. Experience gained during the construction and integration of the Hawaii telescope allowed for an accelerated schedule in Chile.

Gemini Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 1994 & Earlier	$12.00		$47.00				$59.00
FY 1995				$41.00			41.00
FY 1996					$3.82		3.82
FY 1997					5.32		5.32
FY 1998				4.00	5.72		9.72
FY 1999					8.05		8.05
FY 2000					8.38		8.38
FY 2001					8.66		8.66
FY 2002					12.50		12.50
FY 2003					13.48		13.48
FY 2004 Estimate[1]					14.12		14.12
FY 2005 Request[1]					14.93		14.93
FY 2006 Estimate[2]					16.53		16.53
FY 2007 Estimate[2]					18.34		18.34
FY 2008 Estimate[3]					20.00		20.00
FY 2009 Estimate[3]					20.00		20.00
Subtotal, R&RA	$12.00		$47.00		$169.85		$228.85
Subtotal, MREFC		$0.00		$45.00		$0.00	$45.00
Total, Each Phase		**$12.00**		**$92.00**		**$169.85**	**$273.85**

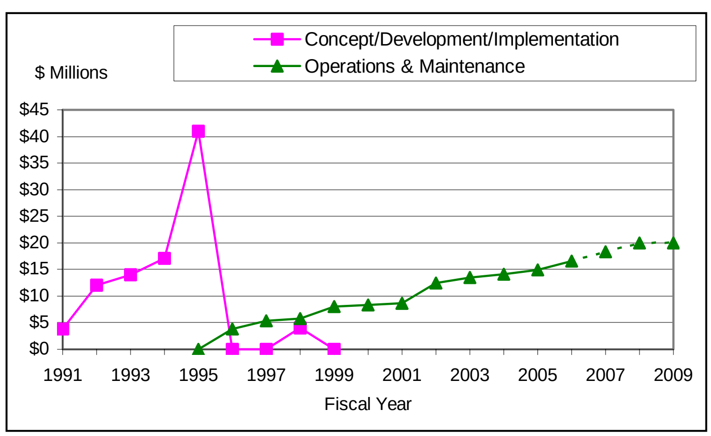
[1] FY 2004 and FY 2005 funding includes the cost of the Chilean capital return, consistent with the U.S. assumption of a portion of the Chilean share.

[2] The current cooperative agreement ends in FY 2005. The figures for FY 2006 and onward reflect the anticipated growth of the operating budget and funds for second generation instrumentation being used by the Observatory and the Gemini Board for planning purposes. They will be updated as new information becomes available. The anticipated lifetime of the Observatory is 25 years.

[3] A steady state of about $20.0 million annually is anticipated for the U.S. share of operations beginning in FY 2008.

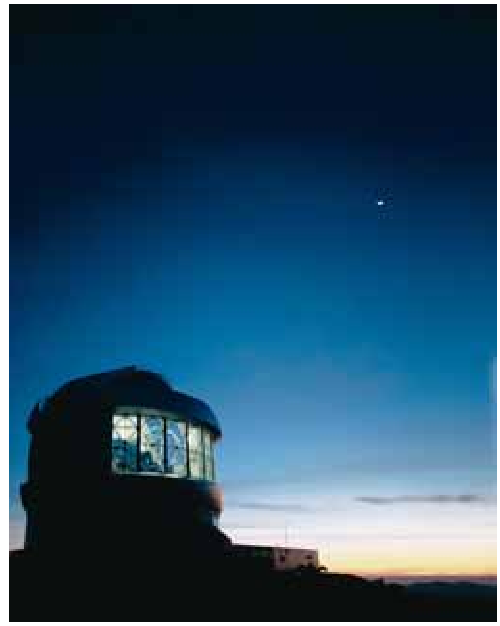
Information pertaining to the data in the table is included below.

- Concept/Development: Funds represent estimated U.S. investments in the development of mirror technologies for a new generation of telescopes, as recommended by the National Academy Report "Astronomy and Astrophysics for the 1980's." Three different mirror technologies were explored. These investments in technology development contributed to the plans for Gemini, as well as to other new telescopes that advance research in astronomy.



- Implementation: Gemini construction was initiated in FY 1991, before establishment of the MREFC Account in FY 1995. The $92.0 million obligated for Gemini construction is the U.S. share of the total cost ($184.0 million) for the two telescopes, with the balance provided by international partners.

- Management and Operations: Funding ramped up as the telescopes approached initial operations. Beginning in FY 2002 operations included the U.S. assumption of a portion of the Chilean share of operations costs, as agreed by the international partners. The funds provide additional observing time to the U.S. astronomy community while Chile maintains a share of observing time as host country. Under this adjustment, NSF supports just over 50% of management, operations and maintenance. In FY 2004-2005, costs reflect Chilean capital return, consistent with U.S. assumption of a portion of Chilean share.



The Gemini South Telescope readying for nighttime observations. *Credit: Gemini Observatory.*

Renewal or Termination: The five-year cooperative agreement for the support of Gemini operations expires in FY 2005. Under the terms of the international agreement, the partnership will determine whether to compete the management of the Observatory at that time.

Associated Research and Educational Activities: The public information and outreach office at Gemini carries out local outreach to schools, teachers, and the general public, as well as coordinates and serves as a liaison for the outreach efforts of partner countries. They also provide media services and web-based resources.

Science Support: Along with direct operations and maintenance support for Gemini, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $5.0 million, once the facility reaches full operations.

Incorporated Research Institutions for Seismology (IRIS)

Project Description: IRIS is a consortium of 101 U.S. universities and not-for-profit institutions with research and teaching programs in seismology. IRIS operates a distributed national facility for the development, deployment, and operational support of modern digital seismic instrumentation to serve national goals in basic research in the earth sciences, in earthquake research, and in nuclear test ban monitoring. IRIS is organized in four major program elements: (1) The Global Seismographic Network (GSN) currently consists of a global deployment of 136 permanently installed digital seismic stations; (2) The Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) manages a pool of portable seismometers which are made available to the seismology research community for scheduled regional and local scale studies; (3) The IRIS Data Management System (DMS) provides the national and international seismic research community with timely access to data from the GSN and PASSCAL; and (4) The IRIS Education and Outreach (E&O) Program which enables audiences beyond seismologists to access and use seismological data and research for educational purposes, including teacher workshops, student internships, museum exhibits, educational materials, and programs for under-resourced schools.

Principal Scientific Goals: The Earth's interior remains a major scientific frontier holding the key to understanding the origin of the planet. Recent developments in seismic sensor design, and the acquisition, transmission and storage of data have resulted in dramatic improvements in the resolving power of seismic imaging of the interior. Earthquake research, including rapid and accurate location and characterization of the earthquake source, its magnitude and a better understanding of the physical process involved, has also benefited greatly from recent technical advances. The IRIS facility serves the research needs of the national and international seismology community by making available state-of-the-art designs in seismic sensors and data acquisition systems. In addition to its role in providing the observational data essential for basic research in geophysics and earthquake dynamics, IRIS plays a significant role in seismic monitoring of the Comprehensive Test Ban Treaty and in bringing seismology to students and the public through the activities of its Education and Outreach program.

Principal Education Goals: The IRIS Education and Outreach (E&O) Program enables audiences beyond seismologists to access and use seismological data and research for educational purposes. E&O activities include teacher workshops, student field internships, museum exhibits, educational materials, the development of classroom seismic stations, and programs for under-resourced schools. E&O projects serve not only to advance public understanding of geoscience, but also to foster improved understanding of the scientific process and scientific data.

Connections to Industry: The use of IRIS PASSCAL instruments for investigations of the shallow crust provides opportunities for collaboration with the petroleum exploration industry. Many students involved in these experiments receive training in techniques that prepare them for careers in the exploration industry. In a broader sense, IRIS continues to closely collaborate with industry in development of seismic instrumentation and software.

Partnerships: IRIS is heavily involved in partnership activities, many international in nature. Installation and operation of the Global Seismographic Network (GSN) has put IRIS in contact with scientists as well as government and non-government organizations all over the world. Many international IRIS GSN stations are designated as the official stations for nuclear test ban monitoring in their host countries. International teams of scientists organize most PASSCAL projects overseas. The IRIS facilities also are multi-use resources for other government agencies that have responsibilities for development of a nuclear test-ban monitoring capability and for monitoring of global seismicity. For these purposes, agencies in partnership with NSF have provided substantial support to IRIS for accelerated development of the GSN (Department of Defense), shared operation and maintenance of the GSN (U.S. Geological Survey), and accelerated development of the PASSCAL instrument pool (Department of Energy).

Management and Oversight: IRIS is incorporated as a nonprofit consortium representing practically all U.S. university and nonprofit organizations with research and teaching programs in seismology. Each member institution appoints a representative who serves with full voting privileges on the IRIS Board of Directors. However, all IRIS program and budget decisions are made by an eight-member Executive Committee, elected by the Board of Directors to three-year terms. These decisions are made after consultation with the IRIS advisory committees (the four standing committees for each of the four IRIS programs and additional *ad hoc* working groups appointed for special tasks). The Executive Committee appoints a president of IRIS to a two-year term. The president is responsible for IRIS operations, all of which are managed through the IRIS Corporate Office.

The Division of Earth Sciences (GEO), through its Instrumentation & Facilities Program (IF), provides IRIS with general oversight to help assure effective performance and administration. The Program also facilitates coordination of IRIS programs and projects with other NSF-supported facilities and projects and with other Federal agencies and evaluates and reviews the scientific and administrative performance of IRIS.

Current Project Status: The IRIS consortium was founded in 1984 by 26 universities in response to recommendations in a report issued in 1983 by the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences. This report urged that "NSF act as overall coordinator and lead agency for funding a global digital seismic array and that the operation be planned and overseen by a university consortium." During the last fifteen years, with support from the Foundation and federal partners, the IRIS consortium has grown to 101 full-member (voting) U.S. universities that operate core research facilities consisting of a Global Seismographic Network (GSN), the Program of Array Seismic Studies of the Continental Lithosphere (PASSCAL), and a Data Management System (DMS). During the last cooperative agreement period, IRIS initiated a new Education and Outreach (E&O) program. The FY 2005 Request for IRIS totals $13.0 million, level with the FY 2004 Estimate.

Funding Profile: All funding for IRIS to date has been provided through the R&RA Account.

IRIS Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$1.67	$5.64	$7.31
FY 1995	2.03	5.52	7.55
FY 1996	5.61	2.39	8.00
FY 1997	2.32	8.83	11.15
FY 1998	1.27	9.76	11.03
FY 1999	0.69	10.77	11.46
FY 2000	0.46	11.16	11.62
FY 2001	1.90	11.38	13.29
FY 2002	1.93	11.00	12.93
FY 2003	2.00	11.20	13.20
FY 2004 Estimate	2.00	11.00	13.00
FY 2005 Request	2.00	11.00	13.00
FY 2006 Estimate	2.30	12.00	14.30
FY 2007 Estimate	2.40	12.20	14.60
FY 2008 Estimate	2.50	12.30	14.80
FY 2009 Estimate	2.60	12.40	15.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: Implementation includes funds for major equipment purchases (data recorders and seismometers) for the PASSCAL Instrument Center in Socorro, NM and the Global Seismographic Network (GSN).

- Operations and Maintenance: This category includes funds to support the IRIS corporate office in Washington, DC, including the Education & Outreach Program (E&O); the PASSCAL

Instrument Center in Socorro, NM; the Data Management System (DMS) in Seattle, WA; and the Global Seismographic Network (GSN). IRIS conducts no “in-house research.”

Renewal or Termination: Two reviews have been stipulated in the new NSF cooperative agreement with IRIS: (1) an in-depth study by IRIS of the operation, personnel, and instrument costs, and support of the Global Seismographic Network (GSN), in collaboration with the USGS, representatives of the Federation of Digital Seismic Networks (FDSN), and GSN network operators by July 1, 2003; and (2) an NSF review of IRIS management in coordination with IRIS and its appropriate governance committees, to be completed by July 1, 2004. This latter review will provide more information for the basis of the decision to either allow the submission of a renewal proposal or to recompete the operation of this facility.

Associated Research and Education Activities: IRIS sponsors an active education and outreach program, which touches a vast number of individuals annually. There are currently 471 schools and individuals on the IRIS mailing list, and 25 K-12 schools with IRIS seismographs. The website visitors’ data in the table below indicate yearly sums of unique visitors, and the K-12 students’ number assumes each teacher interacts with 80 students per year. IRIS also holds a number of workshops each year for K-12 and college students; in FY 2002, 5 such workshops were held.

IRIS Participation

Year	K-12	Undergrad	Graduate	Teachers	Faculty	Museum Display Visitors	Posters Distributed	Website Visitors
FY 1998	3400	2	28	43		500,000	2,000	
FY 1999	5300	9	22	23	35	2,000,000	5,000	
FY 2000	6900	2	30	20	20	9,000,000	4,000	280,000
FY 2001	12000	2	33	65	25	9,000,000	3,000	280,000
FY 2002	18000	6	24	86	16	9,000,000	2,000	410,000

Science Support: The EAR/Geophysics and Continental Dynamics Programs and the OCE/Marine Geology & Geophysics Program provide most of the funds for NSF-sponsored research, totaling approximately $15.0 million per year. Funds permit deployment of PASSCAL instruments and use of GSN data stored at the DMS to solve major earth science problems.

Laser Interferometer Gravitational Wave Observatory (LIGO)

Project Description: Einstein’s theory of general relativity predicts that cataclysmic processes involving super-dense objects in the universe will produce gravitational radiation that will travel to Earth. Detection of these gravitational waves is of great importance, both for fundamental physics and for astrophysics. LIGO, the most sensitive gravitational wave detector ever built, comprises two main facilities, one in Livingston Parish, LA and one in Hanford, WA. At each facility, a large vacuum chamber, with two 4-km arms joined at right angles, houses one or more optical interferometers. The interferometers are used to measure minute changes in the apparent distances between test masses at the ends of the arms caused by a passing gravitational wave. The predicted distortion in space caused by a gravitational wave from a likely type of source is of order one part in 10^{21}, meaning that the expected change in the apparent 4-km length is only of order 4×10^{-18} m or about 1/1000th of the size of a proton. The 4-km length for LIGO, by far the largest for any optical interferometer, was chosen to make the expected signal as large as possible within the terrestrial constraints. Looking for coincident signals in all the interferometers simultaneously increases the likelihood for gravitational wave detection.

Principal Scientific Goals: Of the four known fundamental forces of nature (electromagnetic, weak, strong, and gravitational), the gravitational force is the most enigmatic. It is by far the weakest, yet it holds the universe together, ignites the fusion reaction in stars, and curves space in black holes so severely that light is trapped. And, although the universe is believed to be filled with gravitational waves from a host of cataclysmic cosmic phenomena, we have never detected a gravitational wave and measured its waveform.

The principal scientific goals of LIGO are to detect gravitational waves on Earth for the first time and to develop this capability into a new window on the universe, a window through which we can observe phenomena such as the inspiral and coalescence of neutron stars in binary orbit, black hole collisions, unstable dynamics of newborn neutron stars, supernovae, stochastic background from the early universe, and a host of more exotic or unanticipated processes.

Principal Education Goals: LIGO is a significant source of highly trained Ph.D. graduates for the country's workforce. In addition LIGO has a diverse set of educational activities at its different sites, activities that involve a large number of undergraduate (including those from minority serving institutions), hands-on activities for K-12 classes, teachers at all levels, and informal education and outreach activities for the public, including a planned Visitor's Center at the Livingston, LA site.

Connections to Industry: Substantial connections with industry have been required for the state-of-the-art construction and measurements involved in the LIGO projects. Some have led to new products. Areas of involvement include novel vacuum tube fabrication technology, seismic isolation techniques, ultrastable laser development (new product introduced), development of new ultra-fine optics polishing techniques, and optical inspection equipment (new product).

Management and Oversight: LIGO is sponsored by NSF and managed by Caltech under a cooperative agreement. The management plan specifies significant involvement by the user community, represented by the LIGO Scientific Collaboration (LSC), and collaboration with the other major gravitational wave detector activities in Japan, Europe, and Australia. External peer-review committees organized by the NSF help provide oversight through an annual review. NSF oversight is coordinated internally by the LIGO program director in the Division of Physics (MPS), who has also convened a LIGO Project Advisory Team, comprising staff from the Office of General Counsel, the Office of Legislative and Public Affairs, and Budget, Finance and Award Management. The Project Advisory Team has been in existence since 1994.

Current Project Status: All three LIGO interferometers were fully operational by the spring of 2002. Since then, activity has been divided between improving the sensitivity of the interferometers and collecting scientific data. The first science run, S-1, accumulated nearly 100 hours of triple coincidence data in the period from August 23, 2002 to September 9, 2002 with a sensitivity of about a factor of 100 from the design goal. Results from S-1 have been announced at major scientific conferences and submitted to peer review journals. Work on instrumental refinements between the end of S-1 and the beginning of S-2 in February 2003 produced sensitivities about ten times better than those observed in S-1, i.e., only a factor of about 10 from the design goal. S-2 lasted 59 days (February 14, 2003 – April 14, 2003) with over 300 hours in triple coincidence accumulated. In S-3 (October 31, 2003 – January 8, 2004), the sensitivity achieved with the best of the three interferometers was only about a factor of 3.5 from the design goal, strengthening expectations that the sensitivity for S-4 that should commence sometime in the second half of 2004 will be at or very near the targeted level. The FY 2005 Request for LIGO totals $33.0 million, the same as the FY 2004 Estimate. This funding level reflects work to develop improved interferometers and full operations of the Laser Interferometer Gravitational-wave Observatory (LIGO) to run their interferometers at sites at Hanford, WA and Livingston, LA in coincidence with each other and with gravitational wave detectors abroad.

Funding Profile: The history of the LIGO project dates back to early conceptual work in the mid-1970s, moving through pre-construction R&D in the late 1980s to the initiation of LIGO construction in FY 1992. LIGO pre-dates the establishment of the MREFC Account in FY 1995.

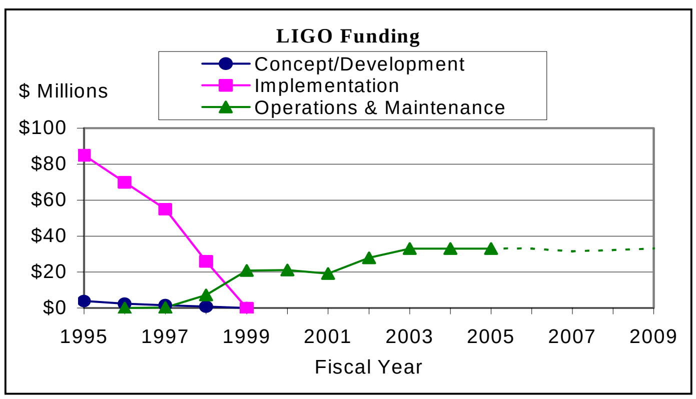
LIGO Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 1994 & Earlier	$38.70		$35.90				$74.60		$74.60
FY 1995	4.00			$85.00			4.00	$85.00	89.00
FY 1996	2.38			70.00			2.38	70.00	72.38
FY 1997	1.62			55.00	$0.30		1.92	55.00	56.92
FY 1998	0.86			26.00	7.30		8.16	26.00	34.16
FY 1999					20.80		20.80		20.80
FY 2000					21.10		21.10		21.10
FY 2001					19.10		19.10		19.10
FY 2002					28.00		28.00		28.00
FY 2003					33.00		33.00		33.00
FY 2004 Estimate					33.00		33.00		33.00
FY 2005 Request					33.00		33.00		33.00
FY 2006 Estimate					33.00		33.00		33.00
FY 2007 Estimate					33.00		33.00		33.00
FY 2008 Estimate					33.00		33.00		33.00
FY 2009 Estimate					33.00		33.00		33.00
Subtotal, R&RA	$47.56		$35.90		$327.60		$411.06		
Subtotal, MREFC				$236.00				$236.00	
Total, each phase		$47.56		$271.90		$327.60			$647.06

NOTE: The present table differs from the previous FY 2004 Budget Request to Congress in the amounts recorded for Operations and Maintenance. In the present Request, amounts recorded in Operations and Maintenance for FY 2002 – FY 2006 reflect the total amount of the award and now include research and development for improved gravitational wave detectors, previously reported under Disciplinary Research. The expected operational lifespan of this project is about 20 years. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Concept/Development: Funds supported three phases of planning, design and development for LIGO: early conceptual R&D - $11.60 million (FY 1975-87); pre-construction R&D - $16.0 million (FY 1988-91); and ongoing R&D throughout construction - $20.0 million (FY 1992-98).



- Implementation: LIGO construction occurred between FY 1992-98, totaling $271.90 million. Prior to the start of the MREFC Account, construction funding was provided through the R&RA Account.

- Management and Operations: LIGO commissioning and operations costs began phasing-in in FY 1997. Commissioning costs are included in LIGO operations (as reported in NSF budget justifications to Congress) through FY 2001. Operations with the first science run began in FY 2002.

Renewal or Termination: The cooperative agreement for the support of LIGO operations is in its third year and expires in FY 2006. NSF expects to renew the agreement at that time pending a satisfactory review of the anticipated proposal from the LIGO Laboratory for a renewal.

Associated Research and Education Activities: Active Outreach programs have been developed at both the Livingston and Hanford sites. Teams at both sites have provided visual displays, hands-on science exhibits, and fun activities for visiting students and members of the public. In the last three years an average of over 2000 students per year have taken advantage of this opportunity. More formal programs at the sites include participation in the Research Experience for Teachers (RET) Program, a set of "scientist-teacher-student" research projects in support of LIGO, and participation in the Research Experiences for Undergraduates (REU) programs for college students. In collaboration with RET participants and networks of local educators, both sites have developed Web-based Resources for teachers that includes information on research opportunities for schools and a set of standards-based classroom activities, lessons, and projects related to LIGO science. Plans are in progress to hire an outreach coordinator at each site to augment the existing activities.

Science Support: Along with direct operations and maintenance support for LIGO, NSF supports science and engineering research directly related to LIGO activities through ongoing research and education programs. The annual support for such activities is estimated to be about $5.0 million.

In 1997, LIGO founded the LIGO Scientific Collaboration (LSC) to organize the major international groups doing research that was supportive of LIGO. The LSC now has 44 collaborating institutions with over 440 participating scientists. The role and membership responsibilities of each participating institution are determined by a MOU between the LIGO Laboratory and the institution. The LSC plays a major role in many aspects of the LIGO effort including: R&D for detector improvements, R&D for Advanced LIGO, data analysis and validation of scientific results, and setting priorities for instrumental improvements at the LIGO facilities.

National High Magnetic Field Laboratory (NHMFL)

Project Description: The NHMFL develops and operates high magnetic field facilities that scientists use for research in physics, biology, bioengineering, chemistry, geochemistry, biochemistry, materials science, medicine, and engineering. It is the world's largest and highest-powered magnet laboratory, outfitted with a comprehensive assortment of high-performing magnet systems. Many of the unique facilities were designed, developed, and built by the magnet engineering and design team at the NHMFL in collaboration with industry. The facilities are available to all qualified scientists and engineers through a peer-reviewed proposal process.

Principal Scientific Goals: NHMFL scientific goals are to provide the highest magnetic fields, state-of-the-art instrumentation, and support services for scientific research conducted by users from a wide range of disciplines, including all areas of science and engineering.

Principal Education Goals: NHMFL promotes science education and assists in developing the next generation of scientists, engineers, and science education leaders. A variety of programs, opportunities, and mentorship experiences are available for teachers and students at all academic levels-K-12 through post-graduate. The laboratory, with its distinguished faculty and world-class facilities, provides a unique interdisciplinary learning environment and has had a national impact in curriculum development. In FY 2003, its regional K-12 outreach efforts engaged over 6800 students from Florida and neighboring Georgia hands-on science activities and tours of the laboratory.

Partnerships and Connections to Industry**:** The Magnet Science and Technology (MS&T) Division of the NHMFL has broad responsibility to develop high magnetic fields and materials for high field magnet wires in response to national needs, such as building advanced magnet systems for the NHMFL sites, working with industry to develop the technology to improve and address new opportunities in magnet-related technologies, and pushing the state-of-the-art beyond what is currently available in high field magnet systems through materials research and magnet technology development. To this purpose, MS&T has established leading capabilities in many aspects of magnet system engineering and assessment. In addition, MS&T cooperates with industry and other international magnet laboratories on a variety of technology projects, including the advancement of conducting materials for magnets, including high quality Cu-Nb micro-composite wires with outstanding characteristics (strength, conductivity, and resistive ratio) now available for the construction of high field coils. These projects cover the range of analysis, design, materials, component development and testing, coil fabrication, cryogenics, system integration and testing.

The laboratory engages in numerous consortium as one of its mission objectives "to engage in the development of future magnet technology." NHMFL researchers and staff work with both academic and non-academic private partners in diverse areas of magnet technology. In 2003, the laboratory collaborated with 17 private sector companies, 13 national laboratories and federal centers, and 19 international institutions. In addition, the NHMFL has established numerous partnerships and programs to enhance science education and public awareness. The annual open house, with many hands-on demonstrations, attracts over 3,000 people.

Management and Oversight: The NHMFL is operated for the NSF by a collaboration of institutions comprising Florida State University (FSU), the University of Florida (UF), and Los Alamos National Laboratory (LANL) under a cooperative agreement that sets forth the goals and objectives of the NHMFL. NSF established the NHMFL in 1990 and new facilities were dedicated and open to users in October 1994. FSU, as the signatory of the cooperative agreement, has the responsibility for establishing and maintaining appropriate administrative and financial oversight and for ensuring that the operations of the laboratory are of high quality and consistent with the broad objectives of the cooperative agreement.

The principal investigator serves as the director of the NHMFL. Four senior faculty members serve as co-principal investigators. The laboratory is organized into three functional activities: User Programs, Magnet Science and Technology Programs, and Research Programs. In addition, the NHMFL has an Office of Government and Public Relations that oversees corporate outreach activities, including interactions with private industry, federal agencies and institutions, and international organizations. The NHMFL also operates a Center for Integrating Research and Learning (CIRL) that manages educational outreach at all levels. Through the organizational network, the director receives guidance and recommendations from the NHMFL Executive Committee, staff, the participating institutions, and user communities. Two external committees meet regularly to provide the laboratory with critical advice on important user, management, and operational issues. The Users' Committee, elected by the user community, reflects the broad range of users of all of the NHMFL facilities and provides guidance on the development and use of NHMFL facilities and services in support of users. The External Advisory Committee comprises representatives from academic, government, and industrial organizations, and from the user community and reports directly to the President of Florida State University. It provides advice and guidance on matters critical to the success of the management of the NHMFL.

From the inception of the NHMFL, NSF administration and oversight was the responsibility of the Executive Officer, Division of Materials Research (MPS), with guidance from an *ad hoc* working group with representatives from the Division of Chemistry (MPS), the Directorate for Engineering, and the Directorate for Biological Sciences. Site visit reviews are conducted annually. Representatives from other federal agencies including DOE and NIH are invited to participate as observers at the site visit reviews. In July 2002 a new position of Program Director, National Facilities, was established in the NSF Division of Materials Research (DMR). Primary responsibility for NSF administration and oversight of the NHMFL was then assigned to this position, together with similar responsibilities for DMR's other national facilities.

Current Project Status: The NHMFL was established in FY 1990. It is currently moving its primary emphasis from magnet technology and development to a new phase of service to users and research. A 5-year renewal proposal was reviewed in FY 2000. More than 300 groups currently use the NHMFL facilities annually, and the laboratory was described by the NSF external review committee as the leading institution of its kind in the world. The National Science Board approved NSF support for the requested 5-year period (January 2001 through December 2005), making support for the final three years of the award contingent on satisfactory progress in the R&D program, management, and leadership of the Nuclear Magnetic Resonance program. A comprehensive NSF site visit review was conducted in May 2002; progress was assessed as satisfactory and the NSB was informed of the outcome of this review in October 2002. A subsequent annual review was conducted in October 2003. The site review committee concluded that the NHMFL is handling its overall mission very well. In particular, the changes made in proposing and tracking large, new magnet projects are important and should be continued. The NHMFL should also continue the process of commissioning the 900 MHz NMR magnet. The NHMFL should continue its efforts to strengthen the NMR program.

The FY 2005 Request for the NHMFL totals $25.61 million, an increase of $1.0 million over FY 2004 Estimate of $24.61 million. This increase reflects the second year of phasing in support for the National High Field Mass Spectrometry Facility (NHFMS). NHFMS was supported by the Chemistry Subactivity of MPS as a separate facility until FY 2003. The National High Field Mass Spectrometry (NHFMS) facility is located at the National High Magnetic Field Laboratory (NHMFL) in Tallahassee, Florida. Its purpose is to develop and exploit the unique capabilities of Fourier Transform Ion Cyclotron Resonance (FT-ICR) mass spectrometry. To that end, the NHFMS facility is routinely used to analyze samples that require ultrahigh resolution and high mass accuracy of FT-ICR. Examples of the ultrahigh resolution provided by this technique include the precise identification of thousands of molecular components in complex biological, pharmaceutical, or petroleum samples. In FY 2004, this facility will be integrated into the NHMFL and supported at $500,000. Future funding will be provided through the NHMFL.

Funding Profile: All NSF funding for the NHMFL to date has been provided through the R&RA Account.

NHMFL Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994 & Earlier	$28.00	$20.00	$48.00
FY 1995	6.30	5.70	12.00
FY 1996	6.00	11.50	17.50
FY 1997	6.80	10.70	17.50
FY 1998	5.30	12.20	17.50
FY 1999	5.50	12.00	17.50
FY 2000	5.20	12.30	17.50
FY 2001	6.20	13.80	20.00
FY 2002	7.97	17.00	24.97
FY 2003[1]	6.50	17.61	24.11
FY 2004 Estimate[2]	3.44	21.17	24.61
FY 2005 Request[2]	3.83	21.78	25.61
FY 2006 Estimate[2]	4.00	21.65	25.65
FY 2007 Estimate[2]	4.00	21.65	25.65
FY 2008 Estimate[2]	4.00	22.00	26.00
FY 2009 Estimate[2]	4.00	22.00	26.00

[1]Includes $183,272 in funding for the Research Experiences for Teachers Program.

[2]Includes funding for the National High Field Mass Spectrometry Center (not included in FY 2003 at $0.99 million).

Note: The data is presented as being either Implementation (permanent equipment) or Operations and Maintenance (non-permanent equipment). Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: The NHMFL supports a wide range of state-of-the-art magnets and instrumentation that are continuously upgraded for the user community. Capacitor driven magnets are the backbone of user programs at the Pulsed Field Facility at Los Alamos. A new 15 mm bore gap-cooled design has been tested and upgrades are underway from the current level of 60 to 65 tesla. The 60 tesla Long Pulse Mark II magnet and the 100 Tesla Multi-shot Magnet are currently under construction. Recently, an ultra fast coherent THz spectroscopy for measurement of high frequency complex conductivity in the range between 100 GHz to 2000 GHz has been developed for the Pulsed Field Facility. The Florida-Bitter DC magnets form the core of the user facilities in Tallahassee, which range from 20 to 45 telsa. Significant upgrades of existing magnets are in progress. The 33 tesla-class magnets will be upgraded to 35 tesla with a 32 mm bore. A new magnet will provide 32 tesla with a 50 mm bore, which is an increase of 7 tesla over the current magnet. The NHMFL hybrid magnet operates routinely at 45 tesla and the rebuild of one of the superconducting coils may allow the hybrid to reach 47 tesla. The 900 MHz wide bore and high-resolution NMR magnet system is in its final stages of testing and depending on the number of training quenches, the first spectra should be obtained in Spring/Summer 2004. In addition, the high temperature superconducting magnet and materials group, in collaboration with Oxford

Superconducting Technologies, designed and built a high field 5 tesla insert coil and successfully tested it in the 20 tesla wide bore resistive magnet. World records for high field insert coils were established for current density in the high temperature superconducting (HTS) winding at high field, stored energy, peak mechanical stress, diameter in a layer-wound HTS coil, and the total number of turns.

- Operations and Maintenance: These funds support the operation of the NHMFL, including magnet technology and development, support for user programs, in-house research, routine maintenance, instrumentation and technical services, and education and outreach programs. The increased level of maintenance and operations support that began in FY 2002 enabled the NHMFL to strengthen its programs for user support, equipment and facility maintenance, educational outreach and partnerships, and in-house research, and to meet increased costs for internal facilities and administration including electricity demand charges to operate high-field magnets. Research in the DC general-purpose facility is supported by eight scientists and an engineer whose specialties cover the kinds of measurements needed for most of the science done at the NHMFL work directly with users. In addition, the DC facility is supported by eight magnet plant and cryogenic system operators and mechanical, electronic, and computer engineers and technicians.

Renewal or Termination: The cooperative agreement for the support of NHMFL operations will expire in FY 2005. NSF plans are to consider support of the NHMFL either by renewal or recompetition.

Associated Research and Education Activities: The NHMFL base award currently includes approximately $240,000 per year in support of Research Experiences for Undergraduates and a wide variety of pre-college educational outreach and partnership activities with additional funding from the State of Florida. Supplementary NSF funding of $183,272 supports a Research Experiences for Teachers program for FY 2003 and FY 2004.

Participation in NHMFL Education Programs

Year	K-12	Undergrad[1]	Graduate[2]	Teachers[3]
FY 1994	1,200	8	N/A	3
FY 1995	1,515	10	N/A	9
FY 1996	3,990	16	N/A	30
FY 1997	4,075	18	19	255
FY 1998	4,080	18	15	547
FY 1999	7,100[a]	20	16	385
FY 2000	4,266	21	22	1,875 [b]
FY 2001	3,959	17	20	1,117
FY 2002	3,500	15	22	1,319
FY 2003 Est	6,841	21	N/A[c]	226[d]

[1]Undergraduates participating in the Summer Minority Program and/or REU

[2]NHMFL-affiliated graduate students earning Ph.D.'s

[3]Reflects teachers participating in workshops, Ambassador Program, and Research Experiences for Teachers

[a]Statewide implementation of curriculum project in 1999

[b]Teacher workshops extended to Connecticut and Illinois in 2000

[C]2003 data available in February 2004.

[d] State of Florida eliminated funding for "Science, Tobacco and You" Program

In addition to the individuals depicted in the table above, the NHMFL also integrates undergraduate and graduate students and postdoctoral fellows into its ongoing research activities on a regular basis. For example, during 2003, the NHMFL at FSU supported an average of 86 graduate students, 29 postdocs, and 16 undergraduates through awards outside the NSF-NHMFL core funding, e.g., individual investigator grants, state funding, and external sources. The NHMFL is actively preparing and recruiting the next generation of high-field magnet scientists, engineers, and users.

Science Support: Users are supported by NSF, other Federal, state and local agencies, other national agencies, and the private sector. User projects and time are allocated by merit on a competitive basis. NSF does not track the level of user support from non-NSF sources. The laboratory serves more than 2,000 individuals annually.

National Nanotechnology Infrastructure Network (NNIN)

Project Description: The National Nanotechnology Infrastructure Network (NNIN) comprises 13 university sites that will form an integrated national network of user facilities supporting research and education in nanoscale science, engineering, and technology. The NNIN will provide users across the nation with access, both on-site and remotely, to leading-edge tools, instrumentation, and capabilities for fabrication, synthesis, characterization, design, simulation, and integration. The broad scope of NNIN coverage includes areas of physics, chemistry, materials, mechanical systems, geosciences, biology, life sciences, electronics, optics, molecular synthesis, and molecular scale devices, among others. The NNIN expands significantly beyond the capabilities of the five-university National Nanofabrication Users Network (NNUN), which concluded after ten years of NSF support at the end of 2003.

Principal Scientific Goals: The NNIN's broad-based national user facilities will enable the nation's researchers from academia, small and large industry, and government to pursue new discoveries and applications in diverse domains of nanoscale science and engineering, and will help stimulate technological innovation. The network will also develop the infrastructure and intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology.

Principal Educational and Outreach Goals: The NNIN will undertake on a national scale a broad spectrum of innovative activities in education, human resource development, knowledge transfer, and outreach, with special emphasis on non-traditional users and under-represented groups, including women and minorities.

Partnerships and Connections to Industry: The NNIN will leverage its capabilities through connections and extensive collaborations with national and industrial laboratories, and with foreign institutions. Through these partnerships and joint meetings and workshops, the network will share expertise and perspectives, provide specialized training opportunities, coordinate access to unique instrumentation, and transfer newly developed technologies.

Management and Oversight: The NNIN will be managed as a cohesive and flexible network partnership through a Network Executive Committee derived from the individual Site Directors, and the Education/Outreach and Society/Ethics Coordinators. The Network Director will provide intellectual leadership for the network; be responsible, in cooperation with the Network Executive Committee, for developing strategies, operational plans, and coordination of the activities of the network; and serve as the principal contact on behalf of the network with the NSF. An external Network Advisory Board will meet at least annually and will provide independent advice and guidance to the Network Director and Executive Committee concerning the network's programs, activities, vision, funding allocations, and new directions. The Advisory Board will share its major recommendations with the NSF. The Site Directors will be responsible for local management functions of the individual user facilities, for interfacing with other facilities and with the management team for the overall network, and for connections with the outside communities.

NSF will provide oversight to the NNIN under a cooperative agreement. The NNIN will be reviewed through annual site reviews. In addition, a semi-annual review will be held at the NSF attended by the Network Director and Executive Committee members. The program officer for the NNIN activity will reside in the Engineering Directorate, Division of Electrical and Communications Systems. The program officer will coordinate NNIN oversight with other Division and Directorate members of the NNIN working group.

Current Project Status: The NNIN was approved by the National Science Board in November 2003. An award under a cooperative agreement is anticipated for February 2004. NSF requests $13.86 million in FY 2005, an increase of $1.41 million over the FY 2004 Estimate of $12.45 million.

NNIN Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 2004 Estimate		$12.45	$12.45
FY 2005 Request		13.86	13.86
FY 2006 Estimate		18.52	18.52
FY 2007 Estimate		21.29	21.29
FY 2008 Estimate		25.09	25.09
FY 2009 Estimate		28.85	28.85
Total	$0.00	$120.06	$120.06

FY 2003 was the final year of funding for NNIN's predecessor program, the National Nanofabrication Users Network (NNUN) at $6.05 million.

Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: N/A

- Management and Operations: The major portion of NSF funds provide for operation and staffing of the user facilities and associated network activities. They also provide for acquisition and for in-house development of appropriate instrumentation, tools, and processes to serve the user needs. The predecessor NNUN supported the national infrastructure through advanced micro- and nanofabrication facilities, instrumentation, processes, and expertise. In the NNUN’s most recent reporting year of 2003, nearly 2,000 unique users, including 1300 graduate and undergraduate students, from 33 states, 8 foreign countries, and 158 start-up and small companies benefited from use of its facilities. For the NNIN, beginning in FY 2005, there is a provision of up to a 15 percent annual increase in its budget to cover expected growth in the user base, with related increased education, training and staffing costs; and enhanced instrumentation.

Renewal or Termination: The award may be renewed once, without re-competition, for an additional five years, subject to satisfactory review of performance and availability of funds. The maximum duration of the award is for ten years.

Associated Research and Education Activities: The institutions comprising the NNIN have strong underlying internal research programs that provide critical research mass and knowledge base in developing new processes, methodologies, and instrumentation. The NNIN educational contributions will include a hyperlinked open textbook on nanotechnology for undergraduate and graduate students, a science magazine designed to stimulate and challenge 6-10 years olds to explore the physical sciences, a web-based multimedia suite encompassing training and courses for various disciplines in nanoscale science and engineering, and a network-wide research experience for undergraduates program.

Science Support: NSF and other agencies independently award research grants to principal investigators who may use the NNIN facilities to carry out some aspects of their research projects.

National Superconducting Cyclotron Laboratory (NSCL)

Project Description: This project supports the operation of the NSCL at Michigan State University (MSU) as a national user facility and also supports the MSU research program. The NSCL is the leading rare isotope research facility in the United States. NSCL scientists and researchers employ a wide range of tools for conducting advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. Important applications of the research conducted at the NSCL benefit society in numerous areas, including new tools for radiation treatments of cancer patients and the assessment of health risks to astronauts. The NSCL began operations of the coupled cyclotron radioactive beam facility in FY 2002, providing users with unique access to beams of unstable nuclei. The NSCL is among the world leaders in heavy ion nuclear physics and, now nuclear physics with radioactive beams.

The NSCL operates two superconducting cyclotrons. The K500 was the first cyclotron to use superconducting magnets, and the K1200 is the highest-energy continuous beam accelerator in the world. These and other related devices have enabled researchers to learn more about the origins of the elements in the cosmos. Through the newly completed Coupled Cyclotron Facility (CCF), heavy ions are accelerated by the K500 and then injected into the K1200, enabling the production of rare unstable isotopes at much higher intensities.

Principal Scientific Goals: Scientists at the NSCL work at the forefront of rare isotope research. They make and study atomic nuclei that cannot be found on earth and perform experimental research using beams of unstable isotopes to extend our knowledge of new types of nuclei, many of which are important to an understanding of stellar processes. Research activities include a broad program in nuclear astrophysics studies, the studies of nuclei far from stability using radioactive ion beams, and studies of the nuclear equation of state. In addition, research is carried out in accelerator physics.

Principal Education Goals: NSCL supports and enhances Ph.D. level graduate education and post-doctoral research experience. In addition, the site provides research experiences for undergraduate students, as well as training for K-12 teachers.

Partnerships and Connections to Industry: NSCL occasionally enters into license agreements with industry for cyclotron technology or nuclear electronics. A specific license agreement with Accel Corporation exists for compact cyclotrons based on superconducting technology.

Management and Oversight: The NSCL is managed by the Laboratory Director and two Associate Directors; one for Nuclear Science and one for Accelerator Research. During the NSCL upgrade, NSF convened several technical panels to review cost, schedule, technical progress, and management of the project. The NSCL research program is guided by a Program Advisory Committee consisting of external experts as well as an in-house expert, and includes the chairperson of the full NSCL User Group. The procedure for users includes writing and submitting proposals to the NSCL Director and oral presentations. There are two opportunities for proposal submission each year. Approximately 5,000 beam hours for experiments are provided each year. There is generally at least a one-year backlog for experiments. NSF oversight is provided through annual site visits by the cognizant program officer of the Physics Subactivity (MPS) and other staff, accompanied by external experts.

Current Project Status: An experimental program using the recently completed coupled cyclotron facility is now underway. The FY 2005 Request for the NSCL totals $16.65 million, an increase of $1.0 million over FY 2004 Estimate of $15.65 million. This increase will support operations and research at this unique radioactive ion beam facility.

Funding Profile: All funding for NSCL to date has been provided through the R&RA Account.

NSCL Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$9.40	$9.40
FY 1995		9.40	9.40
FY 1996		9.70	9.70
FY 1997	$2.10	9.20	11.30
FY 1998	1.90	9.80	11.70
FY 1999	6.00	9.80	15.80
FY 2000	4.70	9.90	14.60
FY 2001	1.00	11.40	12.40
FY 2002	0.40	14.41	14.81
FY 2003		15.65	15.65
FY 2004 Estimate		15.65	15.65
FY 2005 Request		16.65	16.65
FY 2006 Estimate		17.40	17.40
FY 2007 Estimate		17.40	17.40
FY 2008 Estimate		17.40	17.40
FY 2009 Estimate		17.40	17.40

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available. A new cooperative agreement will be competed in FY 2007.

Information pertaining to the data in the table is included below.

- Implementation*:* The facility was recently upgraded to couple two superconducting cyclotrons and to upgrade the fragment separator to produce intense beams of unstable isotopes providing a facility unique in the world. This recent upgrade of the NSCL to the coupled cyclotron facility was accomplished using $12.0 million in incremental funding from the NSF and over $6.0 million from MSU. In addition, $4.0 million was provided to upgrade the cryogenic plant.

- Operations and Maintenance: Funding within this category supports the operation of the facility. Such activities include routine preventative maintenance of the two coupled NSCL cyclotrons, including vacuum systems, RF power systems, beam transport systems, the helium refrigerator used to supply coolant for the superconducting cyclotrons, and miscellaneous subsystems, are carried out each quarter. Approximately 25 percent of the funding is directed toward in-house research (both experimental nuclear science and accelerator research and development) with the remainder used to operate and maintain the facility for all users. The facility serves several hundred users.

Renewal or Termination: The current cooperative agreement expires in FY 2006. NSF expects to consider a proposal to renew the program, and funding amounts for FY 2007 and beyond will be determined through negotiation at that time.

Associated Research and Education Activities: The figures shown in the table, below, under K-12 and Teachers are participants in the NSCL Physics of Atomic Nuclei (PAN) program. This is a two-week summer program sponsored by MSU with the objective to stimulate an interest in science; particularly in female and minority students. The figures shown in the Undergraduates column are the approximate number employed by the NSCL to assist researchers or to work with staff members in operating and maintaining the facility. Figures shown under Graduate are the number of students completing their Ph.D. at MSU in each fiscal year. Additional students from other institutions participated in experiments conducted at the NSCL, but figures are not shown.

Participants in the NSCL Physics of Atomic Nuclei (PAN) Program

Year	K-12	Undergrad	Graduate	Teachers
FY 1998	25	65	4	9
FY 1999	25	65	4	13
FY 2000	21	65	2	12
FY 2001	20	55	5	13
FY 2002	21	58	6	12
FY 2003 Est.	21	58	6	12

Science Support: Theoretical nuclear physics research at the NSCL is separately supported by annual grants totaling approximately $500,000. Additionally, in several recent years Major Research Instrumentation (MRI) grants have been awarded, which have permitted construction of detectors and other equipment important to the operation of the laboratory as a user facility.

Ocean Drilling Program/Integrated Ocean Drilling Program

Project Description: The Ocean Drilling Program (ODP) terminated active operations in September 2003 with its final drilling programs in the North Atlantic. During 18 years of ODP operations, NSF provided 60 percent of the program's resources and all of the required facilities, with the remaining funding provided by international partners. Phase-out of program and contract activities is planned through FY 2007.

The Integrated Ocean Drilling Program (IODP) beginning in FY 2004, is the successor program to the Ocean Drilling Program (ODP), and represents an expanded international partnership of scientists, research institutions, and funding agencies organized to explore the evolution and structure of Earth as recorded in the ocean basins. Ocean drilling is an essential capability in modern geoscience research and education and is used to examine processes ranging from changes in the Earth's climate to the rifting and drifting of continents. Over 600 ocean and earth scientists have completed an internationally coordinated planning effort to examine the scientific objectives for IODP, culminating in the Initial Science Plan, *Earth, Oceans, and Life*. These objectives require a heavy vessel for drilling deep sedimentary and crustal holes, a lighter vessel to provide widely distributed arrays of high-resolution cores to address climate, environmental, and observatory objectives, and occasional use of drilling platforms for the Arctic and nearshore projects, which cannot be undertaken from the two primary IODP vessels.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan has secured funding of approximately $500.0 million and has completed construction of the heavy drillship *Chikyu* (Earth, in Japanese) to address deep drilling objectives in the new program. *Chikyu* was launched in January 2002, will undergo testing in 2004-2006, and will be available for IODP operations in 2007. NSF's planned contribution to this program includes the acquisition, conversion and outfitting of a vessel suitable to achieve the goals of the light vessel requirement using MREFC funds in FY 2005 and FY 2006. An initial period of light drillship operations, beginning in June 2004 and expected to last for one year, will occur on the *JOIDES Resolution.* The European Consortium for Ocean Research Drilling (ECORD) has been organized by 12 European countries (4 additional country memberships are pending, one of which is Canada) for IODP participation and to provide short-term use of chartered drilling platforms for near-shore and Arctic objectives. Arctic operations are expected to commence in August 2004.

After operations begin, IODP will provide sediment and rock samples (cores), shipboard and shore-based facilities for the study of these samples, downhole geophysical and geochemical measurements (logging), and opportunities for special experiments to determine *in situ* conditions beneath the seafloor. The IODP drilling platforms will collect geologic samples from the floor of the deep ocean basins primarily through rotary coring and hydraulic piston coring. The logs and samples of the cores will be made available to qualified scientists throughout the world for research projects.

<u>Principal Scientific Goals</u>**:** The IODP scientific program is identified in the Initial Science Plan for the IODP, <u>Earth, Oceans and Life</u> (http://www.iodp.org/isp.html), and includes emphasis on the following research themes:

- <u>The Deep Biosphere and the Sub-seafloor Ocean:</u> Drilling will concentrate on defining the architecture and dynamics of the vast subseafloor plumbing system, where flowing water alters rock, modifies the long-term chemistry of the oceans, lubricates seismically active faults, concentrates economic mineral deposits, and controls the distribution of the deep biosphere.
- <u>The Processes and Effects of Environmental Change:</u> Using a global array of sites, ocean sediment cores will be used to construct a detailed record of the causes, rates and severity of changes in the earth's climate system and their relation to major pulses in biologic evolution.
- <u>Solid Earth Cycles and Geodynamics:</u> Drilling will concentrate on sampling and monitoring regions of the seafloor that currently have the highest rates of energy and mass transfer, and comparing these results to older geologic settings. A crucial initial program of deep drilling will be to study the seismogenic zone responsible for large destructive earthquakes along active plate boundaries.

<u>Principal Education Goals</u>: Undergraduate and graduate students participate in drilling expeditions, working with some of the world's leading scientists and becoming part of the intellectual fabric essential for future advances in the earth sciences. To reach students that do not participate directly in IODP,

investments are made in curriculum enrichment including interactive CD-ROMs, visiting lecture programs, museum displays, and remote classroom broadcasts from the drillship.

Connections to Industry: As it did in ODP, NSF plans to contract the services of the light drillship from a leading offshore drilling contractor. A commercial contractor will also provide downhole-logging services. In addition, scientists from industrial research laboratories will participate in IODP cruises, are members of the program's scientific and technical advisory committees, and have supplied data for planning and interpretation of drilling results.

Partnerships: MEXT and NSF will be equal partners in the IODP and will contribute equally to program operation costs. A consortium of 12 European countries and the People's Republic of China will officially join IODP in early 2004. In addition to its financial contribution, the European consortium will supply additional drilling facilities for IODP for short-term operations in shallow water and the Arctic.

Management and Oversight: NSF and MEXT have signed a Memoranda of Understanding with respect to cooperation in the IODP that identifies procedures for joint management of a contract to an IODP Central Management Office (CMO). The CMO will coordinate and support scientific planning, drilling platform activity, data and sample distribution, and publication and outreach activities through its management of commingled international science funds, collected and provided by NSF. A non-profit corporation founded by U.S. and Japanese institutions (IODP Management International, Inc.) has proposed to manage these scientific services for IODP. Drillship providers will be responsible for platform operational management and costs. NSF will provide the light drillship through contract with the U.S. System Integration Contractor (SIC), JOI Alliance, a consortium of the Joint Oceanographic Institutions, Inc. (JOI), Texas A&M University, and Lamont-Doherty Earth Observatory. MEXT will manage its drillship through the Japan Marine Science and Technology Center (JAMSTEC).

Scientific advice and guidance for IODP is provided through the scientific advisory structure (SAS). The SAS is responsible for providing scientific advice and guidance for IODP, and consists of the Science Planning and Policy Oversight Committee (SPOCC, the IODP executive authority) and an advisory structure headed by the Science Planning Committee (SPC). The CMO, under the direction of the SPC Chair, is responsible for the coordination of the SAS committees and panels, and for integrating the advice from the panel structure in a manner suitable for providing drilling and operational guidance to the CMO.

The Ocean Sciences Subactivity (GEO) manages the IODP for NSF under the NSF Ocean Drilling Program. NSF's Ocean Drilling Program is placed within the Marine Geosciences Section, with several program officers dedicated to its oversight. One of the program officers will serve as the contracting officer's technical representative on the CMO and SIC contracts.

Current Program Status and Future Program Planning: Drilling activity under the Ocean Drilling Program terminated in September 2003. The FY 2005 Request for ODP totals $4.0 million, an increase of $2.10 million over the FY 2004 Estimate of $1.90 million. Funds are being made available for core storage and data distribution. The increase in NSF funding in FY 2005 is due to late FY 2003 international contributions that were applied to FY 2004 costs, thus reducing NSF's contribution in FY 2004 to $1.90 million.

NSF and MEXT plan to contribute equally to IODP operations costs, with up to one-third of total costs contributed by the European consortium. NSF is requesting $32.10 million in FY 2005 for operations of the IODP program and for planning and design of the Scientific Ocean Drilling Vessel project through the R&RA Account. Further information on the future operations of IODP can be found under Scientific Ocean Drilling Vessel in the MREFC chapter.

Funding Profile**:** All funding for the operation of both the ODP and IODP has been provided through the R&RA Account.

Ocean Drilling / Integrated Ocean Drilling Funding Profile
(Dollars in Millions)

	Implementation	ODP Operations & Maintenance	IODP Operations and Maintenance	Total, NSF
FY 1994		$28.43		$28.43
FY 1995		27.55		27.55
FY 1996		27.68		27.68
FY 1997		27.09		27.09
FY 1998	$3.00	26.95		29.95
FY 1999	3.00	28.13		31.13
FY 2000		29.50	$0.10	29.60
FY 2001		30.60	0.20	30.80
FY 2002		31.50	0.30	31.80
FY 2003		30.00	0.00	30.00
FY 2004 Estimate		1.90	35.60	37.50
FY 2005 Request		4.00	31.60	35.60
FY 2006 Estimate		3.40	37.00	40.40
FY 2007 Estimate		3.10	65.00	68.10
FY 2008 Estimate		0.00	67.00	67.00
FY 2009 Estimate		0.00	69.00	69.00

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Not included in this table is the acquisition of the Scientific Ocean Drilling Vessel (SODV), to be proposed through the MREFC Account in FY 2005 and FY 2006. Please see the MREFC chapter for additional information pertaining to SODV.

Information pertaining to the data in the table is included below.

- Implementation: An upgrade was performed in September/October 1999, which required that the JOIDES Resolution be dry-docked for 58 days. NSF contributed $6.0 million and the ship's operator contributed $1.30 million for repairs and upgrades of the ship and its equipment necessary for the five-year contract extension through FY 2003.

- Operations and Maintenance: The general contractor for the overall management and operation of the ODP is Joint Oceanographic Institutions, Inc. (JOI), a consortium of major United States oceanographic institutions. Drilling operations and science support services (laboratory equipment, technical support, database maintenance, sample storage and distribution) are managed by Texas A&M University. Lamont-Doherty Earth Observatory of Columbia University manages logging. NSF provided support for participation and drilling-related research performed by U.S. scientists. In the IODP, operational management and science support services of the drill ships will be the responsibility of JAMSTEC for the *Chikyu*, and the JOI Alliance for the U.S. light drillship. The British Geological Survey (BGS) will provide similar support for occasional chartered drilling platforms. The CMO, under contract to NSF, will provide IODP scientific planning and coordination of drilling activities.

Renewal or Termination: At its inception, the Ocean Drilling Program was planned as a fixed duration program. The contract for the ship the program has utilized terminated at the end of FY 2003, and at that time, the drilling operations for Ocean Drilling Program ended. The Integrated Ocean Drilling Program is the next phase of scientific ocean drilling.

Associated Research and Education Activities: A breakdown of participants by year and by category is reflected in the table, below. Much of the support for Education and Outreach activities in ODP is through a cooperative agreement with JOI Inc., which has resulted in various educational products and services described here in brief. Two educational CD-ROMs with teaching activities have been developed and widely distributed. An educational poster titled, "Blast from the Past," describing the meteorite impact that led to the demise of the dinosaurs was printed, and 64,000 copies have been distributed. A brochure of abstracts (text and figures), highlighting 17 of the Ocean Drilling Program's greatest scientific accomplishments, was published and distributed. JOI also publishes a newsletter three times a year with a distribution of about 2,000. In addition, a display of ODP materials was produced and contributed to the Smithsonian Museum, in Washington DC, where it has been on permanent display since 1997. This display is viewed daily by thousands of museum visitors (numbers are not reflected in the table below).

The services of the program are also listed here in brief. A Distinguished Lecturer Series, through which each year, approximately 6 lecturers give a total of about 30 lectures at universities, colleges, and other institutions throughout the country. A new Undergraduate Student Trainee Program enables undergraduates to sail on a research vessel as members of the scientific team. Mentors and scientific projects are an integral part of this program. An internship program at JOI Inc. was initiated two years ago as an attempt to introduce recent graduates to the career opportunities of science program management. A longstanding fellowship program provides graduate student fellowship awards to conduct ODP research. Each year, JOI sponsors educational and promotional booths at national and international meetings where products and services are highlighted. The ODP drillship JOIDES Resolution has visited U.S. ports approximately 8 times since 1994. At each visit, ship tours are given, and promotional and educational activities have been held at four of these port calls. JOI/ODP sponsors scientific research and planning workshops that commonly involve graduate students. And lastly, many graduate students have sailed on the JOIDES Resolution.

In the IODP, program-wide Education and Outreach activities will be coordinated by the CMO, as will facilitation and support for national efforts in Education and Outreach. The JOI Alliance, JAMSTEC, and BGS, as operators of drilling platforms, will provide further support and materials for these efforts. The IODP U.S. Science Support Program (USSSP) will coordinate U.S. national efforts in Education and Outreach in a cooperative agreement with NSF. JOI has submitted a proposal, currently under review at NSF, to provide USSSP services.

ODP Participation

Year	K-12	Undergrad	Graduate	Teachers
FY 1994	620	1,500	1,300	700
FY 1995	620	1,550	1,400	700
FY 1996	620	1,500	1,400	700
FY 1997	2,620	6,210	4,900	1,800
FY 1998	1,300	4,110	3,800	1,300
FY 1999	2,600	5,740	5,900	2,200
FY 2000	17,600	13,680	7,400	4,200
FY 2001	5,600	9,750	9,400	9,700
FY 2002	6,000	8,000	9,500	7,000
FY 2003	6,500	8,500	9,500	7,500

Science Support: NSF provides most of the support for the participation of U.S. scientists in the ODP and will also do so in IODP. The majority of the funding comes from the Ocean Sciences Subactivity (GEO), with additional funding from the Office of Polar Programs related to Antarctic drilling research. Total funding for U.S. participation and analysis of samples and data is approximately $15.0 to $18.0 million annually.

Over 1,500 scientists from forty nations have participated on ODP cruises since 1985. About 700 of these have been U.S. scientists from 150 universities, government agencies, and industrial research laboratories who have participated in ODP cruises, with about 300 of them participating in more than one ODP cruise. Samples and data have been distributed to an additional 700 to 800 U.S. scientists. These 1,400 to 1,500 direct U.S. users of ODP materials constitute approximately 10 to 15 percent of the U.S. Geoscience community as identified by the American Geological Institute.

Partnerships for Advanced Computational Infrastructure / Widely-Shared Cyberinfrastructure

Project Description: FY 2005 marks the first year of NSF's plan to create a national cyberinfrastructure – an integrated system of state-of-the-art computing, communications and information resources, tools and services that will revolutionize the conduct of research and education across the science and engineering enterprise. Widely-shared cyberinfrastructure will provide broadly accessible and well-supported high-end computing, communications, storage, and analysis resources; it will include services to support the effective use of these resources by domain scientists and engineers; it will include education, outreach and training support to develop the workforce necessary to take full advantage of or to support this new infrastructure; and it will help create convergent technology and policy platforms that provide for interoperability across science and engineering fields and across organizational, regional and national boundaries. The Extensible Terascale Facility – also known as the Teragrid – will become operational in FY 2005 and serves as one essential component in the widely-shared cyberinfrastucture. Widely-shared cyberinfrastructure activities build on the successes of the Partnerships for Advanced Computational Infrastructure (PACI).

Principal Scientific Goals: Information technology has had widespread impact on science and engineering in the past decade – simulation and modeling are now as important to discovery as theory and experimentation, advances in sensor technology and the availability of affordable mass data storage devices are making possible the collection, creation and federation of large complex datasets, and pervasive networking technology is enriching collaborations and providing broad access to a multitude of scientific resources. Information technology also provides new opportunities to promote and advance learning where both formal and informal education activities are increasingly enabled by enhanced access and peer-to-peer learning opportunities. However, this rapid growth in the use of information technology to advance science and engineering has come about in a largely uncoordinated manner, with limited pooling of resources or experiences, and with little thought given to the systems issues of design, interoperability and long-term sustainability. Beginning in FY 2005, NSF will capitalize upon the science and engineering opportunities provided by continuing advances in information technology through the creation and support of a widely-shared, integrated cyberinfrastructure that enriches and continues to revolutionize discovery, learning and innovation in all science and engineering domains. Widely-shared cyberinfrastructure supports and/or integrates a diverse set of advanced computing engines, data archives and digital libraries, observing and sensor systems, and other research and education instrumentation. It includes the development and deployment of production-quality, open-source and open-standards middleware – software that connects two or more applications across the Internet and allows those applications to share compute engines, data, networks and instruments.

Principal Education Goals: NSF seeks to ensure that the broadest range of individuals, institutions and stakeholder communities will participate in the design, development, deployment and/or use of widely-shared cyberinfrastructure. Consequently, in FY 2005 the agency will support new efforts that leverage the successes of the PACI-Education, Outreach and Training (EOT) activities, to prepare current and future scientists and engineers to use, develop and support cyberinfrastructure now and in the future.

Partnerships and Connections to Industry: Cyberinfrastructure is by definition a partnership activity and involves a large number of academic, industry and government partner organizations. There are also international partnerships. Examples of international partnerships include joint work with the Advanced Computational Modeling Centre at the University of Queensland in Australia, with the Parallel Computing Center at the Royal Institute of Technology in Stockholm, Sweden and with the Center for Research on Parallel Computation and Supercomputers in Naples, Italy.

NSF-supported organizations have had a number of industrial strategic partnerships with Fortune 500 Companies, including Allstate Insurance Company; the Boeing Company; Caterpillar Inc.; Eastman Kodak Company; J. P. Morgan; Kellogg Company; Motorola, Inc.; Sears; Shell Oil Company; Arena Pharmaceuticals; BAE Systems; Brocade; Ceres, Inc; Computer Science Corp.; Pfizer; JVC; Lockheed Martin; and ESRI. They also have had strategic technology partnerships with a number of companies including ANSYS, Inc.; Informix Corp.; Microsoft Corp.; SGI; Sun Microsystems; IBM; Qwest; Oracle; Compaq (now Hewlett Packard); Storage Tek; and Intel.

Management and Oversight: NSF awards for support of widely-shared cyberinfrastructure are made mainly through cooperative agreements. Each awardee is expected to manage their own operations and resources with oversight provided by an NSF (CISE-SCI) program officer. Investments in national supercomputing resources are being made through cooperative agreements with the National Center for Supercomputing Applications (NCSA), the San Diego Supercomputing Center (SDSC) and the partner institutions in the Extensible Terascale Facility. With upgrades in supercomputing capacity being completed during FY 2004, NSF will almost double the computing cycles being made available to the national science and engineering community. A National Resource Allocation Committee meets semi-annually to review and make recommendations on large supercomputing resource requests. Cooperative agreement awardees submit annual reports and plans that are often reviewed by committees of experts external to NSF. Committee recommendations are acted upon by the cognizant NSF program officer and reviewed by the Division Director. NSF investments are being informed by the recent report of the NSF Advisory Committee on Cyberinfrastructure, and by ongoing internal planning activities informed by discussions with the external science and engineering community.

Current Status: The FY 2005 Request for widely-shared cyberinfrastructure totals $137.90 million, an increase of $17.85 million over the FY 2004 Estimate of $120.06 million. This increase will support increased operations costs, and expansion of education outreach and training.

Funding Profile: All funds for the operations and maintenance of widely-shared cyberinfrastructure are being provided through the R&RA Account. In the past, NSF's main investments in widely-shared cyberinfrastructure were made through the Partnerships for Advanced Computational Infrastructure (PACI) as described below.

PACI Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994 & Earlier			$0.00
FY 1995			0.00
FY 1996			0.00
FY 1997			0.00
FY 1998	$21.30	$38.80	60.10
FY 1999	23.90	45.60	69.50
FY 2000	27.20	42.80	70.00
FY 2001	21.90	51.40	73.30
FY 2002	25.90	49.37	75.27
FY 2003	25.00	48.24	73.24
FY 2004 Estimate[1]	25.00	62.00	87.00

[1]FY 2004 total includes an additional $20.0 million in initial cyberinfrastructure investment through hardware upgrades.

Information pertaining to the data in the table is provided below.

- Concept/Development: Concept planning for PACI was done in the 1995-1997 time frame. The recent report of the NSF Advisory Committee for Cyberinfrastructure, issued in February 2003, is informing the agency's plans for widely-shared cyberinfrastructure.

- Implementation: Implementation of the PACI facilities included initial development of supercomputing facilities and includes upgrades to those facilities to maintain the highest performance computing possible. The Partnerships used approximately one third (actuals range from about 32 to 38 percent) of their annual budget for upgrades to keep their computational, storage and networking resources at a state-of-the-art level. In FY 2005, NSF remains focused on likely technology upgrades or new acquisitions in both hardware and software to ensure the national community has access to a state-of-the-art, enabling cyberinfrastructure.

- Operations and Maintenance: The Operations and Maintenance data provided below include funds that support the development of enabling and applications technologies. Approximately half of the funds listed are designated for this purpose. These funds, as defined in the PACI cooperative agreements, were to develop technologies that facilitate the efficient use of the computational resources provided by the program.

Cyberinfrastructure Funding Profile
(Dollars in Millions)

	Implementation[1]	Operations & Maintenance[2]	Total, NSF
FY 2005 Request	$40.00	$97.90	$137.90
FY 2006 Estimate	40.68	99.56	140.24
FY 2007 Estimate	41.49	101.55	143.04
FY 2008 Estimate	42.44	103.89	146.33
FY 2009 Estimate	43.50	106.49	149.99

Note: due to incorporation of other efforts, numbers are not comparable to PACI table. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

[1]Implementation funds above represent support for networking costs, middleware and software development, education and training efforts, and other tools and services.

[2]Operations funding in FY 2005 and beyond represents operations and maintenance support for Widely-shared Cyberinfrastructure, of which support for the operation and maintenance of the Terascale Computing Systems is about $10.0 million in FY 2005. Terascale will be fully integrated with Cyberinfrastructure in future years. For further information on Terascale, please refer to the MREFC chapter.

Renewal or Termination: The PACI cooperative agreements will remain in effect through the end of FY 2004. In FY 2005, revised cooperative agreements with NCSA and SDSC will ensure the continuing provision of high-end computing resources and related services to the national community. Complementing the resources and services provided by NCSA and SDSC, in FY 2005 the Extensible Terascale Facility will begin to demonstrate the potential of revolutionary grid computing approaches to advance science and engineering research and education.

Associated Research and Education Activities: The table below indicates the impact that the PACI Program has had in the area of Education, Outreach and Training (EOT). Historically, the base funding for the EOT-PACI component amounted to approximately 5 percent of the funds for the two PACI cooperative agreements. Funds provided through the PACI Program were highly leveraged through donations from private foundations and through NSF funding from EHR and other programs within the NSF. PACI-EOT partners designed and administered numerous programs for underrepresented groups including Minority Serving Institutions, the Coalition to Diversity Computing, GirlTech, Teacher Education and Training Programs, etc. The numerous activities of the PACI-EOT team may be found at http://www.eot.org. NSF's new cyberinfrastructure activities aimed at education, outreach and training will expand upon the successes of PACI-EOT activities.

PACI Participation

Year	K-12	Undergrad	Graduate	Teachers
FY 1998	3,910	370	60	330
FY 1999	6,300	500	150	420
FY 2000	4,000	460	70	350
FY 2001	6,200	4,600	150	1,300
FY 2002	11,300	730	170	550
FY 2003	8,000	900	150	500

NOTE: FY 2001 Undergrads include 3,000 BioQuest-related undergrads. The large number in Teachers for that year is also related to BioQuest. In FY 2002, K-12 participants included a Girl Scout outreach program in the San Diego area.

Science Support: Leading-edge cyberinfrastructure resources serve many areas of scientific and engineering research supported by the NSF. Percent usage of computational resources by NSF Directorates for FY 2002 are shown in the following table:

Resource Usage, by NSF Directorate

NSF Activity	Percentage of Users	Percentage of Usage
BIO	9%	14%
CISE	20%	13%
ENG	16%	7%
GEO	9%	4%
MPS	41%	61%
SBE	4%	1%

It is estimated that the average annual support of the research and education groups using these facilities is in excess of $200.0 million. This is an estimate based on the number of users. There are approximately 600 projects, with an average of five to six users. We assume that approximately 200 large projects have an estimated grant support of $500,000 per year; approximately 400 smaller projects have estimated grant support of about $250,000 per year.

Other Facilities

Other Facilities support includes continued support for the Network for Computational Nanotechnology (NCN), which focuses on modeling and simulation of chemical, biological and pharmaceutical systems, and will include additional network nodes that focus on these areas. An increase of $1.50 million for a total of $3.85 million for NCN is requested. Other items within this category include facilities for computational sciences, physics, materials research, ocean sciences, atmospheric sciences, and earth sciences.

INFRASTRUCTURE AND INSTRUMENTATION

Investments in state-of-the-art instruments, platforms, information technology, databases, and other tools that uphold U.S. S&E leadership and that enable diverse communities of researchers, educators and students working at the S&E frontier.

Infrastructure and Instrumentation
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Advanced Networking Infrastructure	$46.62	$23.06	$22.90	-$0.16	-0.7%
Major Research Instrumentation	83.45	109.35	90.00	-19.35	-17.7%
National STEM Digital Library	27.63	24.40	27.02	2.62	10.7%
Research Resources[1]	153.66	160.79	181.09	20.30	12.6%
Science Resource Statistics	25.30	23.92	23.92	0.00	0.0%
Total, Infrastructure & Instrumentation	$336.66	$341.52	$344.93	$3.41	1.0%

[1]Research Resources in the FY 2004 Request included an additional $20.0 million in cyberinfrastructure, which has been placed under the Partnerships for Advanced Computational Infrastructure (PACI) facilities program.

NSF will consider annual performance goals related to the Infrastructure and Instrumentation investment goal appropriate for inclusion in a future performance budget at the time the PART analysis for this program is completed.

Advanced Networking Infrastructure (ANI)

Advanced Networking Infrastructure activities enable and expand scholarly communication and collaboration by providing researchers and educators with network access to high performance, remote scientific facilities including supercomputer facilities and information resources. In FY 2005, Advanced Networking Infrastructure will emphasize new projects in the NSF Middleware Initiative that develop new capabilities for distributed systems and demonstrate the use of new capabilities in realistic applications from science and engineering disciplines. Support will continue for new awards for international connectivity with an emphasis on strategic linkages that foster the most important international science and engineering collaborations. NSF's request for Advanced Networking Infrastructure in FY 2005 is $22.90 million, a decrease of $160,000 from the FY 2004 Estimate of $23.06 million.

Major Research Instrumentation (MRI)

The Major Research Instrumentation program is designed to improve access to state-of-the-art scientific and engineering equipment for research and research training in our nation's academic institutions. This program seeks to foster the integration of research and education by providing instrumentation for research-intensive learning environments. In FY 2005, NSF requests $90.0 million, a decrease of $19.35 million from the FY 2004 Estimate of $109.35 million, for continued support of the acquisition and development of research instrumentation for academic institutions. While the overall program may decrease, emphasis will be placed on ensuring the availability of cutting-edge research instrumentation to a broad set of academic institutions, including undergraduate institutions, minority-serving institutions, and community colleges. To facilitate broader participation in the MRI program, NSF will significantly reduce or eliminate the MRI cost-sharing requirement for small and minority institutions.

National STEM Education Digital Library (NSDL)

A National STEM Education Digital Library (NSDL) responds to needs articulated by the NSF, the academic community, and corporate leaders for accelerating improvements in science, technology, engineering and mathematics (STEM) education. The NSDL, capitalizing on recent developments in digital libraries, will provide: a forum for the merit review and recognition of quality educational resources; a mechanism for electronic dissemination of information about high-quality educational materials, pedagogical practices, and implementation strategies; a centralized registry and archive for educational resources; and a resource for research in teaching and learning. In addition, the NSDL will provide an infrastructure to support and accelerate the impact of NSF programs. For example, developers of curricula and courses will benefit from awareness and knowledge of extant instructional materials, as well as information on their implementation. NSF support for the NSDL in FY 2005 totals $27.02 million, an increase of $2.62 million over the FY 2004 Estimate of $24.40 million.

Research Resources

Research Resources supports a range of activities throughout the Research and Related Activities Account including: multi-user instrumentation; mid-scale instrumentation, the development of instruments with new capabilities, improved resolution or sensitivity; upgrades to field stations and marine laboratories; support of living stock collections; facility-related instrument development and operation; and the support and development of databases and informatics tools and techniques and other domain-specific cyberinfrastructure. These various resources provide the essential platforms and tools for effective research in all areas of science and engineering. In FY 2005, funding for Research Resources totals $181.09 million, an increase of $20.30 million over the FY 2004 Estimate of $160.79 million. Most of this increase represents investments in domain-specific cyberinfrastructure.

Science Resources Statistics (SRS)

Science Resources Statistics (SRS) provides researchers and policymakers with data and information that is the basis for making informed decisions and formulating policy about the nation's science, engineering and technology enterprise. The primary statistical series produced by the SRS Subactivity (SBE) includes the education and employment of scientists and engineers and the performance and financial support of research and development. NSF is requesting $23.92 million for FY 2005, the same as the FY 2004 Estimate. Funding enables NSF to fulfill its statutory mandate to produce data and analysis on the scientific and engineering enterprise, provides funds to support survey redesign activities, quality improvement projects and begin feasibility and development activities related to research instrumentation and postdoctorates.

POLAR TOOLS, FACILITIES AND LOGISTICS

Investments that provide state-of-the-art tools, facilities and other infrastructure to enable world-class polar research and education.

Polar Tools, Facilities and Logistics
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Antarctic Facilities and Operations	$141.43	$149.48	$153.96	$4.48	3.0%
Polar Logistics	98.84	99.47	100.19	0.72	0.7%
Antarctic Logistics	*68.55*	*68.07*	*68.07*	*0.00*	*0.0%*
Arctic Logistics	*30.29*	*31.40*	*32.12*	*0.72*	*2.3%*
South Pole Station[1]	12.69	1.29	0.00	-1.29	-100.0%
Total, Polar Tools, Facilities and Logistics	$252.96	$250.24	$254.15	$3.91	1.6%

[1]South Pole Station includes initial support for operations and maintenance funded through R&RA as well as construction, acquisition and commissioning costs funded through MREFC. For a complete discussion of South Pole Station, please refer to the MREFC chapter.

NSF will consider annual performance goals related to the Polar Tools, Facilities and Logistics investment goal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

Antarctic Facilities and Operations

Project Description: Antarctic Facilities and Operations provide the basic infrastructure and transportation support for all U.S. research conducted in Antarctica, including that funded by U.S. mission agencies, for year-round work at three U.S. stations, two research ships, and a variety of remote field camps. All life support is provided by NSF, including facilities infrastructure, communications, and utilities (water and power), and health and safety infrastructure.

Principal Scientific Goals: Antarctic Facilities and Operations provides science support in Antarctica, ranging from astrophysics to microbiology and climatology; provides environmental stewardship, and maintains U.S. presence in Antarctica in accord with U.S. policy.

Principal Education Goals: By maintaining and operating the three U.S. stations in Antarctica, Antarctic Facilities and Operations support all scientific work performed by U.S. scientists in Antarctica. Specific science and education goals are managed by the science programs.

Partnerships and Connections to Industry: Raytheon Polar Services Company is the primary support contractor, which oversees approximately 385 separate subcontractors for supplies and technical services.

Management and Oversight: The Office of Polar Programs (OPP) has the overall management responsibility for Antarctic Facilities and Operations. The performance of the support contractor is evaluated every year by an Award Fee Board, with representatives from OPP and the Budget, Finance and

Award Management. In addition, performance is reviewed by Committees of Visitors and the OPP Advisory Committee.

Antarctic Facilities and Operations also includes management of South Pole Station Modernization, an activity funded out of the Major Research Equipment and Facilities Construction (MREFC) Account from FY 1998 through FY 2005. The new station will provide the infrastructure required for imaginative new science on the drawing board.

Current Project Status: All three Antarctic stations are currently operating as normal.

Funding Profile: All funding for Antarctic Facilities and Operations has been provided through the R&RA Account. Support for South Pole Station Modernization, the South Pole Safety and Environment, and the Polar Aircraft Upgrades projects are found in the MREFC Section.

Antarctic Facilities and Operations Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		104.54	104.54
FY 1995		104.67	104.67
FY 1996		107.35	107.35
FY 1997		100.29	100.29
FY 1998		97.80	97.80
FY 1999		102.03	102.03
FY 2000		108.11	108.11
FY 2001		117.96	117.96
FY 2002		126.15	126.15
FY 2003		143.93	143.93
FY 2004 Estimate		152.29	152.29
FY 2005 Request		155.14	155.14
FY 2006 Estimate		159.80	159.80
FY 2007 Estimate		164.60	164.60
FY 2008 Estimate		169.50	169.50
FY 2009 Estimate		174.60	174.60

NOTE: Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Operations and Maintenance: The Office of Polar Programs (OPP) contracts with a prime support contractor for science support, and operations and maintenance of the Antarctic stations and related infrastructure in New Zealand and Chile, as well as leasing of research vessels and fixed-wing aircraft used in support of research. The contractor is selected through a competitive bidding process. Other agencies and contractors also provide technical support in areas of expertise such as engineering, construction and communications.

Renewal or Termination: Not applicable to the facilities themselves. The current Antarctic support contract was recompeted and awarded in FY 2000. After a five-month phase-in period the contractor assumed responsibility for operations in March 2000. The contract's ten year performance period is segregated into a five-year initial period and a five-year optional period. NSF is presently considering whether to exercise its option to extend the performance period.

Associated Research and Education Activities: The Antarctic infrastructure makes science in Antarctica possible - ranging from astrophysics to microbiology and climatology - and maintains U.S. presence in Antarctica in accord with U.S. policy. Research is funded through the Antarctic Research Grants Program at NSF and through other federal agencies funding research in Antarctica.

Science Support: OPP's prime support contractor provides science support, as well as operations and maintenance of the facilities.

Polar Logistics

Arctic research support and logistics is driven by and responsive to the science supported in U.S. Arctic Research programs. Funding for logistics is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. Major components include: access to U.S. Coast Guard and other icebreakers, University-National Oceanographic Laboratory vessels and coastal boats, and support on the U.S. Coast Guard Cutter *Healy*; access to fixed and rotary-wing airlift support; upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; safety training for field researchers and funding for field safety experts, global satellite telephones for emergency response, and improved logistics coordination; development of a network of strategically placed U.S. Long-Term Observatories linked to similar efforts in Europe and Canada; and installation of a modern local area network in Barrow/Naval Arctic Research Laboratory with improved access to the Internet.

U.S. Antarctic Logistical Support is provided by U.S. Department of Defense (DoD) components. Major elements include: Military personnel of the 109th Airlift Wing (AW) of the New York Air National Guard; 109th AW LC-130 flight activity and aircraft maintenance; transportation and training of personnel in connection with the U.S. Antarctic Program; logistics facilities of the Air Force Detachment 13 in Christchurch, New Zealand and the 109th Airlift Wing in Scotia, New York; air traffic control, weather forecasting, and electronic equipment maintenance; charter of Air Mobility Command Airlift and Military Sealift Command ships for the re-supply of McMurdo Station; fuel purchased from the Defense Logistics Agency; and use of Department of Defense satellites for communications.

NSF is requesting $100.19 million for Polar Logistics, an increase of $720,000 over the FY 2004 Estimate of $99.47 million. This increase in Arctic Logistics support, to $32.12 million, will provide continuing support for research projects throughout the Arctic including Alaska, Canada, the Arctic Ocean, Greenland, Scandinavia and Russia; support for Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope; continuing support for a cooperative agreement with the Barrow Arctic Science Consortium to improve support and logistics in the area and make any new facilities useful for basic research programs. Support provided by DoD for the U.S. Antarctic Logistics program is level in FY 2005, at $68.07 million.

FEDERALLY-FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCS)

Investments in research, development, and R&D policy that create unique, important and long-term capabilities for the Federal government, in response to law, mandate or widely-recognized need.

Federally-Funded Research and Development Centers (FFRDCs)
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
National Astronomy R&D Centers	$100.68	$108.67	$98.91	-$9.76	-9.0%
National Astronomy & Ionosphere Center	*12.73*	*12.34*	*12.50*	*0.16*	*1.3%*
National Optical Astronomy Observatories	*42.62*	*41.35*	*39.00*	*-2.35*	*-5.7%*
National Radio Astronomy Observatories	*45.33*	*54.98*	*47.41*	*-7.57*	*-13.8%*
National Center for Atmospheric Research	80.27	83.27	84.52	1.25	1.5%
Science and Technology Policy Institute	3.97	3.98	4.00	0.02	0.5%
Total, FFRDC Support	$184.92	$195.92	$187.43	-$8.49	-4.3%

NSF will consider annual performance goals related to the Federally-Funded Research and Development Centers investment goal appropriate for inclusion in a future performance budget at the time the PART for this program is completed.

NATIONAL ASTRONOMY CENTERS – NAIC, NOAO and NRAO

National Astronomy and Ionosphere Center (NAIC)

Project Description: The NAIC is a visitor-oriented national research center, supported by NSF and focusing on radio and radar astronomy and atmospheric sciences. Its principal observing facility is the world's largest radio/radar telescope, a 305m-diameter spheroid constructed within a karst depression in western Puerto Rico near the town of Arecibo. The facility itself is called the Arecibo Observatory. The NAIC is operated by Cornell University for NSF under a cooperative agreement. NAIC provides telescope users with a wide range of research and observing instrumentation. The center has a permanent staff of scientists, engineers, and technicians who are available to help visiting investigators with their observation programs.

Principal Scientific Goals: The NAIC was founded to advance the study of basic research in Radio Astronomy, Solar System Radar Astronomy, and Ionospheric Physics.

Principal Education Goals: NAIC's primary education goal is to support and enhance the education of graduate and undergraduate student researchers. Arecibo was one of NSF's first sites for the Research Experiences for Undergraduates (REU) program. At Arecibo, graduate students receive training through use of the facility for Ph.D. research. NAIC also sponsors a major outreach program in Puerto Rico via a modern Visitor's Center, a new Learning Center, and summer workshops for K-12 teachers. In addition NAIC holds, in collaboration with NRAO, a summer school on single-dish radio astronomy techniques. This is a continuing bi-yearly school alternating between NRAO sites and Arecibo.

Partnerships and Connections to Industry: NAIC currently has partnerships with NASA, NRAO, Penn State and other Universities, and the Angel Ramos Foundation of Puerto Rico (a private organization).

Management and Oversight: NAIC is one of four National Centers in astronomy supported by the Astronomical Sciences Subactivity (MPS). Management is through a cooperative agreement with Cornell University. This agreement requires that an annual progress report and program plan be submitted to and approved by NSF. Bi-weekly teleconferences are maintained between the NSF program manager and the NAIC Director. The program manager visits the Observatory several times per year. The NSF program manager attends Arecibo Visiting Committee meetings (commissioned by Cornell), and committee reports are made available to NSF. NAIC/Cornell representatives present yearly status reports and long-range plans during visits to NSF. Management reviews by external review panels for NSF are held typically three years into a 5-year cooperative agreement.

Current Project Status: The current cooperative agreement with Cornell to manage NAIC expires in September 2004. A solicitation for the management of NAIC was issued in November 2003; the due date for proposals is March 12, 2004. The FY 2005 Request for NAIC totals $10.60 million, an increase of $60,000 relative to the FY 2004 Estimate of $10.54 million.

Funding Profile: All funding for NAIC to date has been provided through the R&RA Account.

NAIC Funding Profile
(Dollars in millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$1.30	$7.40	$8.70
FY 1995	0.40	7.30	7.70
FY 1996	0.60	7.70	8.30
FY 1997	0.40	8.20	8.60
FY 1998	0.40	7.80	8.20
FY 1999	0.50	8.80	9.30
FY 2000		8.80	8.80
FY 2001	1.10	9.00	10.10
FY 2002		9.40	9.40
FY 2003		10.93	10.93
FY 2004 Estimate		10.54	10.54
FY 2005 Request		10.60	10.60
FY 2006 Estimate		10.60	10.60
FY 2007 Estimate		10.60	10.60
FY 2008 Estimate		10.60	10.60
FY 2009 Estimate		10.60	10.60

The current Cooperative Agreement expires in FY 2004. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available. GEO contributions for science support are not included.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning occurred before this reporting period. Construction of the Arecibo Observatory by the Air Force was completed in 1963. NSF took over funding for operations in 1970. The primary NSF-funded upgrade during the period reported was installation of a Gregorian feed system to enhance telescope efficiency and increase useable bandwidth.

The Arecibo Observatory is part of the National Astronomy and Ionosphere Center (NAIC), a national research center operated by Cornell University under a cooperative agreement with the National Science Foundation. As the site of the world's largest single-dish radio telescope, the Observatory is recognized as one of the most important national centers for research in radio astronomy, planetary radar and terrestrial aeronomy.

- Operations and Maintenance: In-house research accounts for about 6 percent of the total operations budget of NAIC. Most of this research concerns traditional radio-astronomical observations (interstellar gas, galaxies, pulsars) and radar astronomy of solar system objects (asteroids, planetary surfaces and moons). This research furthers the scientific mission of the facility and maintains a scientifically competent staff. The planetary radar program, which has been funded by NASA since 1974, is in a period of transition. NASA has decided to ramp down and then terminate its support by the end of FY 2005. The FY 2004 Estimate and the FY 2005 Request include $300,000 for NSF support of the program.

Renewal or Termination: The current cooperative agreement with Cornell to manage NAIC expires in September 2004, and NSF has decided to recompete the award. A solicitation has been issued for an award covering the period FY 2005-2009.

Associated Research and Education Activities: Teacher training is conducted in intensive workshops, held in the past at the Visitor’s Center, and as of 2002 in the new Learning Center (both built with funding from the Angel Ramos Foundation of Puerto Rico). Arecibo attracts roughly 110,000 visitors per year, with many K-12 school groups visiting from across the island. Many graduate students use NAIC for dissertation research and Research Experiences for Undergraduates (REU) students also use the telescope as part of their summer research experience. Support for REU is at the level of roughly $40,000 per year.

Science Support: In addition to MPS funding, the Atmospheric Sciences subactivity in the Geoscience Activity expects to provide $1.80 million in FY 2004 and $1.70 million in FY 2005 for ionospheric research and staff support. NSF does not provide individual investigator awards targeted specifically for use of NAIC. Many users are supported through NSF or NASA grants which pursue scientific programs that require use of NAIC.

National Optical Astronomy Observatory (NOAO)

Project Description: The National Optical Astronomy Observatory was established in 1982 by uniting the operations of the Kitt Peak National Observatory in Arizona and the Cerro Tololo Inter-American Observatory in Chile. NOAO is a federally funded research and development center (FFRDC) for research in ground-based nighttime optical and infrared astronomy. NOAO also represents the U.S. astronomical community in the International Gemini Observatory. The National Solar Observatory (NSO), once administratively part of NOAO but now with an independent management structure, makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona. The NSO operates facilities in Sunspot, New Mexico and Tucson, Arizona. As national facilities, NOAO and NSO telescopes are open to all astronomers regardless of institutional affiliation on the basis of peer-reviewed observing proposals.

Principal Scientific Goals: To support basic research in astronomy and solar physics by providing the best ground-based astronomical telescopes to the nation's astronomers, promoting public understanding and support of science, and advancing all aspects of U.S. ground-based astronomical research.

Principal Education Goals: To promote and enhance the education of undergraduate and graduate student researchers and outreach training and curriculum development for K-12 teachers. Approximately 15 percent of all NOAO and NSO users are graduate students. Some recent examples of outreach activities include: Project ASTRO, which matches astronomers with 4th to 9th grade teachers and community educators in the Tucson and Sunspot areas who want to enrich their astronomy and science teaching; and the use of Astronomy in the Teacher Leaders in Research-Based Science Education (TLRBSE), a summer workshop for middle and high school teachers.

Partnerships and Connections to Industry: Thirty U.S. Member Institutions and six International Affiliate Members comprise the Member Institutions of the Association of Universities for Research in Astronomy (AURA), Inc, the management organization for NOAO. Other partners include the USAF Office of Scientific Research, NASA, and industrial vendors. Development of new telescopes, instrumentation, and sensor techniques is done in partnership with relevant industry, through subawards to various large and small aerospace, optical fabrication, and IT companies.

Management and Oversight: Management is through a cooperative agreement with AURA. Separate Directors for NOAO and NSO report to the President of AURA. Oversight is through detailed annual program plans and long range plans for NOAO and NSO, plus quarterly and annual reports. NSF has periodic reviews of AURA management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director (AST/MPS) and by a standing external committee for NOAO.

Current Project Status: Cooperative agreements for continuing management and operations are for terms of five years; a new agreement was recently competed and awarded to AURA October 1, 2002. A management review will be carried out three years into the current cooperative agreement. The FY 2005 Request for NOAO totals $39.0 million, an decrease of $2.35 million from the FY 2004 Estimate of $41.35 million. NOAO funding includes $35.0 million for NOAO and NSO telescopes, plus $4.0 million for the Telescope System Instrumentation Program (TSIP), which is administered for the community through NOAO. TSIP is a program to unify the privately held and the national optical and IR observatory facilities by funding instrument development and construction at the private observatories in return for observing time on those facilities which is in turn allocated to the astronomical community at large on the basis of peer-reviewed observing proposals. NSO is nearing the completion of the design and development phase for the Advanced Technology Solar Telescope (ATST) and has submitted a proposal for its construction in late calendar year 2003. NOAO is actively participating in the development of both the Giant Segmented Mirror Telescope and the Large Synoptic Survey Telescope, both of which are high priority recommendations of the Decadal Survey conducted by the NRC's Astronomy and Astrophysics Survey Committee.

Funding Profile: All funding for NOAO to date has been provided through the R&RA Account.

NOAO Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	NSF Total
FY 1994		$28.60	$28.60
FY 1995		29.00	29.00
FY 1996		27.10	27.10
FY 1997		28.00	28.00
FY 1998	$3.00	27.90	30.90
FY 1999	1.40	28.70	30.10
FY 2000	1.40	28.70	30.10
FY 2001		31.20	31.20
FY 2002[1]		36.82	36.82
FY 2003		42.62	42.62
FY 2004 Estimate		41.35	41.35
FY 2005 Request		39.00	39.00
FY 2006 Estimate		39.00	39.00
FY 2007 Estimate		39.00	39.00
FY 2008 Estimate		39.00	39.00
FY 2009 Estimate		39.00	39.00

[1]Beginning in FY 2002, TSIP is funded at $4.0 million.

NOTE: The current cooperative agreement expires in FY 2006. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning of major telescopes occurred before this reporting period. Recent upgrades have been made in the National Solar Observatory facilities, with the completion and commissioning of the Synoptic Optical Long-term Investigations of the Sun (SOLIS) telescope in 2003.

- Operations and Maintenance: The management and operations budget primarily maintains and utilizes existing facilities and develops new instrumentation for existing telescopes in support of research by the national astronomical community. Basic research by in-house scientific staff accounts for approximately 5 percent of the total budget.

Renewal or Termination: The current cooperative agreement expires in FY 2006. A management review of the cooperative agreement will be carried out during FY 2004, on the basis of which NSF will decide whether to renew or recompete the program. Funding amounts for FY 2007 and beyond will be determined through negotiation based on proposals received at this time.

Associated Research and Educational Activities: Teacher training includes participation of more than 350 teachers in Project ASTRO; intensive (multi-week) training of about 25 teachers per year through Teacher Learning through Research Based Science Education; and Research Experience for Teachers. K-12 numbers are not tracked but it is estimated that school groups make up about 10 percent of the roughly 85,000 visitors per year to public visitor centers at NOAO and NSO. Instructional materials are developed in collaboration with the Lawrence Hall of Science Great Explorations in Math and Science (GEMS) program. The "Hands on Optics" program, aimed at middle school students, is being developed by NOAO in collaboration with the Optical Society of America and the International Society for Optical Engineering. Observational facilities are also used by approximately 200 graduate students each year and by undergraduate students participating in the REU program.

Science Support: In addition to the funds listed above, approximately $500,000 per year is provided in total from the Division of Elementary, Secondary and Informal Education (EHR), the Division of Atmospheric Sciences (GEO), the Program for Education and Special Programs in the Astronomy Division (REU and teacher enhancement) (MPS), and the Off ice of International Science and Engineering (OISE). For all NOAO and NSO telescopes, a peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide awards targeted specifically for use of NOAO. Most users are supported through NSF or NASA grants to pursue scientific programs that require use of NOAO.

National Radio Astronomy Observatory (NRAO)

Project Description: The National Radio Astronomy Observatory (NRAO) is a federally-funded research and development center (FFRDC) that provides state-of-the-art radio telescope facilities for use by the scientific community. NRAO conceives, designs, builds, operates and maintains radio telescopes used by scientists from around the world to study virtually all types of astronomical objects known, from planets and comets in our own Solar System to quasars and galaxies billions of light-years away. NRAO operates major radio telescopes at Green Bank, West Virginia, at Socorro, New Mexico, and at ten telescope array sites spanning the U.S. from the Virgin Islands to Hawaii. NRAO's headquarters are in Charlottesville, Virginia. These federally funded, ground-based observing facilities for radio astronomy are available to any qualified astronomer, regardless of affiliation or nationality, on the basis of scientific peer-reviewed proposals.

Principal Scientific Goals: NRAO supports and advances basic research in the astronomical sciences, including understanding: the geometry and the matter content of the universe; the formation of galaxies, stars and planets; and the nature of black holes.

Principal Education Goals: NRAO supports and enhances the education of undergraduate and graduate student researchers and outreach training for K-12 teachers. The primary education goal is to support the development of a scientifically and technically literate society through a comprehensive outreach program in which information about radio astronomy is made available to the public through the world-wide web and news media. NRAO sites support visitor/education centers; and educational programs are developed in partnership with other institutions. NRAO also supports undergraduate, graduate and post-doctoral students in radio-astronomy scientific research, the design, construction, test and implementation of innovative scientific instruments and telescopes for radio-astronomy and of software tools for the scientific data analysis and for the interpretation of radio-astronomical data.

Partnerships and Connections to Industry: To make the observations needed to sustain radio astronomy research, 2000 scientists from over 150 institutions around the world partner with NRAO. Numerous other U.S. universities, NASA, foreign scientific and technical institutes and industrial vendors are also partners. The development of new telescopes, instrumentation, and sensor techniques is completed in partnership with relevant industry, through competitive subawards to various large and small aerospace companies, radio antenna manufacturing firms, and specialized electronics and computer software companies.

Management and Oversight: Management is through a cooperative agreement with Associated Universities Incorporated (AUI). The NRAO director reports to the President of AUI. Oversight is through detailed annual program plans and long range plans for NRAO, plus quarterly and annual reports. NSF has periodic reviews of AUI management by external committees. Ongoing oversight and evaluation is by an assigned NSF program director (AST/MPS) and by a standing external committee for NRAO.

Current Project Status: Cooperative agreements for continuing management and operations are for terms of five years. The current agreement expires on September 30, 2004. A recent management review led to the recommendation, approved by the National Science Board, that AUI continue as managing organization of NRAO during the period of the next cooperative agreement. The renewal proposal from AUI for operations of NRAO currently under review will form the basis of a new 5-year cooperative agreement. The NRAO is engaged currently in two construction projects: the Expanded Very Large Array (EVLA) and the international Atacama Large Millimeter Array (ALMA), a millimeter/submillimeter interferometer which was approved as a Major Research Equipment and Facilities Construction project by the National Science Board in winter 2001. NRAO is the U.S. implementing organization of the ALMA project. The FY 2005 Request for NRAO totals $47.41 million, a decrease of $7.57 million from the FY 2004 Estimate of $54.98 million, which included a one time funding increment for major repairs to the Green Bank telescope track structure and accelerated work on the EVLA.

Funding Profile: All funding for NRAO to date, excluding construction funding for ALMA, which is managed by NRAO, has been provided through the R&RA Account.

NRAO Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994		$29.00	$29.00
FY 1995		29.40	29.40
FY 1996		29.60	29.60
FY 1997		30.70	30.70
FY 1998		31.50	31.50
FY 1999		33.00	33.00
FY 2000		33.10	33.10
FY 2001	$5.00	47.10	52.10
FY 2002	5.00	35.43	40.43
FY 2003	5.00	40.33	45.33
FY 2004 Estimate[1]	9.34	45.64	54.98
FY 2005 Request	6.34	41.07	47.41
FY 2006 Estimate	5.00	41.50	46.50
FY 2007 Estimate	5.00	41.50	46.50
FY 2008 Estimate	4.32	41.50	45.82
FY 2009 Estimate	0.00	41.50	41.50

[1]The current cooperative agreement expires in FY 2004. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: All construction and commissioning of NRAO telescopes occurred before this reporting period. The Observatory is now engaged in a major upgrade to the 25-year-old Very Large Array (VLA) radio telescope located in Soccoro, NM, a project known as the Expanded Very Large Array (EVLA).

- Operations and Maintenance: Funding for management, operations and maintenance primarily maintains and utilizes existing facilities and develops new instrumentation for existing telescopes in support of research by the national astronomical community. Basic research by in-house staff is less than 5 percent of the total budget.

- ALMA operations: The funding profile for the ALMA activity includes early operations funding beginning in FY 2005 at $1.0 million. These additional funds are not explicitly included in the table above, but are expected to be part of the NRAO operating expenditures beginning in FY 2005.

Renewal or Termination: The current cooperative agreement expires in FY 2004. A renewal proposal from AUI for operations of NRAO will form the basis of a new 5-year cooperative agreement and funding amounts for FY 2005 and beyond will be determined through negotiation at that time.

Associated Research and Education Activities: NRAO conducts an active educational and public outreach program. The observatories host a combined total of approximately 50,000 visitors each year to the Green Bank and Very Large Array facilities, including school field trips for K-12 students. The Green Bank observatory recently completed the construction of a bunkhouse to house student groups on overnight trips. Observatory professional scientific and engineering staff also visit classrooms regularly to provide special instruction in the astronomical and radio sciences. Observational facilities are used by graduate students carrying out dissertation research and those on work experience programs and by undergraduate students participating in the REU program.

Science Support: In addition to the funding listed above, approximately $500,000 per year is provided in total from the Division of Elementary, Secondary and Information Education in EHR and the Program for Education and Special Programs in the Astronomy Division. A peer-review telescope allocation committee provides merit-based telescope time but no financial support. NSF does not provide individual investigator awards targeted specifically for use of NRAO. Many users are supported through NSF or NASA grants to pursue scientific programs that require use of NRAO.

National Center for Atmospheric Research (NCAR)

Project Description: National Center for Atmospheric Research (NCAR) is a federally-funded research and development center (FFRDC) serving a broad research community, including atmospheric scientists, as well as researchers in complementary areas of the environmental and geosciences. Facilities available to university, NCAR, and other researchers include a world-class supercomputing facility providing services well suited for the development, validation and execution of large computational models in the atmospheric, oceanic and related sciences. NCAR is also responsible for the curation, archiving and manipulation of large data sets and NCAR's aviation infrastructure provides research aircraft, which can be equipped with sensors to measure dynamic physical and chemical states of atmospheric phenomena at local, regional and global scales. In addition, airborne and portable ground-based radar systems are available for atmospheric research as are other surface sensing systems. NCAR operates the several facilities of the High Altitude Observatory (HAO), which are dedicated to the study of the sun, solar phenomena, space weather, and the responses of the upper atmosphere to the sun's output. As a NSF sponsored facility, NCAR is committed to the dissemination of newly discovered knowledge in all the above areas.

Principal Scientific Goals: As an internationally recognized center of excellence, NCAR scientific research programs include focus on the following areas: large-scale atmospheric and ocean dynamics that contribute to an understanding of the past and present climate processes and global climate change, including interactions with other of the Earth's environmental systems; global and regional atmospheric chemistry including atmospheric connections to geochemical and biogeochemical cycles; the variable nature of the Sun and the physics of the corona and their interaction with the earth's magnetic field; the physics of clouds, thunderstorms, precipitation formation, and the interactions and effects on larger-scale weather; and the examination of human society's impact on and response to global environmental change. In addition, NCAR provides fellowships, internships, workshops and colloquia for a complete range of visiting scientists to conduct research and interact with NCAR scientists.

Principal Education Goals: NCAR disseminates knowledge of the geosciences to the general public, K-12 schools, teachers and students, to undergraduate, and graduate institutions, to postdoctoral and career scientists and researchers, as well as to policy and decision-makers. One way this is achieved is through educational tours and exhibits reaching tens of thousands of people every year. Professional training courses, innovative and award-winning science education websites, as well as the directed activities of the Office of Education and Outreach, are further examples of how NSF's goal of integrating research and education is attained through NCAR activities.

Connections to Industry: NCAR works to develop new collaborations and partnerships with the private sector through directed research and technology transfer. These activities span improved capabilities for detecting, warning and forecasting mesoscale weather phenomena of economic and social importance to the private and public sectors to longer term economic consideration of climate change issues.

Partnerships: Research collaborations among NCAR staff and university colleagues are integral to its success as an institution, and as a focus and meeting point for the broader atmospheric and related sciences community. NCAR fosters and strongly supports these interactions through many approaches devised and refined over the course of 43 years. Notable recent examples include the community models, extensive collaboration with university partners (e.g., 538 peer-reviewed papers in FY 2003, which were co-authored by NCAR and university-based scientists), and extensive collaboration with non-academic scientists nationally and internationally.

Management and Oversight: NCAR is currently managed by the University Corporation for Atmospheric Research (UCAR), a university-governed and university-serving organization comprised of over 68 Ph.D. granting academic institutions, with NCAR as its major engine of basic and applied research. UCAR works in partnership with NSF, the university community, and its other research sponsors such as NASA, NOAA, DOE, EPA, and the FAA whenever such research collaboration enhances NCAR's basic NSF-supported research goals or facilities missions. NSF's Division of Atmospheric Sciences (GEO) along with Budget, Finance and Award Management (BFA), provide cognizant oversight of this facility via a cooperative agreement with the managing institution, UCAR.

Current Project Status: With the completion of a strategic plan "*NCAR as Integrator*," in FY 2001, NCAR embarked on plan to implement 27 strategic initiatives that collectively have a wide-ranging scientific scope. Examples include the water cycle across scales, biogeosciences, data assimilation, and undergraduate leadership workshops. In addition, NCAR is managing the acquisition of the Major Research Equipment and Facilities Construction (MREFC) project High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER). UCAR contracted with Gulfstream, Inc. and Lockheed-Martin to procure a modified G-V aircraft that should be ready for scientific operation in FY

2005. (For further information on the capabilities of HIAPER, see the MREFC chapter). In FY 2005, NSF requests funding of $84.52 million for NCAR, an increase of $1.25 million over the FY 2004 Estimate of $83.27 million.

Funding Profile: All funds for NCAR during this time frame have been provided through the R&RA Account.

NCAR Funding Profile
(Dollars in Millions)

	Implementation	Operations & Maintenance	Total, NSF
FY 1994	$0.85	$54.90	$55.75
FY 1995	3.95	59.60	63.55
FY 1996	3.90	59.50	63.40
FY 1997	3.88	59.30	63.18
FY 1998	3.42	60.30	63.72
FY 1999	7.47	64.10	71.57
FY 2000	7.50	64.70	72.20
FY 2001	7.53	70.50	78.03
FY 2002	3.75	73.84	77.59
FY 2003	4.50	75.77	80.27
FY 2004 Estimate[1]	4.61	78.66	83.27
FY 2005 Request	4.73	79.79	84.52
FY 2006 Estimate	4.85	82.80	87.65
FY 2007 Estimate	4.97	87.00	91.97
FY 2008 Estimate	5.00	90.80	95.80
FY 2009 Estimate	5.10	92.40	97.50

[1]The current cooperative agreement expires in FY 2008. Estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current usage and cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is included below.

- Implementation: In FY 1999-2003, a project to refurbish the Mesa Lab building located in Boulder, CO was funded and project tasks undertaken. The refurbishment included long-sought upgrades of various facets of NCAR's Mesa Lab facilities such as handicap accessibility, wiring systems, structural and utilities upgrades, and has been completed.

- Operations and Maintenance: This funding supports the operation of the NCAR facilities, including supercomputers, instrumented research aircraft and associated flight costs, and ground-based portable observing systems. Routine maintenance costs of the aircraft and facilities are also covered under this category. In addition, approximately half of the management, operations and maintenance amount is used to support science conducted by NCAR scientists.

Renewal or Termination: The management of NCAR will be competed before the end of the current cooperative agreement, September 30, 2008. In addition, a mid-award review of both science activities as well as management effectiveness will be performed. Future funding levels beyond FY 2005 will be dependent on the outcome of those reviews and on the continuous oversight provided by NSF. Proposals for the next funding award, beyond FY 2008, will be subject to NSF's standard merit review procedures, and will be reviewed by both individual expert reviewers as well as a focus panel composed of preeminent researchers and managers

Associated Research and Education Activities: NCAR employs a large number of scientists who pursue research objectives individually and in groups. In addition, numerous external researchers use NCAR facilities to further their research objectives. NCAR has recently created an expanded and updated visitor area where various hands-on displays for K-12 when school-children or citizens come to visit the Mesa Laboratory. Lectures and demonstrations are also provided for visiting students and teachers. Teachers listed in the table below are those K-12 instructors coming to attend a workshop or bring students to learn about atmospheric sciences. Undergraduate and graduate students are those who arrive at NCAR for a temporary stay to do specific research that usually lasts three months to a year or two at most.

Direct Impact of NCAR's Participation in Education Activities

Year	K-12	Undergrad	Graduate	Teachers
FY 1994	3,799	*23*	*66*	108
FY 1995	8,477	*23*	*66*	100
FY 1996	5,926	*25*	*65*	47
FY 1997	7,067	*25*	*67*	32
FY 1998	7,063	*26*	*68*	264
FY 1999	9,569	*24*	*69*	90
FY 2000	9,894	*24*	*69*	92
FY 2001	8,995	23	63	101
FY 2002	9,424	*67*	*57*	865[a]
FY 2003	7,295[a,b]	*85*	*109*	815[a]

NOTE: *All numbers in italics are estimates.*

[a] The increased number of teachers in FY 2002 includes participants at a series of workshops.

[b] The decreased number in FY 2003 reflects partial closure of Mesa Lab facilities tours during refurbishment.

Science Support: NSF-supported researchers with grants totaling approximately $22.0 million per year used the aircraft and observational facilities operated by NCAR in FY 2003. This support comes from programs within the Atmospheric Sciences Subactivity for proposals submitted for use of the NSF aircraft, operated and maintained by NCAR, during field campaigns. Additional use of NCAR observational facilities by other NSF-funded activities such as oceanography and polar programs, along with NSF wide priority areas such as Biocomplexity in the Environment, also contribute to this support. NSF-supported researchers with grants totaling approximately $30.0 million per year used the computational resources of NCAR for a wide range of modeling, simulation and data assimilation tasks. Many principal investigators additionally request computing time at the NCAR facility to accomplish analyses required to evaluate results from their completed field and observational work.

Science and Technology Policy Institute (STPI)

The Science and Technology Policy Institute (STPI), a federally funded research and development center (FFRDC), provides analytical support to the Office of Science and Technology Policy (OSTP) to identify near-term and long-term objectives for research and development, and identifies options for achieving those objectives. NSF is requesting $4.0 million in FY 2005, an increase of $20,000 over the FY 2004 Estimate, which includes $1.0 million for database activities in support of STPI operations.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION PROJECTS

The MREFC Account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Projects supported by this account are intended to extend the boundaries of technology and open new avenues for discovery for the science and engineering community. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) and Education and Human Resources (EHR) Accounts.

The National Science Board (NSB) reviews and approves potential MREFC projects for inclusion in future budget requests. The NSF Director, after discussion with OMB, then selects from the group of NSB-approved projects those appropriate for inclusion in a budget request to the Congress. Funding is requested in this Budget Request for all projects approved by the NSB to date. In FY 2005, funding is requested for the highest priority items, the ongoing projects identified in the following table, and for three new starts. In addition, a further two new starts are requested in FY 2006. In priority order, these new projects are:

- National Ecological Observatory Network ($12.0 million in FY 2005)
- Scientific Ocean Drilling Vessel ($40.85 million in FY 2005)
- Rare Symmetry Violating Processes ($30.0 million in FY 2005)
- Ocean Observatories ($24.76 million in FY 2006)
- Alaska Regional Research Vessel ($49.32 million in FY 2006)

A total of $213.27 million is requested in FY 2005, an increase of $58.30 million over the FY 2004 Estimate, to support three ongoing projects, and three new starts. Additional information on these projects, and the later year starts can be found in the MREFC chapter.

MREFC Funding
(Dollars in Millions)

Projects[1]	FY 2003[2] Actual	FY 2004 Estimate	FY 2005 Request
Atacama Large Millimeter Array Construction	29.81	50.70	49.67
EarthScope: USArray, SAFOD, PBO	29.81	43.24	47.35
High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER)	13.00		
IceCube Neutrino Observatory	25.75	41.75	33.40
Large Hadron Collider (LHC)	9.69		
Network for Earthquake Engineering Simulation (NEES)	13.47	8.05	
South Pole Station	12.69	1.29	
Terascale Computing Systems	44.83	9.94	
National Ecological Observatory Network (NEON)			12.00
Scientific Ocean Drilling Vessel (SODV)			40.85
Rare Symmetry Violating Processes (RSVP)			30.00
Total, Major Research Equipment and Facilities Construction (MREFC) Account	$179.03	$154.97	$213.27

Totals may not add due to rounding.
[1] Does not include funding provided for early concept and development or follow-on operations and maintenance. These funds are provided through the Research and Related Activities and Education and Human Resources Accounts.
[2]FY 2003 Actuals include $35.0 million in carryover from prior year appropriations for Terascale Computing Systems due to the NSB meeting schedule. The award was approved in October 2002, and the funds were subsequently obligated. $66.06 million appropriated in FY 2003 is carried over into FY 2004 for HIAPER ($12.53 million), the IceCube Neutrino Observatory ($3.67 million), the Large Hadron Collider ($33,819), the Polar Projects ($49.71 million) and Terascale Computing Systems ($107,959). This FY 2003 carryover will be reflected in the FY 2004 Current Plan.

- Atacama Large Millimeter Array (ALMA) Construction (Phase II) is the construction phase of the ALMA project, begun in FY 2002 and supported by international partnership through NSF. ALMA is planned as a millimeter wave interferometer made up of 64 12-meter antennas and will be an aperture-synthesis radio telescope operating in the wavelength range from 3 mm to 0.4 mm.

- EarthScope is planned as a distributed, multi-purpose geophysical instrument array that will make major advances in our knowledge and understanding of the structure and dynamics of the North American continent. The three components of the project are the USArray, the San Andreas Fault Observatory at Depth (SAFOD), and the Plate Boundary Observatory (PBO).

- IceCube is planned as an extension of the successful AMANDA project. It will be a neutrino observatory that uses one cubic kilometer of the Antarctic ice sheet as the detector medium. IceCube will open a new astronomical window, giving us hitherto unseen views of the most active and energetic astrophysical objects, and it will complement the existing and planned instruments funded by NSF, NASA and others.

- National Ecological Observatory Network (NEON) will be a continental scale research instrument consisting of 17 geographically distributed observatories, networked via state-of-the-art communications, for integrated studies to obtain a predictive understanding of the nation's environments.

- The Scientific Ocean Drilling Vessel (SODV) is support for the contracting, conversion, outfitting and acceptance trials of a deep-sea drilling vessel for long-term use in a new international scientific ocean drilling program.

- Rare Symmetry Violating Processes (RSVP) consists of two major experiments that will address new physics at the cutting-edge of the sensitivity frontier and represents an extraordinary opportunity to empower a large and growing community led by university-based groups to make major discoveries.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS – TOOLS

Cosmic Snapshots: NSF-supported astronomers and instruments reported the most detailed images of the oldest light emitted by the universe -- twice. Recent results from the Cosmic Background Imager in the Chilean desert (http://www.nsf.gov/od/lpa/news/02/pr0299.htm) and from the Arcminute Cosmology Bolometer Array Receiver (ACBAR) at the South Pole (http://www.nsf.gov/od/lpa/news/02/pr0241.htm) produced high-resolution images of the cosmic microwave background (CMB) radiation. Among other results, the images map the first tentative seeds of matter and energy that later evolved into clusters of hundreds of galaxies.

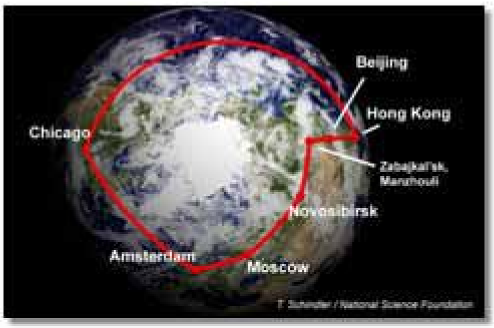
The Cosmic Background Imager consists of 13 radio antennas located on a plateau at 5,080 meters (16,700 feet) in Chile's Atacama Desert. *Credit: CBI/Caltech/NSF*

North Pole Environmental Observatory: In recent years, scientists have observed a rapid thinning of the sea ice that covers the Arctic Ocean as well as shifts in ocean circulation. These changes appear to be caused by an alteration in the atmospheric circulation of the Northern Hemisphere—known as the Arctic Oscillation—which is roughly centered at the North Pole. The Arctic Ocean circulation and the flowing of waters from the Arctic into the Greenland Sea affect the deep overturning circulation of the Atlantic Ocean and play an important role in regulating the Earth's climate. To better understand these changes and their implications for global climate, the National Science Foundation is supporting a five-year project, called the North Pole Environmental Observatory.

An oceanographic buoy deployed by Tim Stanton, of the Naval Postgraduate School, and others like it, will drift for a year in the Arctic Ocean, gathering data as part of NSF's North Pole Environmental Observatory. *Photo Credit: Peter West/NSF*

Principal Investigator James Morison, of the University of Washington, confers with a field technician about the retrieval of a deep-sea mooring at the National Science Foundation's North Pole Environmental Observatory. *Photo Credit: Peter West/NSF*

New Telescope is Born: The dream, now more than 40 years old, of constructing a radically different telescope has been realized by the innovative AMANDA-II project. Instead of sensing light, like all telescopes since the time of Galileo, AMANDA responds to a fundamental particle called a neutrino. Neutrino messengers provide a startlingly new view of the Universe. Members of the AMANDA team designed the first practical implementation of the generic ideas formulated many years ago, and re-introduced in late 80's with the twist of using Antarctic ice instead of water. Due to the remoteness of the site in Antarctica, they decided to minimize complexity of the design while recognizing that the simplest devices and system architectures were sufficient to answer the key questions. This concept proved highly effective. AMANDA is now an international collaboration involving institutions from the US, Germany, Sweden, Belgium, and Venezuela.

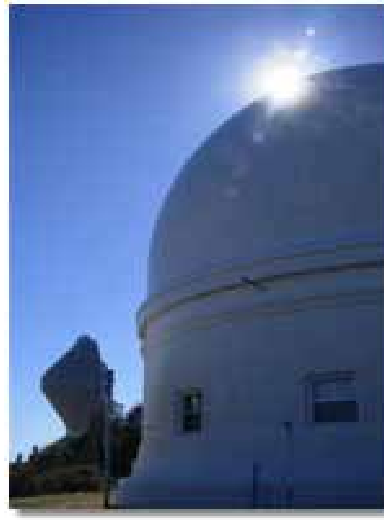


The Little GLORIAD network ring. This image shows the route of the Little GLORIAD network as it passes through Chicago, Amsterdam, Moscow, Novosibirsk, Zabajkal'sk, Manzhouli, Beijing and Hong Kong. *Credit: Trent L. Schindler/NSF*

United States, Russia, China Link Up First Global-Ring Network for Advanced Science and Education Cooperation. The National Science Foundation, a broad consortium of Russian ministries and science organizations and the Chinese Academy of Sciences have begun operations for the first round-the-world computer network ring, which will be used for joint scientific and educational projects. Known as Little GLORIAD, the ring "begins" in Chicago at the NSF-supported StarLight facility, managed by the University of Illinois at Chicago and Northwestern University. The network crosses the Atlantic Ocean to the NetherLight facility in Amsterdam from which it continues to Moscow, then to the Russian science city of Novosibirsk, across Siberia to the border at Zabajkal'sk. After crossing the border to Manzhouli, the network continues to Beijing, then Hong Kong and crosses the Pacific Ocean to complete the ring in Chicago. The new network will provide both increased reliability and flexibility for researchers as they address scientific issues including joint responses to natural and man-made disasters, safeguards for nuclear materials, better understanding of the human genome, joint exploration of space, distributed monitoring of seismic events and environmental studies and simulations. The network will also enable collaborations between universities and local schools, such as shared seminars, distance-learning programs and multi-national science fairs.

Development of a Lagrangian Balloon for Atmospheric Research. The objective of this project is to design and fly a new kind of balloon as a platform for atmospheric measurements. Atmospheric sounding by balloon-borne instruments has been practiced for nearly a century. Conventional meteorological balloons ascend relative to the air, measuring temperature, pressure, and humidity. They expand in size as they move to higher and higher altitudes, and eventually burst. Dr. Paul Voss is designing a different kind of balloon for atmospheric sounding -- one that can be controlled from the ground to reach a certain high altitude and from there on to float in equilibrium with the air around it, providing a "Lagrangian" frame of reference for measuring temperature, pressure, humidity, ozone, and other trace gases. These measurements are needed to understand the histories of air parcels as they undergo photochemical and cloud physical processes in the high atmosphere.

Wireless Network Boosts Supernova Search to Stellar First Year. Astrophysicist Greg Aldering and colleagues reported that their supernova factory project has discovered an unprecedented 34 new supernovae last year. The accomplishment would not have been possible without the National Science Foundation-supported high-performance wireless network link to Palomar Observatory. "This has been the best rookie year for any supernova search project," Aldering said. The Nearby Supernova Factory at Lawrence Berkeley National Laboratory, is seeking out 300 new exploding stars to be used as standard distance markers in future studies to measure the change in the universe's rate of expansion and thereby determine its dark energy content.



The Oschin Telescope dome at Caltech's Palomar Observatory, with adjacent HPWREN antenna. *Credit: High Performance Wireless Research and Education Network (HPWREN)*

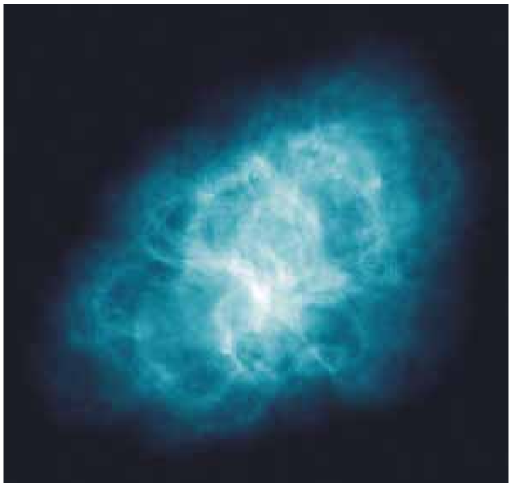
Breakthrough Brings Laser Light to New Regions of the Spectrum. Combining concepts from electromagnetic radiation research and fiber optics, researchers have created an extreme-ultraviolet, laser-like beam capable of producing tightly-focused light in a region of the electromagnetic spectrum not previously accessible to scientists. Between 10-100 times shorter than visible light waves, the extreme-ultraviolet (EUV) wavelengths will allow researchers to "see" tiny features and carve miniature patterns, with applications in such fields as microscopy, lithography and nanotechnology. The achievement is based on a new structure called a "waveguide," a hollow glass tube with internal humps that coax light waves into traveling along at the same speed and help the waves reinforce each other.

The waveguide as it appears within the femtosecond laser amplifier system. *Image courtesy of the University of Colorado.*

High-Performance Probes Developed at the National High Magnetic Field Laboratory. A unique capability of the NSF National High Magnetic Field Laboratory is to develop high-performance probes for nuclear magnetic resonance spectroscopy and imaging. These probes, which are used, for example, to study membrane proteins and materials chemistry under high magnetic fields, are not commercially available. Probes have been developed to support the NHMFL user programs in NMR studies of inorganic solids and for magnetic resonance imaging. More probes are in development for biological and inorganic solids. One such probe has been used to obtain spectra sensitive enough to resolve different valence states in a solid sample. Other probes used for solid-state NMR provide measurements over a wide temperature range for samples smaller than 5 mm. Still other probes have been developed for stray-field imaging. High-sensitivity cryoprobes for solution NMR experiments are in great demand, and probes are currently being developed for NMR at the highest fields available.

New South Pole Seismic Station Is One of World's Quietest and Most Sensitive. Data collected by a new seismic observatory at the National Science Foundation's Amundsen-Scott South Pole Station indicate that it is the quietest listening post on the planet for observing shudders produced by earthquakes around the world as they vibrate through the Earth. The South Pole Remote Earth Science Observatory is located eight kilometers (five miles) from the South Pole and the new seismometers have been installed roughly 300 meters (1000 feet) beneath the surface of the continental East Antarctic ice sheet in specially drilled boreholes. The newest station in the Global Seismograph Network is now recording some of the smallest vibrations on Earth, some as much as four times smaller than could previously be recorded in the frequencies that are crucial for monitoring earthquakes both in Antarctica and globally.

South Pole Station



VLA Image of Crab Nebula

Pulsar Bursts Coming From Beachball-Sized Structures. In a major breakthrough for understanding what one of them calls "the most exotic environment in the Universe," a team of astronomers has discovered that powerful radio bursts in pulsars are generated by structures as small as a beach ball. "These are by far the smallest objects ever detected outside our solar system," said Tim Hankins, leader of the research team, which studied the pulsar at the center of the Crab Nebula, more than 6,000 light-years from Earth. "The small size of these regions is inconsistent with all but one proposed theory for how the radio emission is generated," he added. Hankins was a visiting scientist at the NSF Arecibo Observatory in Puerto Rico at the time the pulsar observations were made. Pulsars, superdense neutron stars and the remnants of massive stars that exploded as supernovae, emit powerful beams of radio waves and light. As the neutron star spins, the beam sweeps through space like the beam of a lighthouse.

Flood Damage Data Reanalysis Project. Serious floods occur in the United States every year. The President declared more than twenty US flood-related disasters in 2002 alone. Damage estimates for floods can only be considered approximate, since no one agency in the United States has specific responsibility for collecting and evaluating detailed flood loss information. The National Weather Service (NWS) is the only organization that has maintained consistent long-term historical records of flood damage throughout the country. Mary Downton, Zoe Miller, and Roger Pielke, Jr. (Center for Science and Technology Policy Research, U. Colorado) have prepared a reanalysis of NWS flood damage estimates from 1926 to 2000. Objectives of the reanalysis were to (1) assemble a national database of historical flood damage, making it as complete and consistent as possible; (2) describe what the estimates represent; (3) evaluate the accuracy and consistency of the estimates; and (4) develop guidelines for use of the data and make it widely available to users. These data sets are available on an interactive website created by

ESIG at www.flooddamagedata.org. According to NWS estimates, damage from floods caused approximately $50 billion damage in the United States during the 1990s alone.

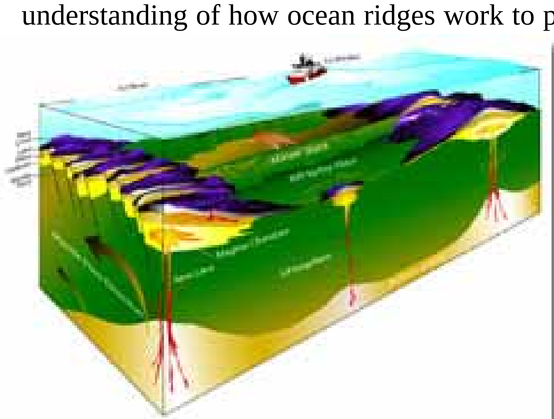
COPLINK: An Intelligent Workbench for Information Analysis and Visualization. This project initially explored different information analysis and visualization techniques for collaborative work and Web analysis using an agent approach to build personalized and collaborative tools. These techniques appeared to be both suitable and promising for applications in national security and law enforcement. Crime analysts and detectives need to analyze large sets of data to investigate criminal and terrorist activities. Software agents can monitor criminal activities and alert detectives through email, voice message, or cellular phone as soon as suspicious changes occur in databases. The ongoing COPLINK project at the University of Arizona and the Tucson Police Department can leverage these techniques in future development. The COPLINK system is designed to allow diverse police departments to share data seamlessly through simple interface, and reveals various criminal associations among police databases.

Scientists Discover Effects from Rapid, Global Climate and Ocean Changes of the Past. An international team of marine geologists has recently completed an expedition to an area off the coast of Surinam known as the Demerara Rise. The scientists were part of the NSF-supported Ocean Drilling Program (ODP) expedition in the equatorial Atlantic Ocean. The project studied periods in Earth's history that have undergone rapid climate and ocean circulation changes and likely led to mass extinctions of plants and animals.

Scientists brought up sediment cores that show other periods of dramatic change in Earth's history. In these sediments are well-preserved intervals of the Cretaceous/Tertiary boundary. At that time, some 65 million years ago, a huge asteroid or comet crashed into the Earth.

Using equipment like the drill pictured here, workers obtain geologic samples from the deep seafloor that provide scientists with new information on Earth's history. Examples of information documented by these samples include a history of the ocean basins and evidence of drastically changing climates on earth, including more ice ages than were previously known. *Photo Credit: Texas A&M*

Gakkel Ridge. The discovery that an ocean ridge under the Arctic ice cap is unexpectedly volcanically active and contains multiple hydrothermal vents may cause scientists to modify a decades-long understanding of how ocean ridges work to produce the Earth's crust. The new results, which come from a study of the Gakkel Ridge, one of the slowest spreading ridges on Earth, have broad implications for the understanding of the globe-encircling mid-ocean ridge system where melting of the underlying mantle creates the ocean floor.



This cross-section of the Gakkel Ridge as compiled by Henry Dick, co-chief scientist on the Arctic Mid-Ocean Ridge Expedition, contains a drawing of the USCGC Healy for scale. *Credit: Paul Oberlander /WHOI*

Organizational Excellence

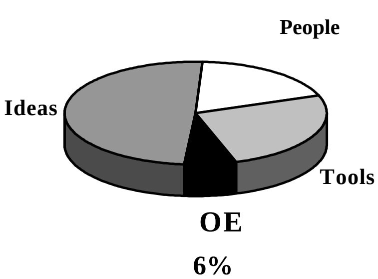
An agile, innovative organization that fulfills its mission through leadership and state-of-the-art business practices.

Summary of Organizational Excellence
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Human Capital	188.91	209.63	230.90	21.27	10.1%
Business Analysis	3.65	2.79	5.35	2.56	91.8%
Technology and Tools	46.50	60.94	112.74	51.80	85.0%
OIG	8.70	9.94	10.11	0.17	1.7%
NSB	2.88	3.88	3.95	0.07	1.8%
Total, Organizational Excellence	$250.63	$287.18	$363.05	$75.87	26.4%

Totals may not add due to rounding.

Organizational Excellence = $363.05 Million



Excellence in managing NSF's activities is an objective on par with the Foundation's mission-oriented outcome goals. It is critical for the achievement of all NSF goals. NSF's commitment to Organizational Excellence (OE) furthers its efforts under the President's Management Agenda and focuses on management challenges and reforms identified by OMB, GAO, the NSF Office of Inspector General, and through NSF's annual review of financial and administrative systems as required by the Federal Managers' Financial Integrity Act.

NSF's OE portfolio increases by 26.4 percent in FY 2005 to a total of $363.05 million, which represents 6 percent of the total NSF budget.

Organizational Excellence Long-Term Objectives: Three long-term objectives underlie NSF's Organizational Excellence goal: Human Capital, Business Processes, and Technologies and Tools.

Human Capital – a diverse, agile, results oriented cadre of NSF knowledge workers committed to enabling the agency's mission and to constantly expanding their abilities to shape the agency's future.

Business Analysis – effective, efficient, strategically aligned business processes that integrate and capitalize on the agency's human capital and technology resources.

Technologies and Tools – flexible, reliable, state-of-the-art business tools and technologies designed to support the agency's mission, business processes, and customers.

Summary of Organizational Excellence by Function
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Human Capital					
Personnel Compensation & Benefits	128.46	138.69	145.95	7.26	5.2%
IPA and Program Support (including program-related travel)	49.64	54.66	54.99	0.33	0.6%
Management of Human Capital	2.69	3.55	15.70	12.15	342.3%
Operating Expenses	3.80	6.68	7.00	0.32	4.8%
Travel	4.32	6.05	7.26	1.21	20.0%
Subtotal, Human Capital	188.91	209.63	230.90	21.27	10.1%
Business Analysis	3.65	2.79	5.35	2.56	91.8%
Technology and Tools					
Information Technology	24.36	37.18	84.29	47.11	126.7%
Space Rental	17.10	18.20	19.30	1.10	6.0%
Other Infrastructure	5.04	5.56	9.15	3.59	64.6%
Subtotal, Technology and Tools	$46.50	$60.94	$112.74	51.80	85.0%
Office of the Inspector General	8.70	9.94	10.11	0.17	1.7%
Office of the National Science Board	2.88	3.88	3.95	0.07	1.8%
Total, Organizational Excellence	$250.63	$287.18	$363.05	75.87	26.4%

Totals may not add due to rounding.

NSF Workforce
(Full-Time Equivalents (FTE))

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
NSF S&E -- Regular	1,146	1,200	1,225	25	2.1%
NSF S&E -- Student	32	24	24	0	0.0%
Office of the Inspector General[1]	55	60	60	0	0.0%
National Science Board[2]	9	12	12	0	0.0%
Arctic Research Commission[3]	4	4	4	0	0.0%
Subtotal, FTE	1,246	1,300	1,325	25	1.9%
IPA[4]	142	170	170	0	0.0%
Detailees to NSF	6	5	5	0	0.0%
Contractors Performing Admn. Functions	191	210	210	0	0.0%
Total, Workforce	1,585	1,685	1,710	25	1.5%

[1]The Office of Inspector General is described in a separate section of the justification and is funded through a separate appropriation.
[2]The National Science Board is described in a separate section of the justification and is funded through a separate appropriation.
[3]The Arctic Research Commission is described and funded in the Research and Related Activities section of the justification under Polar Programs.
[4]Intergovernmental Personnel Act (IPAs) are described in the Organizational Excellence section and are funded through the Research and Related Activities and Education Human Resources Appropriations accounts.

FY 2005 Annual Performance Goal for Organizational Excellence: NSF will demonstrate significant achievement for the majority of the following performance indicators related to the *Organizational Excellence* outcome goal:

- Operate a credible, efficient merit review system.
- Utilize and sustain broad access to new and emerging technologies for business application.
- Develop a diverse, capable, motivated staff that operates with efficiency and integrity.
- Develop and use performance assessment tools and measures to provide an environment of continuous improvement in NSF's intellectual investments as well as its management effectiveness.

Comparison to FY 2004 Goal: This is a new performance goal for FY 2005 that will also be evaluated for FY 2004. It was developed based on the updated NSF Strategic Plan FY 2003 through FY 2008.

Means and Strategies for Success:

The means and strategies NSF uses to successfully achieve Organizational Excellence include:

- Support for the NSF Academy. Enabling the future of NSF by inspiring a culture of learning, the NSF Academy is committed to ensuring the highest level of achievement for all NSF staff by providing continuous learning opportunities through a variety of educational venues in support of the agency's mission. The Academy will expand in the areas of e-business courses, NSF's blended learning portfolio, new employee orientation and career development activities.

- External input through the Business and Operations Advisory Committee. The committee includes leading officials in research administration, education management, information technology, and public administration. The Committee is charged with providing advice on issues related to NSF's business practices and operations, including innovative approaches to the achievement of NSF's strategic goals.
- Evaluation through the Advisory Committee for GPRA Performance Assessment. NSF determined that a more efficient and effective process for the assessment of agency performance with respect to strategic goals was to charge a single external committee of experts with review of all Foundation accomplishments. The Committee is comprised of about 18-25 independent external experts representing academia, industry, and government.

- Findings and Recommendations from the NSF Business Analysis. The Business Analysis is central to NSF's overall framework for long-term investments in OE. The analysis focuses on how NSF can best respond to such challenges as managing a portfolio that is growing in both size and complexity and becoming a fully integrated organization capable of working both within and across boundaries – be they disciplinary, sectoral, institutional, or international. The analysis also addresses key underlying issues raised in the President's Management Agenda and to government-wide issues identified by the Government Accounting Office.
- Implementation of the new Strategic Human Capital Initiatives. These initiatives include recruitment, outreach, and accountability.

- Employment of next-generation technology. NSF is continuing to re-engineer internal processes to implement technology-enabled solutions for the future.

- Improved monitoring and oversight through increased funding for travel. These capabilities include additional management and oversight activities, such as site visits to major facilities, as well as increased outreach, participation in science and engineering workshops, and staff training.

Resources Required: This goal can be achieved with NSF's requested FY 2005 staff and budgetary resources, as outlined later in this chapter.

FY 2005 Annual Performance Goal – Time to Decision: For 70 percent of proposals, be able to inform applicants whether their proposals have been declined or recommended for funding within six months of deadline or target date, or receipt date, whichever is later.

Percent proposals processed within 6 mos of deadline/target date, or receipt date, whichever is later									
FY:	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Baseline	61%								
Goal			70%	70%	70%	70%	70%	70%	70%
Result		59%	58%	54%	62%	74%	77%	&	&

Means and Strategies for Success (Time to Decision):

- NSF initiated a series of staff brainstorming sessions on "time to decision" in order to identify effective practices related to timely processing of proposals. The results of these sessions have been widely disseminated throughout NSF.
- "Real-time" management reports to help staff pinpoint pending proposals in danger of exceeding the six-month processing goal were developed and are distributed monthly to NSF senior management.
- Some divisions have added "performance on prompt handling of proposals" to their performance evaluation criteria for Program Officers.
- Managers and staff throughout the Foundation are being recognized for efforts to improve timely processing of proposals and thereby reduce the time to decision.

NSF celebrates achieving the "time to decision" goal in FY 2002. Dr. Colwell is pictured here presenting an award to NSF staff.

- NSF staff continue to work towards shortening the award process time by making more effective use of electronic mechanisms in conducting reviews, working cooperatively to eliminate overloads and bottlenecks, and carefully tracking the stage of processing and age of all proposals.

Resources Required (Time to Decision): This goal can be achieved with NSF's requested FY 2005 staff and budgetary resources.

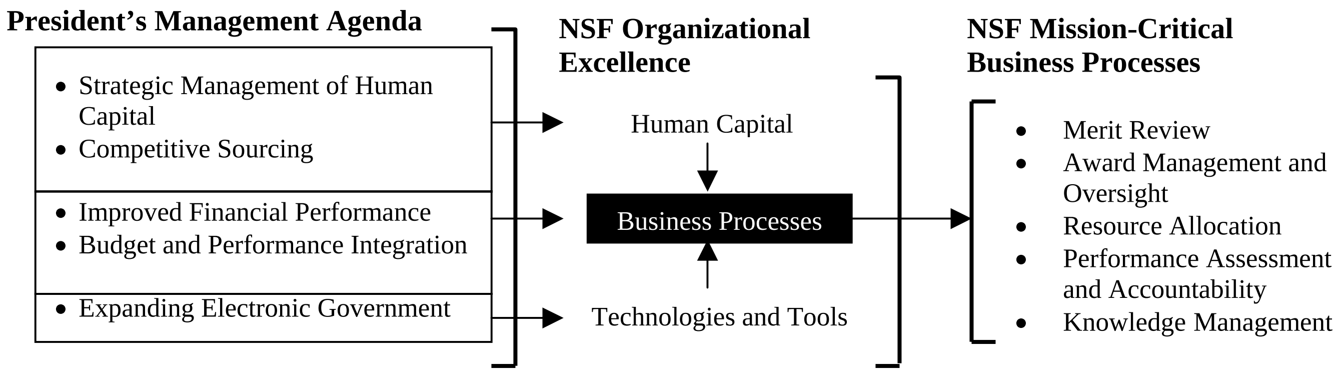
FY 2005 Investments in Organizational Excellence

Organizational Excellence (OE) is NSF's top investment priority for FY 2005. This will enable NSF to address the mounting pressures on staff and infrastructure brought on by the increased workload and the increasing complexity of the workload.

The National Science Foundation's commitment to OE parallels its leadership in advancing the frontiers of science and engineering research and education. The agency has a solid history of leveraging its agile, motivated workforce, mission-essential management processes, and state-of-the-art technological resources to promote the progress of science and engineering through investments in People, Ideas, Tools, and Organizational Excellence.

NSF's ongoing emphasis on Organizational Excellence relates directly to the President's Management Agenda (PMA), as illustrated below.

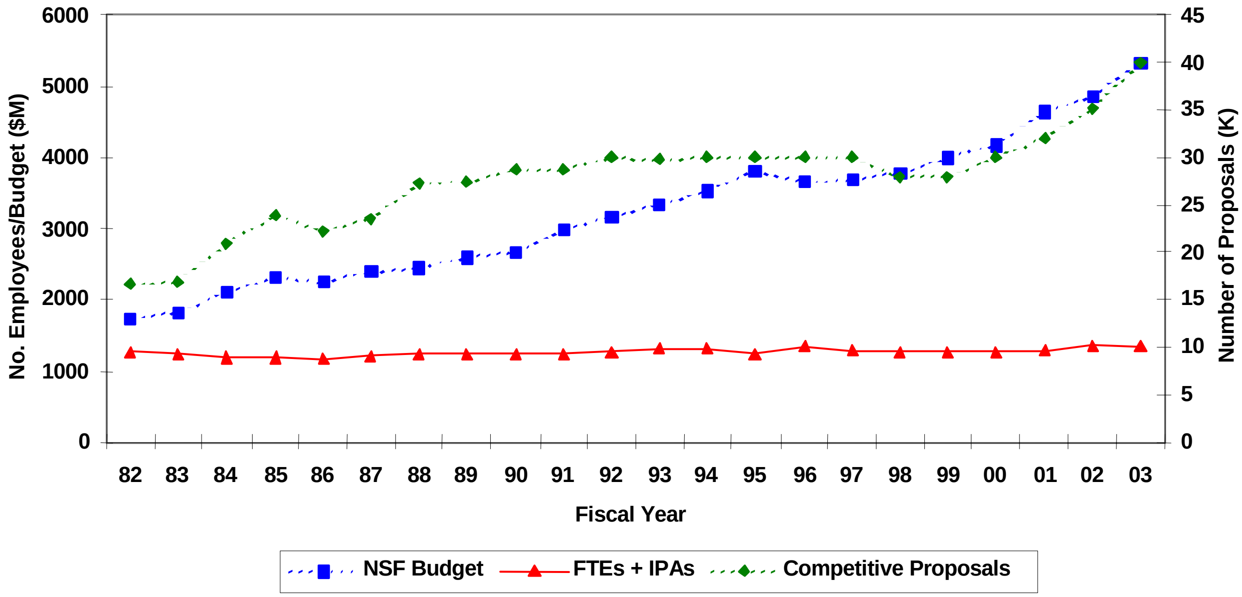
Relationship of PMA, NSF's Strategic Plan, and NSF Mission-Critical Business Processes



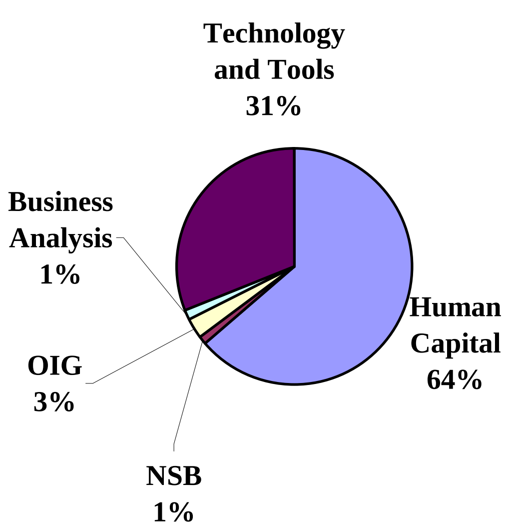
The FY 2005 request for Organizational Excellence is based on the framework established in the updated NSF Strategic Plan. **Human Capital** and **Technology and Tools** represent the two principal investment thrusts, which in turn enable NSF's **Business Processes.**

NSF began placing special emphasis on increasing funding for OE in FY 2003. As is shown in the graph below, over the last two decades, the number of proposals has doubled and the budget has tripled in constant dollars, while the staff has remained essentially level. It is essential to maintain this focus in FY 2005 and beyond in order to adequately provide the agency with resources needed to operate effectively.

Comparison of NSF Budget, Staff and Competitive Proposal Submissions over Time



FY 2005 Organizational Excellence Budget Request by Percentage



The Organizational Excellence Portfolio

The Foundation's Organizational Excellence activities are funded through five appropriations:

- **Salaries and Expenses** (S&E) increases by $75.30 million, or 34.4 percent, to $294.0 million in FY 2005. These resources include funding for personnel compensation and benefits, administrative travel, training, rent, IT-enabled business systems, administrative contractual services, supplies, equipment, and other operating expenses necessary for effective management of NSF's research and education activities.
- **Office of Inspector General** (OIG) increases by $170,000, or 1.7 percent, to $10.11 million in FY 2005. These resources include funding for personnel compensation and benefits, contract audits, training and operational travel, office supplies, materials, and equipment.
- **Office of the National Science Board** (NSB) increases by $70,000, or 1.8 percent, to $3.95 million in FY 2005. These resources include funding for personnel compensation and benefits, contract, training and operational travel, office supplies, materials, and equipment.
- Support costs funded in the **Program Accounts - Research and Related Activities** (R&RA) and **Education and Human Resources** (EHR) - increase by $330,000 to $54.99 million in FY 2005. These costs include funding for personnel appointments under the Intergovernmental Personnel Act (IPAs), administrative contracts, and requisitions that directly support programs. Support costs also include funding for Foundation-wide evaluation contracts of NSF priority area investments and other strategically significant programs.

Organizational Excellence by Appropriations
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Salaries and Expenses	194.45	224.70	300.00	75.30	33.5%
Less Reimbursements[1]	5.03	6.00	6.00	0.00	0.0%
Subtotal	189.42	218.70	294.00	75.30	34.4%
Office of Inspector General					
Appropriation	8.70	9.94	10.11	0.17	1.7%
Financial Statement Audit[2]	[0.83]	[0.80]	[0.81]	[0.01]	[1.25]
Office of the National Science Board	2.88	3.88	3.95	0.07	1.8%
Administrative Activities funded in					
R&RA Appropriation	37.55	39.29	41.62	2.33	5.9%
EHR Appropriation[3]	12.09	15.37	13.37	-2.00	-13.0%
Total	$250.63	$287.18	$363.05	$75.87	26.4%

Totals may not add due to rounding.

[1]NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. Reimbursements in the Salaries and Expenses Account are realized from administrative cost recoveries that are associated with these interagency agreements.

[2]Non-add funded from R&RA and EHR Appropriations and included in those estimates.

[3]Excludes OE expenses for H-1B Nonimmigrant Petitioner Receipts.

HIGHLIGHTS OF RECENT ACCOMPLISHMENTS - ORGANIZATIONAL EXCELLENCE

- NSF's "Evaluation Culture" Highlighted by the General Accounting Office (GAO). NSF's commitment to Organizational Excellence is greatly enhanced by the agency's tradition of seeking external advice and guidance. Two committees in particular - the Advisory Committee for Business and Operations and the Advisory Committee for GPRA Performance Assessment - have integral roles in areas related to OE, notably electronic government, human capital management, business processes, and assessment and evaluation. This tradition of routinely seeking outside advice and input was highlighted in the May 2003 GAO report, *Program Evaluation: An Evaluation Culture and Collaborative Partnerships Help Build Agency Capacity*. GAO found that the NSF was one of five Federal agencies that foster an "evaluation culture - a commitment to self-examination, data quality, analytic expertise, and collaborative partnerships."

- NSF's exemplary performance was highlighted by receipt of the President's 2003 Award for Management Excellence for the Foundation's innovative electronic capabilities to solicit, receive, review, select, award, manage and report results on public research and education investments. The award recognizes NSF's successful FastLane system, an interactive, real-time, web-based system used by over 200,000 scientists, educators, technology experts and administrators, including the country's top researchers, to conduct business over the Internet. The award further recognizes NSF's leadership role in the Federal eGovernment initiatives that directly relate to NSF's science and engineering, research and education mission as well as supporting initiatives that affect all Federal agencies.

- Final Highlight - NSF continues to strive towards improving its systems to better serve the community. For example, in FY 2003 NSF improved its policies and systems to make it easier for researchers from all types of institutions to collaborate on research projects. In large part because of the improvements, NSF projects the number of projects that utilize researchers from multiple institutions to double by the end of fiscal year 2005.

TECHNICAL INFORMATION

FY 2005 Appropriation Language

National Science Foundation

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; and acquisition of aircraft; $4,452,310,000, of which not to exceed $350,000,000 shall remain available until expended for Polar research and operations support, and for reimbursement to other Federal agencies for operational and science support and logistical and other related activities for the United States Antarctic program; the balance to remain available until September 30, 2006; *Provided*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation.

EDUCATION AND HUMAN RESOURCES

For necessary expenses in carrying out science and engineering education and human resources programs and activities pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109, and rental of conference rooms in the District of Columbia, $771,360,000, to remain available until September 30, 2006.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

For necessary expenses for the acquisition, construction, commissioning, and upgrading of major research equipment, facilities, and other such capital assets pursuant to the National Science Foundation Act of 1950, as amended, including authorized travel, $213,270,000, to remain available until expended.

SALARIES AND EXPENSES

For salaries and expenses necessary in carrying out the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); services authorized by 5 U.S.C. 3109; hire of passenger motor vehicles; not to exceed $9,000 for official reception and representation expenses; uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; rental of conference rooms in the District of Columbia; and reimbursement of the General Services Administration for security guard services; $294,000,000: *Provided*, That contracts may be entered into under “Salaries and Expenses” in fiscal year 2005 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General as authorized by the Inspector General Act of 1978, as amended $10,110,000, to remain available until September 30, 2006.

OFFICE OF THE NATIONAL SCIENCE BOARD

For necessary expenses (including payment of salaries, authorized travel, hire of passenger motor vehicles, the rental of conference rooms in the District of Columbia, and the employment of experts and consultants under section 3109 of title 5, United States Code) involved in carrying out section 4 of the

National Science Foundation Act of 1950 and Public Law 86-209, $3,950,000: Provided, That not more than $9,000 shall be available for official reception and representation expenses.

SUMMARY OF FY 2005 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN THOUSANDS)

	FY 2003 APPROPRIATION	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
RESEARCH AND RELATED ACTIVITIES					
Biological Sciences	$570,490	$586,890	$599,930	$13,040	2.2%
Computer and Information Science and Engineering	589,291	604,650	618,050	13,400	2.2%
Engineering	541,702	565,130	575,900	10,770	1.9%
Geosciences	691,836	713,100	728,500	15,400	2.2%
Mathematical and Physical Sciences	1,040,697	1,091,510	1,115,500	23,990	2.2%
Social, Behavioral and Economic Sciences	198,599	203,790	224,710	20,920	10.3%
Office of International Science and Engineering [1]	39,073	28,120	34,040	5,920	21.1%
U.S. Polar Research Programs	255,407	274,080	281,660	7,580	2.8%
U.S. Antarctic Logistical Support Activities	68,552	68,070	68,070	0	0.0%
Integrative Activities	97,859	144,140	239,990	95,850	66.5%
Subtotal R&RA	$4,054,433	$4,251,360	$4,452,310	$206,870	4.9%
Unobligated Balance Available Start of Year	-3,015				
Unobligated Balance Available End of Year	28,422				
Recoveries of Prior Year Obligations	-12,593				
Adjustments to Prior Year Accounts	5				
Unobligated Balance Lapsing	2,036				
Reduction Pursuant to P.L. 108-7	26,540				
Subtotal R&RA	$4,095,828	$4,251,360	$4,452,310	$206,870	4.9%
Transferred from other funds	(12,828)				
Appropriation Total	$4,083,000	$4,251,360	$4,452,310	$206,870	4.9%
EDUCATION AND HUMAN RESOURCES					
Math and Science Partnerships	$144,070	$139,170	$0	-139,170	-100.0%
EPSCoR	89,210	94,440	84,000	-10,440	-11.1%
Elementary, Secondary and Informal Education	223,300	212,260	172,750	-39,510	-18.6%
Undergraduate Education	172,550	155,500	158,850	3,350	2.2%
Graduate Education	139,500	155,950	173,880	17,930	11.5%
Human Resource Development	99,480	115,850	107,940	-7,910	-6.8%
Research, Evaluation and Communication	66,770	65,810	73,940	8,130	12.4%
Subtotal EHR	$934,879	$938,980	$771,360	-$167,620	-17.9%
H-1B Nonimmigrant Petitioner Receipts	46,571	0	0	0	0.0%
Subtotal EHR	$981,450	$938,980	$771,360	-167,620	-17.9%
Unobligated Balance Available Start of Year	-29,198				
Unobligated Balance Available End of Year	5,001				
Recoveries of Prior Year Obligations	-8,550				
Adjustments to Prior Year Accounts	-10				
Unobligated Balance Lapsing	1,049				
H-1B Nonimmigrant Petitioner Receipts	-46,571	0	0	0	0.0%
Reduction Pursuant to P.L. 108-7	5,909				
Appropriation Total	$909,080	$938,980	$771,360	-$167,620	-17.9%

SUMMARY OF FY 2005 BUDGET BY APPROPRIATION AND ACTIVITY

(DOLLARS IN THOUSANDS)

	FY 2003 APPROPRIATION	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
MAJOR RESEARCH EQUIPMENT & FACILITIES CONSTRUCTION	$179,029	$154,970	$213,270	$58,300	37.6%
Unobligated Balance Available Start of Year	-96,551				
Unobligated Balance Available End of Year	66,108				
Recoveries of Prior Year Obligations	-48				
Adjustments to Prior Year Accounts	0				
Reduction Pursuant to P.L. 108-7	972				
Appropriation Total	$149,510	$154,970	$213,270	$58,300	37.6%
SALARIES AND EXPENSES [1]	$189,423	$218,700	$294,000	$75,300	34.4%
Unobligated Balance Available Start of Year	0				
Unobligated Balance Available End of Year	0				
Adjustments to Prior Year Accounts	0				
Unobligated Balance Lapsing	7				
Reduction Pursuant to P.L. 108-7	1,237				
Subtotal, S&E	$190,667	$218,700	$294,000	$75,300	34.4%
Transferred from other funds	-315				
Appropriation Total	$190,352	$218,700	$294,000	$75,300	34.4%
NATIONAL SCIENCE BOARD	$2,876	$3,880	$3,950	$70	1.8%
Unobligated Balanced Available Start of Year	0				
Unobligated Balanced Available End of Year	0				
Recoveries of Prior Year Obligations	0				
Adjustments to Prior Year Accounts	0				
Unobligated Balance Lapsing	601				
Reduction Pursuant to P.L. 108-7	23				
Appropriation Total	$3,500	$3,880	$3,950	$70	1.8%
OFFICE OF INSPECTOR GENERAL	$8,697	$9,940	$10,110	$170	1.7%
Unobligated Balanced Available Start of Year	-137				
Unobligated Balanced Available End of Year	646				
Recoveries of Prior Year Obligations	-27				
Adjustments to Prior Year Accounts	0				
Unobligated Balance Lapsing	11				
Reduction Pursuant to P.L. 108-7	60				
Appropriation Total	$9,250	$9,940	$10,110	$170	1.7%
TOTAL, NATIONAL SCIENCE FOUNDATION	$5,344,693	$5,577,830	$5,745,000	$173,090	3.1%

Totals may not add due to rounding.

[1] FY 2003 includes an Appropriations Transfer from the Department of State in the amount of $13.14 million for an award to the U.S. Civilian Research and Development Foundation.

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
BIOLOGICAL SCIENCES					
MOLECULAR AND CELLULAR BIOSCIENCES					
Molecular & Cellular Biosciences Research	$121,891	$121,770	$124,980	$3,210	2.6%
Total	121,891	121,770	124,980	3,210	2.6%
INTEGRATIVE BIOLOGY AND NEUROSCIENCE					
Integrative Biology & Neuroscience Research	107,470	107,410	110,630	3,220	3.0%
Total	107,470	107,410	110,630	3,220	3.0%
ENVIRONMENTAL BIOLOGY					
Environmental Biology Research	108,276	108,260	111,480	3,220	3.0%
Total	108,276	108,260	111,480	3,220	3.0%
BIOLOGICAL INFRASTRUCTURE					
Research Resources	42,410	48,630	51,380	2,750	5.7%
Human Resources	32,620	31,590	34,090	2,500	7.9%
Total	75,030	80,220	85,470	5,250	6.5%
EMERGING FRONTIERS					
Emerging Frontiers	73,373	79,760	77,900	-1,860	-2.3%
Total	73,373	79,760	77,900	-1,860	-2.3%
PLANT GENOME RESEARCH					
Plant Genome Research	84,450	89,470	89,470	0	0.0%
Total	84,450	89,470	89,470	0	0.0%
Total, BIO	$570,490	$586,890	$599,930	$13,040	2.2%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING					
COMPUTER & NETWORK SYSTEMS					
Computer & Network Systems	$117,150	$114,930	$132,390	$17,460	15.2%
Total	117,150	114,930	132,390	17,460	15.2%
COMPUTING & COMMUNICATION FOUNDATIONS					
Computing & Communication Foundations	81,150	78,930	91,410	12,480	15.8%
Total	81,150	78,930	91,410	12,480	15.8%
INFORMATION & INTELLIGENT SYSTEMS					
Information & Intelligent Systems	82,150	80,050	92,540	12,490	15.6%
Total	82,150	80,050	92,540	12,490	15.6%
SHARED CYBERINFRASTRUCTURE					
Shared Cyberinfrastructure	95,071	112,630	123,600	10,970	9.7%
Total	95,071	112,630	123,600	10,970	9.7%
INFORMATION TECHNOLOGY RESEARCH (ITR)					
Information Technology Research (ITR)	213,770	218,110	178,110	-40,000	-18.3%
Total	213,770	218,110	178,110	-40,000	-18.3%
Total, CISE	$589,291	$604,650	$618,050	$13,400	2.2%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
ENGINEERING					
BIOENGINEERING AND ENVIRONMENTAL SYSTEMS					
Bioengineering and Environmental Systems	$49,452	$51,020	$49,770	-$1,250	-2.5%
Total	49,452	51,020	49,770	-1,250	-2.5%
CHEMICAL AND TRANSPORT SYSTEMS					
Chemical and Transport Systems	68,331	68,920	67,210	-1,710	-2.5%
Total	68,331	68,920	67,210	-1,710	-2.5%
CIVIL AND MECHANICAL SYSTEMS					
Civil and Mechanical Systems	63,229	67,170	85,510	18,340	27.3%
Total	63,229	67,170	85,510	18,340	27.3%
DESIGN, MANUFACTURE, AND INDUSTRIAL INNOVATION					
Design, Manufacture, and Industrial Innovation	64,000	65,810	65,880	70	0.1%
Small Business-Industrial Innovation	90,923	103,590	104,090	500	0.5%
Total	154,923	169,400	169,970	570	0.3%
ELECTRICAL AND COMMUNICATIONS SYSTEMS					
Electrical and Communications Systems	73,046	74,580	72,730	-1,850	-2.5%
Total	73,046	74,580	72,730	-1,850	-2.5%
ENGINEERING EDUCATION AND CENTERS					
Engineering Education and Centers	132,722	134,040	130,710	-3,330	-2.5%
Total	132,722	134,040	130,710	-3,330	-2.5%
Total, ENG	$541,702	$565,130	$575,900	$10,770	1.9%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
<u>GEOSCIENCES</u>					
ATMOSPHERIC SCIENCES					
Atmospheric Sciences Research Support	$147,943	$156,780	$160,130	$3,350	2.1%
National Center for Atmospheric Research	83,348	82,000	83,500	1,500	1.8%
Total	231,291	238,780	243,630	4,850	2.0%
EARTH SCIENCES					
Earth Sciences Project Support	115,378	119,580	122,610	3,030	2.5%
Instrumentation and Facilities	31,937	32,000	33,000	1,000	3.1%
Total	147,315	151,580	155,610	4,030	2.7%
OCEAN SCIENCES					
Ocean Section	117,980	120,450	120,450	0	0.0%
Integrative Programs Section	110,260	118,080	120,240	2,160	1.8%
Marine Geosciences Section	84,980	84,210	88,570	4,360	5.2%
Total	313,230	322,740	329,260	6,520	2.0%
Total, GEO	$691,836	$713,100	$728,500	$15,400	2.2%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
MATHEMATICAL AND PHYSICAL SCIENCES					
ASTRONOMICAL SCIENCES					
Astronomical Sciences	$187,074	$196,550	$204,350	$7,800	4.0%
Total	187,074	196,550	204,350	7,800	4.0%
CHEMISTRY					
Chemistry	181,609	185,220	188,910	3,690	2.0%
Total	181,609	185,220	188,910	3,690	2.0%
MATERIALS RESEARCH					
Materials Research	241,386	250,890	253,180	2,290	0.9%
Total	241,386	250,890	253,180	2,290	0.9%
MATHEMATICAL SCIENCES					
Mathematical Sciences	178,785	200,410	202,250	1,840	0.9%
Total	178,785	200,410	202,250	1,840	0.9%
PHYSICS					
Physics	224,502	227,670	235,760	8,090	3.6%
Total	224,502	227,670	235,760	8,090	3.6%
MULTIDISCIPLINARY ACTIVITIES					
Research Project Support	27,341	30,770	31,050	280	0.9%
Total	27,341	30,770	31,050	280	0.9%
Total, MPS	$1,040,697	$1,091,510	$1,115,500	$23,990	2.2%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES					
SOCIAL AND ECONOMIC SCIENCES					
Social and Economic Sciences	$71,007	$81,020	$88,520	$7,500	9.3%
Total	71,007	81,020	88,520	7,500	9.3%
BEHAVIORAL AND COGNITIVE SCIENCES					
Behavioral and Cognitive Sciences	62,315	68,500	76,000	7,500	10.9%
Total	62,315	68,500	76,000	7,500	10.9%
SCIENCE RESOURCES STATISTICS					
Science Resource Statistics	25,305	26,150	26,150	0	0.0%
Total	25,305	26,150	26,150	0	0.0%
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING[1]					
Office of International Science and Engineering	39,973	28,120	34,040	5,920	21.1%
Total	39,973	28,120	34,040	5,920	21.1%
Total, SBE	$198,599	$203,790	$224,710	$20,920	10.3%
UNITED STATES POLAR RESEARCH PROGRAMS	$255,407	$274,080	$281,660	$7,580	2.8%
UNITED STATES ANTARCTIC LOGISTICAL SUPPORT ACTIVITIES	$68,552	$68,070	$68,070	$0	0.0%
INTEGRATIVE ACTIVITIES	$97,859	$144,140	$239,990	$95,850	66.5%
Total, RESEARCH AND RELATED ACTIVITIES	$4,054,433	$4,251,360	$4,452,310	$200,950	4.7%

[1] FY 2003 Actual includes a transfer of $12.83 million from the Department of State for an award to the U.S. Civilian Research and Development Foundation.

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
EDUCATION AND HUMAN RESOURCES					
MATH & SCIENCE PARTNERSHIP					
Math & Science Partnership	144,070	139,170	0	-$139,170	-100.0%
Total	144,070	139,170	0	-139,170	-100.0%
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)					
Experimental Program to Stimulate Competitive Research (EPSCoR)	89,210	94,440	84,000	-10,440	-11.1%
Total	89,210	94,440	84,000	-10,440	-11.1%
ELEMENTARY, SECONDARY AND INFORMAL SCIENCE EDUCATION [1]					
Instructional and Assessment Materials Development	28,780	28,820	29,450	630	2.2%
Teacher & Student Development	134,080	121,310	93,300	-28,010	-23.1%
Informal Science Education	60,440	62,130	50,000	-12,130	-19.5%
Total	223,300	212,260	172,750	-39,510	-18.6%
UNDERGRADUATE EDUCATION					
Curriculum, Laboratory and Instructional Development	99,700	93,200	88,140	-5,060	-5.4%
Workforce Development	72,850	62,300	70,710	8,410	13.5%
Total	172,550	155,500	158,850	3,350	2.2%
GRADUATE EDUCATION					
Graduate Student Support	139,500	155,950	173,880	17,930	11.5%
Total	139,500	155,950	173,880	17,930	11.5%
HUMAN RESOURCE DEVELOPMENT					
Undergraduate/ Graduate Student Support	60,760	68,370	64,490	-3,880	-5.7%
Research & Education Infrastructure	22,740	32,330	28,300	-4,030	-12.5%
Opportunities for Women and Persons with Disabilities	15,980	15,150	15,150	0	0.0%
Total	99,480	115,850	107,940	-7,910	-6.8%
RESEARCH, EVALUATION AND COMMUNICATION					
Research	54,270	54,240	62,370	8,130	15.0%
Evaluation	12,500	11,570	11,570	0	0.0%
Total	66,770	65,810	73,940	8,130	12.4%
Total, EHR	$934,879	$938,980	$771,360	-$167,620	-17.9%

[1] FY 2003 Actual and FY 2004 Estimate have been restated for the purposes of the FY 2005 Budget Request to reflect all funds for the Teacher Professional Continuum (TPC) in the ESIE Subactivity, including those previously shown in DUE (FY 2003, $6.71 million; FY 2004 Estimate, $6.48 million).

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 ESTIMATE	FY 2005 REQUEST	CHANGE FY 2005 Req/FY 2004 Estimate AMOUNT	PERCENT
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$179,029	$154,970	$213,270	$58,300	37.6%
Total, MREFC	$179,029	$154,970	$213,270	$58,300	37.6%
SALARIES AND EXPENSES	$189,423	$218,700	$294,000	$75,300	34.4%
Total, S&E [1]	$189,423	$218,700	$294,000	$75,300	34.4%
NATIONAL SCIENCE BOARD	$2,876	$3,880	$3,950	$70	1.8%
Total, NSB	$2,876	$3,880	$3,950	$70	1.8%
OFFICE OF INSPECTOR GENERAL	$8,697	$9,940	$10,110	$170	1.7%
Total, OIG	$8,697	$9,940	$10,110	$170	1.7%
TOTAL, NATIONAL SCIENCE FOUNDATION	$5,369,338	$5,577,830	$5,745,000	$167,170	3.0%

Totals may not add due to rounding.

[1] FY 2003 includes an Appropriations Transfer from the Department of State in the amount of $13.14 million for an award to the U.S. Civilian Research and Development Foundation. ($12.83 million in SBE and $315,436 in S&E)

OBJECT CLASSIFICATION

NSF Consolidated Budget by Object Classification
(Includes All Appropriation Headings) [1]

Object Class Code	Standard Title	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
11.1	Full-time permanent	100	104	109
11.3	Other than fulltime permanent	7	7	7
11.5	Other personnel compensation	4	4	5
11.8	Special personal service payment	1	1	1
	Total personnel compensation	112	116	122
12.1	Civilian personnel benefits	25	32	33
21.0	Travel and transportation of persons	15	18	22
23.1	Rental payments to GSA	17	18	19
23.3	Communications, utilities, and miscellaneous charges	2	3	3
25.1	Advisory and assistance services	58	60	77
25.2	Other services	7	12	15
25.3	Purchases of goods and services from Government accounts	18	18	18
25.4	Operation and maintenance of facilities	180	180	180
25.5	Research and development contracts[2]	26	26	26
2.56	Medical Care	0	0	1
25.7	Operation and maintenance of facilities	9	10	43
26.0	Supplies and materials	3	3	3
31.0	Equipment	13	24	34
41.0	Grants, subsidies, and contributions	4,931	5,247	5,149
	Total, Direct obligations [3]	$5,416	$5,767	$5,745

Totals may not add due to rounding.
[1]Excludes obligations for the Donations Account.
[2]The funding pattern for research and development contracts varies in accordance with annual appropriations for construction of the South Pole Station within the Major Research Equipment and Facilities Construction (MREFC) account.
[3]Excludes carryover and includes H-1B Nonimmigrant Petitioner obligations.

REIMBURSABLE ACTIVITY

Reimbursements for the Research and Related Activities Appropriation and the Education and Human Resources Appropriation are realized from other federal agencies that have entered into interagency agreements with the Foundation. NSF enters into agreements (including Memoranda of Understanding) with other U.S. government agencies, as authorized by the NSF Act, 42 U.S.C. 1870 (c) and the Economy Act: 31 U.S.C. 1535, under which NSF assumes some responsibility for activities supported by these agencies. These activities can include jointly funded projects and programs, support of research operations and logistics, and access to NSF supported research facilities.

REIMBURSABLE AWARDS BY AGENCY

(Dollars in Millions)

DEPARTMENT/AGENCY	FY 2003
DEFENSE	
AIR FORCE	3.7
ARMY	5.5
Other DOD (DARPA, NSA & Intelligence Agency)	14.6
NAVY	2.0
SUBTOTAL, DOD	$25.8
ARMY CORP OF ENGINEERS	0.7
CIA	18.5
COMMERCE	6.0
EDUCATION	1.1
ENERGY	8.7
EPA	0.8
HEALTH & HUMAN SERVICES	22.6
HOMELAND SECURITY	0.8
HUD	0.9
NASA	15.2
TRANSPORTATION	0.7
STATE	0.5
OTHER (less than $500,000)	1.6
TOTAL REIMBURSEMENTS	**$103.9**

Totals may not add due to rounding.

Since the 1980s, the number of interagency agreements NSF handles has increased dramatically. This increase is indicative of the growth in the breadth and complexity of the Foundation's programmatic activity. Consistent with applicable legislation and GAO decisions, agreements include reimbursement for costs that are incurred in the management and administration of these awards.

In FY 2003 the largest portion of NSF's reimbursable activity came from joint activities with the Department of Defense, (24.8 percent) the Department of Health and Human Services (21.8 percent) and the Central Intelligence Agency (17.8 percent). Reimbursable activities with the Department of Defense were primarily for support of the Air Force's Advanced Electro-Optical System (AEOS) and Army's 4 Dimensional Weather System (4DWX). Reimbursable activities with the Department of Health and Human Services are for non-medical biological research such as the human frontiers science program and the protein data bank.

PERSONNEL SUMMARY

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Amount	Change Percent
Full-Time Equivalent Employment (FTE)	1,246	1,300	1,325	25	1.9%
Average GS Grade	10.75	10.67	10.80	0.13	1.2%
Average Salary	$84,797	$84,597	$87,158	$2,561	3.0%

DETAIL OF PERMANENT APPOINTMENTS

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Executive Level II	1	1	1
Executive Level III	1	1	1
Subtotal	2	2	2
ES-5	87	88	92
AD	289	282	300
GS/GM-15	72	82	84
GS/GM-14	85	92	94
GS/GM-13	115	102	104
GS-12	93	106	108
GS-11	49	55	55
GS-10	12	15	15
GS-9	78	77	77
GS-8	69	65	65
GS-7	132	127	127
GS-6	25	35	35
GS-5	4	24	24
GS-4	1	4	4
Subtotal	735	784	792
Total Permanent Appointments	1,113	1,156	1,186
FTE	1,246	1,300	1,325

EXPLANATION OF CARRYOVER FOR FY 2004

The National Science Foundation's total unobligated balance of $100.18 million from the FY 2003 Appropriation consists of amounts displayed below.

- Within the Research and Related Activities (RRA) appropriation $28.42 million was carried forward into FY 2004. Integrative Activities carried over $1.78 million for the Science and Technology Centers awards, and $17.68 million for the Science of Learning Centers (SLC). The Directorate for Social, Behavioral, and Economics Sciences (SBE) will manage the SLC awards. Under the SBE activity, $8.43 million was brought forward for funding of the Human and Social Dynamics awards. The remaining amounts are from several awards in various programs that were not ready for obligation in FY 2003.

- Within the Education and Human Resources (EHR) appropriation $5.00 million was carried forward into FY 2004 for funding of the Centers of Research Excellence in Science and Technology (CREST) awards.

- Within the Major Research Equipment and Facilities Construction (MREFC) appropriation $66.11 million was carried forward into FY 2004. This includes $53.38 million for the Office of Polar Programs (OPP) activity (i.e., $49.55 million for the South Pole Station Modernization, $115,000 for Polar Support Aircraft upgrades, and $44,216 for the South Pole Safety project, and $3.67 million for IceCube), and $12.54 million for the Geosciences (GEO) activity for the High-performance Instrumented Airborne Platform for Environmental Research (HIAPER).

- Within the Office of Inspector General appropriation a total of $645,872 was carried forward into FY 2004 to cover priority audits that are contracted out, fund contracts for financial analysis and other technical support for OIG investigations, provide OIG's share of the development costs of new space for the office, fund the final phase of a contract to upgrade OIG's knowledge management system, and protect the appropriation against unanticipated variations between obligations and expenditures.

Distribution of FY 2003 Carryover into FY 2004
(Dollars in Millions)

	FY 2004 Estimate	FY 2004 Carryover from FY 2003	Adjusted Total FY 2004 Estimate
Research and Related Activities	4,251.36	28.42	4,279.78
Education and Human Resources[1]	938.98	5.00	943.98
Major Research Equipment and Facilities Construction	154.97	66.11	221.08
Salaries and Expenses	218.70	-	218.70
National Science Board	3.88	-	3.88
Office of Inspector General	9.94	0.65	10.59
Total	5,577.83	100.18	5,678.01

Totals may not add due to rounding.
[1]Carryover excludes $83.90 million of H-1B Nonimmigrant Petitioner Fees.

NATIONAL SCIENCE FOUNDATION
FY 2005 CONGRESSIONAL REQUEST
FULL BUDGETARY COSTING

The tables below show two methods for allocating the full budgetary cost of the NSF FY 2005 Request. The first shows the full budgetary costs allocated to each of NSF's operating directorates. The second shows these costs allocated to three of NSF's strategic outcome goals: People, Ideas, and Tools. Organizational Excellence, NSF's fourth strategic goal encompasses the indirect costs to be allocated under full budgetary costing. These allocations represent initial steps, using readily available information, in NSF's plans to achieve the integration of budget, cost, and performance, consistent with the President's Management Agenda.

What is Full Budgetary Cost? OMB Circular A-11 defines "full-cost" as the sum of all budget resources used by an agency to achieve program outputs and outcomes. These include both *direct* program costs and *indirect* costs, which generally include administrative costs and other activities that are not directly attributable to a single program or activity. For two of NSF's appropriations, Research and Related Activities (R&RA) and Education and Human Resources (EHR), all funds are directly attributable to directorates and outcome goals. For NSF's other four appropriations, Major Research Equipment and Facilities Construction (MREFC), Salaries and Expenses (S&E), National Science Board (NSB), and the Office of Inspector General (OIG), the funds are distributed using the methodologies described below.

Allocation by Directorate

The current budget structure contains program activities within R&RA and EHR that equate to directorates. Therefore, R&RA and EHR funding is already aligned by directorate. MREFC funds projects that are managed by a particular NSF directorate. Therefore, each MREFC project can be directly associated with a particular directorate. In addition, each managing directorate is responsible for the initial planning, design and follow-on operations and maintenance costs that are funded R&RA. The MREFC program funds were assigned to the managing directorate responsible for oversight of a particular project. (Table 1)

All budget items funded through the S&E, NSB, and OIG appropriations accounts are defined as Organizational Excellence (OE) and are allocated to directorates. More than half of the S&E account can be precisely associated with an individual directorate. These S&E Direct budget items consist of distributed funding for travel, training, equipment, supplies, incentive awards and premium pay. Also, space rental and personnel compensation and benefits (PC&B) of employees in a particular directorate are attributed to that directorate in the financial accounting system.

Once S&E Direct budget items that are directly associated with a particular directorate have been assigned, then budget items associated with the Office of Information and Resource Management (IRM), Office of Budget, Finance and Awards Management (BFA), the staff offices in the Office of the Director (OD), NSB, and OIG are allocated. These S&E Indirect budget items are allocated to a particular directorate based on the proportion of the total FY 2005 Directorate Request. The FY 2005 NSB and OIG budgetary costs are assigned using the same methodology as the S&E Indirect costs total. (Table 1)

Allocations by Strategic Outcome Goal

The full budgetary costing by People, Ideas, and Tools (PIT) was derived by using the same methodology as stated above, except the Direct S&E budget items, Indirect S&E budget items, and total NSB and OIG funding were assigned using the PIT percentages for the applicable directorate. (Table 2)

FY 2005 FULL BUDGETARY COSTING

Table 1: Allocation of Major Research Equipment and Facilities Construction (MREFC), Salaries and Expenses (S&E), National Science Board (NSB), and the Office of Inspector General (OIG)
(Dollars in Thousands)

	BIO	CISE	ENG	GEO	MPS	SBE	OPP	IA	R&RA Total	EHR	TOTAL
FY 2005 CONGRESSIONAL REQUEST	**599,930**	**618,050**	**575,900**	**728,500**	**1,115,500**	**224,710**	**349,730**	**239,990**	**4,452,310**	**771,360**	**5,223,670**
MREFC											
Large Hadron Collider (LHC)									**-**	-	**-**
NEES			-						**-**	-	**-**
Terascale Computing Syst (TCS)									**-**	-	**-**
HIAPER				-					**-**	-	**-**
South Pole Station							-		**-**	-	**-**
Earth Scope				47,350					**47,350**	-	**47,350**
NEON	12,000								**12,000**	-	**12,000**
IceCube							33,400		**33,400**	-	**33,400**
ALMA					49,670				**49,670**	-	**49,670**
Ocean Drilling				40,850					**40,850**	-	**40,850**
RSVP					30,000				**30,000**	-	**30,000**
MREFC Subtotals	**12,000**	**-**	**-**	**88,200**	**79,670**	**-**	**33,400**	**-**	**213,270**	**-**	**213,270**
Total Directorate FY 2005 Request including MREFC	**611,930**	**618,050**	**575,900**	**816,700**	**1,195,170**	**224,710**	**383,130**	**239,990**	**4,665,580**	**771,360**	**5,436,940**
Direct S&E											
Space Rental Direct	1,406	998	1,563	1,207	1,404	1,531	520	-	8,629	1,857	10,485
PC&B Direct	11,812	8,920	15,223	13,711	17,044	18,862	6,341	-	91,913	16,964	108,878
Distributed S&E Direct	903	685	1,097	738	1,134	785	496	-	5,838	911	6,750
Direct S&E Subtotals	**14,121**	**10,603**	**17,883**	**15,656**	**19,582**	**21,178**	**7,357**	**-**	**106,380**	**19,732**	**126,113**
Indirect S&E Cost Allocation	20,210	20,820	19,401	24,541	37,578	7,570	11,781	-	141,901	25,985	167,887
S&E Direct & Indirect Subtotals	**34,331**	**31,423**	**37,284**	**40,197**	**57,160**	**28,748**	**19,138**	**-**	**248,281**	**45,717**	**294,000**
NSB Allocation	**475**	**490**	**456**	**577**	**884**	**178**	**277**		**3,337**	**611**	**3,950**
OIG Allocation	**1,217**	**1,254**	**1,168**	**1,478**	**2,263**	**456**	**709**	**-**	**8,545**	**1,565**	**10,110**
NSF TOTAL	**647,953**	**651,217**	**614,808**	**858,952**	**1,255,477**	**254,092**	**403,254**	**239,990**	**4,925,743**	**819,253**	**5,745,000**

FY 2005 FULL BUDGETARY COSTING

Table 2: Allocation by People, Ideas, and Tools
(Dollars in Thousands)

Total Directorate FY 2005	**BIO**	**CISE**	**ENG**	**GEO**	**MPS**	**SBE**	**OPP**	**IA**	**R&RA**	**EHR**	**TOTAL**
People	63,765	67,791	95,184	35,592	139,366	20,249	5,944	90,000	517,891	622,327	**1,140,219**
Ideas	458,173	422,951	482,118	437,026	745,277	183,405	92,223	55,990	2,877,163	174,110	**3,051,275**
Tools	126,015	160,475	37,506	386,334	370,834	50,438	305,087	94,000	1,530,689	22,816	**1,553,506**
FULL BUDGETARY COST	**647,953**	**651,217**	**614,808**	**858,952**	**1,255,477**	**254,092**	**403,254**	**239,990**	**4,925,743**	**819,253**	**5,745,000**

Subtotals may not add due to rounding.

SUMMARY TABLES/CHARTS

National Science Foundation
By Strategic Goal and Account
FY 2005 Congressional Request

NSF Accounts	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request: People	Ideas	Tools	OrgExc	FY 2005 Request	Change over FY 2004 Estimate: $	%
FY 2003 Actual	**$5,369.34**		**$1,117.00**	**$2,689.00**	**$1,312.70**	**$250.63**			
FY 2004 Estimate		**$5,577.83**	**$1,133.77**	**$2,788.99**	**$1,367.89**	**$287.18**			
BIO	570.49	586.89	59.68	428.82	106.71	4.72	599.93	13.04	2.2%
CISE	589.29	604.65	63.51	396.24	150.34	7.96	618.05	13.40	2.2%
ENG *(less SBIR/STTR)*	450.78	461.54	87.96	341.44	34.66	7.75	471.81	10.27	2.2%
SBIR/STTR	*90.92*	*103.59*	*0.00*	*104.09*	*0.00*	*0.00*	*104.09*	*0.50*	*0.5%*
GEO	691.84	713.10	33.39	409.99	279.69	5.43	728.50	15.40	2.2%
MPS	1,040.70	1,091.51	131.49	703.16	274.71	6.14	1,115.50	23.99	2.2%
SBE	158.63	175.67	10.44	133.27	43.44	3.52	190.67	15.00	8.5%
OISE	*39.97*	*28.12*	*7.00*	*24.69*	*0.00*	*2.35*	*34.04*	*5.92*	*21.1%*
OPP	323.96	342.15	5.56	86.27	254.15	3.75	349.73	7.58	2.2%
IA	97.86	144.14	90.00	55.99	94.00	0.00	239.99	95.85	66.5%
Research & Related Activities	**$4,054.43**	**$4,251.36**	**$489.03**	**$2,683.96**	**$1,237.70**	**$41.62**	**$4,452.31**	**$200.95**	**4.7%**
Education & Human Resources	**$934.88**	**$938.98**	**$575.79**	**$161.09**	**$21.11**	**$13.37**	**$771.36**	**-$167.62**	**-17.9%**
Major Research Equipment & Facilities Construction	**$179.03**	**$154.97**	**$0.00**	**$0.00**	**$213.27**	**$0.00**	**$213.27**	**$58.30**	**37.6%**
Salaries & Expenses	**$189.42**	**$218.70**	**$0.00**	**$0.00**	**$0.00**	**$294.00**	**$294.00**	**$75.30**	**34.4%**
National Science Board	**$2.88**	**$3.88**	**$0.00**	**$0.00**	**$0.00**	**$3.95**	**$3.95**	**$0.07**	**1.8%**
Office of Inspector General	**$8.70**	**$9.94**	**$0.00**	**$0.00**	**$0.00**	**$10.11**	**$10.11**	**$0.17**	**1.7%**
Total, National Science Foundation	**$5,369.34**	**$5,577.83**	**$1,064.82**	**$2,845.05**	**$1,472.08**	**$363.05**	**$5,745.00**	**$167.17**	**3.0%**
H-1B Visa	*$65.68*	*$0.00*					*$0.00*		
Total NSF, Including H-1B Visa	*$5,435.02*	*$5,577.83*	*$1,064.82*	*$2,845.05*	*$1,472.08*	*$363.05*	*$5,745.00*	*$167.17*	*3.0%*
Percent Increase over Prior Year, excluding H-1B Visa			**-6.1%**	**2.0%**	**7.6%**	**26.4%**			

Totals may not add due to rounding.

National Science Foundation
By Strategic Outcome Goal and Investment Category
FY 2005 Congressional Request

Strategic Outcome Goals and Investment Category	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Estimate Amount	Percent
Individuals	471.53	477.39	498.85	21.46	4.5%
Institutions	182.54	180.15	172.35	-7.80	-4.3%
Collaborations	462.93	476.23	393.62	-82.61	-17.3%
PEOPLE	**1,117.00**	**1,133.77**	**1,064.82**	**-68.95**	**-6.1%**
Fundamental Science & Engineering	2,095.56	2,124.25	2,150.44	26.19	1.2%
Centers Programs	364.23	413.02	457.26	44.24	10.7%
Capability Enhancement	229.21	251.72	237.35	-14.37	-5.7%
IDEAS	**2,689.00**	**2,788.99**	**2,845.05**	**56.06**	**2.0%**
Facilities	538.17	580.21	685.57	105.36	18.2%
Infrastructure & Instrumentation	336.66	341.52	344.93	3.41	1.0%
Polar Tools, Facilities & Logistics	252.96	250.24	254.15	3.91	1.6%
Federally-Funded R&D Centers	184.92	195.92	187.43	-8.49	-4.3%
TOOLS	**1,312.70**	**1,367.89**	**1,472.08**	**104.19**	**7.6%**
ORGANIZATIONAL EXCELLENCE	**250.63**	**287.18**	**363.05**	**75.87**	**26.4%**
TOTAL, NSF	**$5,369.34**	**$5,577.83**	**$5,745.00**	**$167.17**	**3.00%**

Strategic Outcome Goals as a Percent of NSF Budget

Strategic Outcome Goals and Investment Category	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	% Change over FY 2004 Estimate
People	20.8%	20.3%	18.5%	-1.8%
Ideas	50.1%	50.0%	49.5%	-0.5%
Tools	24.4%	24.5%	25.6%	1.1%
Organizational Excellence	4.7%	5.1%	6.3%	1.2%
Total, NSF	**100%**	**100%**	**100%**	**0.0%**

NSF Tools
FY 2005 Congressional Request

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Amount	Change Percent
Facilities[1,2,3]	**$538.166**	**$580.21**	**$685.57**	**$105.36**	**18.2%**
Academic Research Fleet	$65.200	76.50	83.20	6.70	8.8%
Advanced Modular Incoherent Scatter Radar	$14.000	11.00	12.30	1.30	11.8%
Cornell Electron Storage Ring	$19.490	18.00	19.70	1.70	9.4%
Gemini	$13.480	14.12	14.93	0.81	5.7%
Incorporated Research Institutions for Seismology	$13.200	13.00	13.00	0.00	0.0%
Laser Interferometer Gravitational Wave Observatory	$33.000	33.00	33.00	0.00	0.0%
Major Research Equipment & Facilities Construction[1]	$184.816	189.88	278.22	88.34	46.5%
Nanofabrication (NNUN/NNIN)	$6.050	12.45	13.86	1.41	11.3%
National High Magnetic Field Laboratory[2]	$25.100	24.61	25.61	1.00	4.1%
National Superconducting Cyclotron Laboratory	$15.650	15.65	16.65	1.00	6.4%
Ocean Drilling Program/Integrated Ocean Drilling Pgm	$30.000	37.50	35.60	-1.90	-5.1%
Partnerships for Advanced Computational Infrastructure	$73.240	87.00	90.00	3.00	3.4%
Other Facilities[3]	$44.940	47.50	49.50	2.00	4.2%
Infrastructure & Instrumentation	**$336.659**	**341.52**	**344.93**	**3.41**	**1.0%**
Advanced Networking Infrastructure	$46.620	23.06	22.90	-0.16	-0.7%
Major Research Instrumentation	$83.449	109.35	90.00	-19.35	-17.7%
National STEM Digital Library	$27.630	24.40	27.02	2.62	10.7%
Research Resources	$153.660	160.79	181.09	20.30	12.6%
Science Resource Statistics	$25.300	23.92	23.92	0.00	0.0%
Polar Tools, Facilities and Logistics[4]	**$252.956**	**250.24**	**254.15**	**3.91**	**1.6%**
Antarctic Facilities and Operations	$141.430	149.48	153.96	4.48	3.0%
Antarctic Logistics	$68.550	68.07	68.07	0.00	0.0%
Arctic Logistics	$30.290	31.40	32.12	0.72	2.3%
South Pole Station[1]	$12.686	1.29	0.00	-1.29	-100.0%
Federally-Funded R&D Centers	**$184.920**	**195.92**	**187.43**	**-8.49**	**-4.3%**
National Astronomy & Ionosphere Center	$12.730	12.34	12.50	0.16	1.3%
National Center for Atmospheric Research	$80.270	83.27	84.52	1.25	1.5%
National Optical Astronomy Observatories	$42.620	41.35	39.00	-2.35	-5.7%
National Radio Astronomy Observatories	$45.330	54.98	47.41	-7.57	-13.8%
Science and Technology Policy Institute	$3.970	3.98	4.00	0.02	0.5%
Total, Tools Support	**$1,312.701**	**$1,367.89**	**$1,472.08**	**$104.19**	**7.6%**

Totals may not add due to rounding.

[1]All MREFC projects are included in Facilities, except South Pole Station. Funding levels for MREFC projects in this table include initial support for operations and maintenance funded through R&RA (and EHR) as well as construction, acquisition and commissioning costs funded through MREFC.

[2]Support for the National High Field Mass Spectrometry Facility will be integrated into the National High Magnetic Field Laboratory in FY 2004, and has been included in the FY 2003 Actual..

[3]Other Facilities includes support for the Network for Computational Nanotechnology, and other physics, materials research, ocean sciences, atmospheric sciences, and earth sciences facilities.

[4]Polar Tools, Facilities and Logistics includes South Pole Station, an MREFC project, with funding as described above.

National Science Foundation
Selected Cross-Cutting Programs
FY 2005 Congressional Request

Selected Cross-Cutting Programs		FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Estimate Amount	Change over FY 2004 Estimate Percent
ADVANCE/Professional Opportunities for Women in Research and Education - POWRE	Research & Related Activities	16.73	19.16	20.27	1.11	5.8%
	Education & Human Resources	0.45	0.00	0.00	0.00	N/A
	Total, NSF	**$17.18**	**$19.16**	**$20.27**	**$1.11**	**5.8%**
Course, Curriculum & Lab Improvement - CCLI	Research & Related Activities	6.10	4.58	4.44	-0.14	-3.1%
	Education & Human Resources	48.10	40.41	46.53	6.12	15.1%
	Total, NSF	**$54.20**	**$44.99**	**$50.97**	**$5.98**	**13.3%**
Interagency Education Research Initiative - IERI	Research & Related Activities	9.95	9.63	9.63	0.00	0.0%
	Education & Human Resources	14.90	14.91	14.91	0.00	0.0%
	Total, NSF	**$24.85**	**$24.54**	**$24.54**	**$0.00**	**0.0%**
Faculty Early Career Development - CAREER	Research & Related Activities	133.87	130.68	130.68	0.00	0.0%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**$133.87**	**$130.68**	**$130.68**	**$0.00**	**0.0%**
Graduate Research Fellowships - GRF	Research & Related Activities	5.26	8.06	8.56	0.50	6.2%
	Education & Human Resources	79.76	89.21	94.74	5.53	6.2%
	Total, NSF	**$85.02**	**$97.27**	**$103.30**	**$6.03**	**6.2%**
Graduate Teaching Fellowships in K-12 Education - GK-12	Research & Related Activities	6.06	7.64	8.24	0.60	7.9%
	Education & Human Resources	36.34	42.21	47.46	5.25	12.4%
	Total, NSF	**$42.40**	**$49.85**	**$55.70**	**$5.85**	**11.7%**
Integrative Graduate Education and Research Training - IGERT	Research & Related Activities	34.46	42.47	50.06	7.59	17.9%
	Education & Human Resources	23.39	24.53	31.68	7.15	29.1%
	Total, NSF	**$57.85**	**$67.00**	**$81.74**	**$14.74**	**22.0%**
Long-Term Research Sites - LTER	Research & Related Activities	18.06	20.52	22.82	2.30	11.2%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**$18.06**	**$20.52**	**$22.82**	**$2.30**	**11.2%**
Model Institutions for Excellence-MIE	Research & Related Activities	7.26	7.27	7.27	0.00	0.0%
	Education & Human Resources	2.49	2.51	2.51	0.00	0.0%
	Total, NSF	**$9.75**	**$9.78**	**$9.78**	**$0.00**	**0.0%**
Postodoctoral Programs	Research & Related Activities	17.84	17.46	18.31	0.85	4.9%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**$17.84**	**$17.46**	**$18.31**	**$0.85**	**4.9%**
Research Experience for Undergraduates - REU	Research & Related Activities	54.08	51.79	52.06	0.27	0.5%
	Education & Human Resources	0.00	0.99	0.99	0.00	N/A
	Total, NSF	**$54.08**	**$52.78**	**$53.05**	**$0.27**	**0.5%**
Research Opportunity Awards - ROA	Research & Related Activities	0.83	1.29	1.29	0.00	0.0%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**$0.83**	**$1.29**	**$1.29**	**$0.00**	**0.0%**
Research in Undergraduate Institutions - RUI	Research & Related Activities	33.43	31.19	31.09	-0.10	-0.3%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**$33.43**	**$31.19**	**$31.09**	**-$0.10**	**-0.3%**
Science and Technology Centers - STCs	Research & Related Activities	44.07	42.52	72.39	29.87	70.2%
	Education & Human Resources	0.00	0.00	0.00	0.00	N/A
	Total, NSF	**44.07**	**42.52**	**72.39**	**$29.87**	**70.2%**

**Totals may not add due to rounding.*

NSF Funding Profile

Approximately half of the awards that are supported in a particular fiscal year are competitively reviewed in that year through NSF's merit review process. The other awards are continuations of projects that were competitively reviewed in a prior year. As shown in the Number of Competitive Awards, the Funding Rate is the number of competitive awards made during a year as a percentage of total proposals competitively reviewed. It indicates the probability of receiving an award when submitting proposals to NSF.

Research Grants are those limited to research projects and excludes other categories of awards that fund infrastructure-type activities such as equipment and conference awards, which do not require multi-year support.

The Annualized Award Size displays the annual level of research grants provided to awardees by dividing the total dollars of each award by the number of years over which it extends. Both the average and the median annualized award size for competitively reviewed awards are shown.

Average Duration is the average length of the award in years for research grants.

The Quantitative Data Tables, provided under a separate tab, are based on all proposals and awards, including competitive awards, contracts, cooperative agreements, supplements and amendments to existing grants and contracts.

NSF FUNDING PROFILE

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards			
Number	10,650	10,560	10,480
Funding Rate	28%	27%	27%
Statistics for Research Grants			
Number of Research Grants	6,140	6,217	6,145
Funding Rate	24%	24%	23%
Median Annualized Award Size	$100,000	$102,570	$104,150
Average Annualized Award Size	$135,000	$139,000	$142,000
Average Duration (yrs.)	2.9	3.0	3.0

NSF NSTC CROSSCUTS
FY 2005 Budget Request to Congress

	U.S. Global Change Research Programs Includes U.S. Global Change Research Program Climate Change Research Initiative			Networking and Information Technology Research & Development			National Nanotechnology Initiative		
	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
BIO	15.10	15.10	15.10	31.60	50.00	57.00	2.98	5.31	5.85
CISE				566.78	588.86	594.28	11.14	15.79	19.40
ENG	1.00	1.00	1.00	11.17	11.17	12.73	94.35	108.88	133.81
GEO	147.43	157.49	157.49	13.21	14.56	15.56	7.53	7.94	7.94
MPS	5.45	5.45	5.45	59.23	55.45	56.20	103.92	111.48	132.14
SBE	20.45	20.35	20.48	12.70	12.70	13.34	1.11	1.56	1.50
OISE									0.26
OPP	13.78	13.78	10.50	1.33	1.33	1.50	0.00	0.00	0.00
IA									
R&RA	203.21	213.17	210.02	696.02	734.07	750.61	221.03	250.96	300.90
EHR				2.48	9.53	10.01	0.22	2.55	4.16
MREFC				44.83	9.94	0.00			
NSF TOTAL	**$203.21**	**$213.17**	**$210.02**	**$743.33**	**$753.54**	**$760.62**	**$221.25**	**$253.51**	**$305.06**

Note: The Climate Change Science Programs incorporate the U.S. Global Change Research Program and the Climate Change Research Initiative per Section 84-Character Classification (Schedule C) in OMB Circular No. A-11 (2003)

NSF People Programs by Level of Education
FY 2005 Congressional Request

(Dollars in Millions)

New Structure	Old Structure - FY 2003 Actual				Old Structure - FY 2004 Estimate				Old Structure - FY 2005 Request			
	K-12 Support	Undergrad Support	Grad & Prof Support	Other People Support	K-12 Support	Undergrad Support	Grad & Prof Support	Other People Support	K-12 Support	Undergrad Support	Grad & Prof Support	Other People Support
Individuals Support	**$77.57**	**$72.70**	**$319.46**	**$4.94**	**$73.40**	**$55.06**	**$348.92**	**$4.00**	**$73.40**	**$51.88**	**$373.84**	**$4.60**
CAREER			133.87				130.68				130.68	
Distinguished Teaching Scholars		1.88				1.80				2.00		
GRF			85.02				97.27				103.30	
IGERT			57.85				67.00				81.74	
Noyce Scholarships		6.93				7.95				4.00		
Postdocs			17.84				17.46				18.31	
PAEMST	4.15				4.30				4.30			
REU Supplements		23.59				21.20				21.47		
Scholarships for Service/Cybercorps		30.14				16.08				16.18		
Teacher Prof Continuum (STEM TP & TE)	66.65				62.16				62.16			
VIGRE			19.00				25.78				27.78	
Other Individuals Support	6.77	10.16	5.88	4.94	6.94	8.03	10.73	4.00	6.94	8.23	12.03	4.60
Institutions Support	**$29.86**	**$133.90**	**$21.13**	**$0.00**	**$28.82**	**$130.56**	**$22.83**	**$0.20**	**$29.45**	**$117.60**	**$27.93**	**$0.30**
ADVANCE/POWRE			17.18				19.16				20.27	
ATE		42.33				45.23				38.16		
Course, Curriculum & Lab Improvement		54.20				44.99				50.97		
Engineering Education Reform		16.08				15.49				13.47		
Instructional Materials Assessment	27.36				28.82				29.45			
STEM Talent Expansion (Tech Talent)		21.29				24.85				15.00		
Other Institutions Support	2.50		3.95				3.67	0.20			7.66	0.30
Collaborations Support	**$213.44**	**$104.73**	**$55.13**	**$96.24**	**$198.81**	**$117.94**	**$67.02**	**$101.58**	**$111.67**	**$124.10**	**$72.41**	**$91.01**
Centers for Learning & Teaching	26.58				28.84				28.84			
Evaluation				12.50				11.57				11.57
GK-12			42.40				49.85				55.70	
HBCU-UP		18.71				23.86				19.98		
Informal Science Education				60.23				62.13				50.00
Louis Stokes AMP		31.81				34.30				34.30		
Math & Science Partnership	144.07				139.17				80.00			
MGE-AGEP			11.48				14.91				14.91	
MIE		9.75				9.78				9.78		
PFI				4.97				9.94				10.00
PAESMEM				0.57				0.29				0.29
PGE				10.50				9.90				9.90
PPD/RiDE				4.97				5.25				5.25
REU Sites		30.49				31.58				31.58		
RSI	12.58				6.04				0.00			
SSI	0.00				0.00				0.00			
Tribal Colleges		9.85				9.92				9.92		
USP	27.73				21.97				0.00			
Other Collaborations Support	2.48	4.12	1.25	2.50	2.79	8.50	2.26	2.50	2.83	18.54	1.80	4.00
Subtotals, People	**$320.87**	**$311.33**	**$395.72**	**$101.18**	**$301.03**	**$303.56**	**$438.77**	**$105.78**	**$214.52**	**$293.58**	**$474.18**	**$95.91**
Total EHR A&M Offset	-4.88	-3.39	-2.41	-1.41	-5.87	-4.22	-3.47	-1.81	-2.79	-4.55	-4.28	-1.75
SUBTOTALS, PEOPLE	**$315.98**	**$307.94**	**$393.31**	**$99.77**	**$295.16**	**$299.34**	**$435.30**	**$103.97**	**$211.73**	**$289.03**	**$469.90**	**$94.16**
TOTALS, PEOPLE				**$1,117.00**				**$1,133.77**				**$1,064.82**

NSF By Account

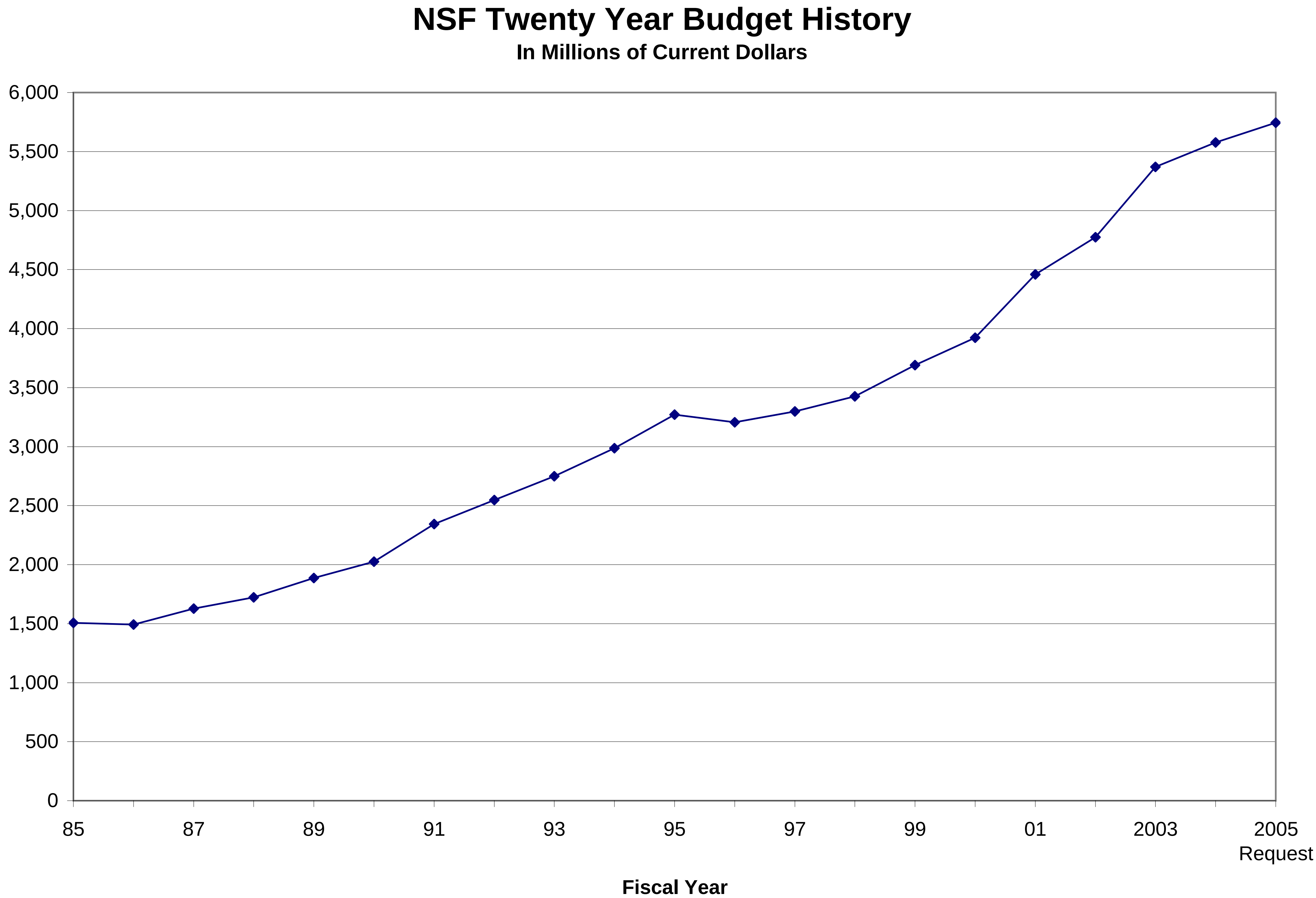
(Actual Dollars in Millions - Current Dollars)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Salaries & Expenses	Office of Inspector General	National Science Board	NSF
51	0.0	0.0	0.0		0.1	0.0		0.2
52	1.4	1.5	0.0		0.5	0.0		3.5
53	2.1	1.4	0.0		0.9	0.0		4.4
54	4.5	1.9	0.0		1.5	0.0		8.0
55	8.9	2.1	0.0		1.5	0.0		12.5
56	10.8	3.5	0.0		1.7	0.0		16.0
57	22.0	14.3	0.0		2.4	0.0		38.6
58	27.4	19.2	0.0		2.9	0.0		49.5
59	66.3	61.3	0.0		5.3	0.0		132.9
60	88.4	63.7	0.0		6.5	0.0		158.6
61	104.0	63.4	0.0		7.6	0.0		175.0
62	173.3	78.6	0.0		9.0	0.0		260.8
63	218.9	91.0	0.0		10.9	0.0		320.8
64	239.9	102.6	0.0		12.1	0.0		354.6
65	282.4	120.4	0.0		13.1	0.0		416.0
66	328.6	124.3	0.0		13.1	0.0		466.0
67	327.7	123.4	0.0		14.0	0.0		465.1
68	350.2	134.7	0.0		15.4	0.0		500.3
69	292.9	123.1	0.0		16.5	0.0		432.5
70	316.4	126.4	0.0		19.7	0.0		462.5
71	369.4	105.0	0.0		21.8	0.0		496.1
72	482.4	93.7	0.0		24.6	0.0		600.7
73	519.4	62.2	0.0		28.6	0.0		610.3
74	533.3	80.7	0.0		31.7	0.0		645.7
75	581.2	74.0	0.0		37.9	0.0		693.1
76	619.7	62.5	0.0		42.2	0.0		724.4
77	672.0	74.3	0.0		45.5	0.0		791.8
78	734.7	73.9	0.0		48.7	0.0		857.3
79	791.8	80.4	0.0		54.8	0.0		926.9
80	836.8	80.1	0.0		58.2	0.0		975.1
81	900.4	75.7	0.0		59.2	0.0		1,035.3
82	909.8	26.2	0.0		63.2	0.0		999.1
83	1,013.0	23.0	0.0		65.7	0.0		1,101.7
84	1,177.7	63.0	0.0		66.3	0.0		1,306.9
85	1,344.6	90.6	0.0		72.0	0.0		1,507.1
86	1,329.6	91.7	0.0		71.8	0.0		1,493.2
87	1,440.0	109.9	0.0		77.8	0.0		1,627.6
88	1,481.3	156.8	0.0		84.5	0.0		1,722.6
89	1,600.5	194.1	0.0		91.3	0.0		1,885.9
90	1,696.6	230.4	0.4		96.4	2.3		2,026.1
91	1,868.5	331.9	39.0		101.2	2.9		2,343.5
92	1,940.5	459.4	33.4		110.0	3.9		2,547.1
93	2,046.3	505.1	49.8	34.1	110.8	3.7		2,749.7
94	2,168.4	569.0	105.4	17.0	123.5	3.9		2,987.2
95	2,281.5	611.9	117.5	126.0	129.0	4.5		3,270.3
96	2,327.8	601.2	70.9	70.0	132.5	4.0		3,206.3
97	2,433.9	619.1	30.0	76.1	134.3	5.3		3,298.8
98	2,572.6	633.2	0.0	78.2	136.9	4.8		3,425.7
99	2,821.6	662.5	0.0	56.7	144.1	5.4		3,690.3
00	2,979.9	683.6	0.0	105.0	149.3	5.6		3,923.4
01	3,372.3	795.4	0.0	119.2	166.3	6.6		4,459.9
02	3,616.0	866.1	0.0	115.4	169.9	6.7		4,774.1
2003	4,054.4	934.9	0.0	179.0	189.4	8.7	2.9	5,369.3
2004 Estimate	4,251.4	939.0	0.0	155.0	218.7	9.9	3.9	5,577.8
2005 Request	4,452.3	771.4	0.0	213.3	294.0	10.1	4.0	5,745.0

NSF By Account

(FY Actuals - FY 2003 Constant Dollars in Millions)

Fiscal Year	Research & Related Activities	Education & Human Resources	Academic Research Infrastructure	Major Research Equipment & Facilities Construction	Salaries & Expenses	Office of Inspector General	National Science Board	NSF
51	0.2	0.0	0.0	0.0	0.8	0.0	0.0	0.9
52	8.3	9.1	0.0	0.0	3.1	0.0	0.0	20.5
53	12.4	8.2	0.0	0.0	5.1	0.0	0.0	25.7
54	25.9	10.8	0.0	0.0	8.9	0.0	0.0	45.6
55	50.4	11.8	0.0	0.0	8.8	0.0	0.0	71.0
56	59.8	19.5	0.0	0.0	9.3	0.0	0.0	88.6
57	117.3	76.3	0.0	0.0	12.5	0.0	0.0	206.2
58	141.8	99.5	0.0	0.0	15.2	0.0	0.0	256.5
59	338.4	312.7	0.0	0.0	26.8	0.0	0.0	677.9
60	445.3	321.3	0.0	0.0	32.8	0.0	0.0	799.4
61	516.7	315.3	0.0	0.0	37.6	0.0	0.0	869.6
62	851.4	386.2	0.0	0.0	44.1	0.0	0.0	1,281.7
63	1,062.4	441.6	0.0	0.0	52.7	0.0	0.0	1,556.7
64	1,150.8	492.0	0.0	0.0	57.8	0.0	0.0	1,700.6
65	1,331.7	567.7	0.0	0.0	61.9	0.0	0.0	1,961.2
66	1,517.0	573.8	0.0	0.0	60.4	0.0	0.0	2,151.3
67	1,465.4	551.7	0.0	0.0	62.8	0.0	0.0	2,079.9
68	1,512.4	581.8	0.0	0.0	66.4	0.0	0.0	2,160.6
69	1,209.7	508.4	0.0	0.0	68.1	0.0	0.0	1,786.2
70	1,239.1	495.0	0.0	0.0	77.1	0.0	0.0	1,811.1
71	1,377.6	391.6	0.0	0.0	81.2	0.0	0.0	1,850.5
72	1,718.2	333.8	0.0	0.0	87.5	0.0	0.0	2,139.5
73	1,771.8	212.3	0.0	0.0	97.6	0.0	0.0	2,081.7
74	1,696.7	256.8	0.0	0.0	100.7	0.0	0.0	2,054.2
75	1,675.0	213.3	0.0	0.0	109.1	0.0	0.0	1,997.5
76	1,665.7	167.9	0.0	0.0	113.5	0.0	0.0	1,947.2
77	1,680.3	185.7	0.0	0.0	113.9	0.0	0.0	1,979.9
78	1,721.3	173.1	0.0	0.0	114.1	0.0	0.0	2,008.4
79	1,716.7	174.3	0.0	0.0	118.7	0.0	0.0	2,009.7
80	1,668.1	159.6	0.0	0.0	116.1	0.0	0.0	1,943.8
81	1,634.7	137.4	0.0	0.0	107.5	0.0	0.0	1,879.6
82	1,546.0	44.5	0.0	0.0	107.4	0.0	0.0	1,697.8
83	1,648.6	37.4	0.0	0.0	106.9	0.0	0.0	1,793.0
84	1,848.4	98.8	0.0	0.0	104.0	0.0	0.0	2,051.3
85	2,044.0	137.7	0.0	0.0	109.4	0.0	0.0	2,291.0
86	1,975.3	136.2	0.0	0.0	106.7	0.0	0.0	2,218.3
87	2,084.8	159.1	0.0	0.0	112.6	0.0	0.0	2,356.5
88	2,079.3	220.1	0.0	0.0	118.6	0.0	0.0	2,417.9
89	2,162.6	262.2	0.0	0.0	123.3	0.0	0.0	2,548.1
90	2,210.2	300.2	0.5	0.0	125.5	3.0	0.0	2,639.5
91	2,346.1	416.8	49.0	0.0	127.1	3.6	0.0	2,942.6
92	2,376.8	562.7	40.9	0.0	134.7	4.7	0.0	3,119.8
93	2,450.8	604.9	59.6	40.8	132.7	4.4	0.0	3,293.3
94	2,542.3	667.2	123.6	20.0	144.8	4.6	0.0	3,502.4
95	2,619.8	702.6	134.9	144.7	148.1	5.1	0.0	3,755.2
96	2,622.6	677.3	79.9	78.9	149.3	4.5	0.0	3,612.4
97	2,695.2	685.6	33.2	84.3	148.7	5.9	0.0	3,652.9
98	2,814.6	692.7	0.0	85.6	149.8	5.2	0.0	3,747.9
99	3,047.0	715.4	0.0	61.2	155.6	5.8	0.0	3,985.1
00	3,154.2	723.6	0.0	111.1	158.0	5.9	0.0	4,152.9
01	3,488.0	822.7	0.0	123.3	172.0	6.8	0.0	4,612.8
02	3,675.0	880.2	0.0	117.2	172.7	6.8	0.0	4,852.0
2003	4,054.4	934.9	0.0	179.0	189.4	8.7	2.9	5,369.3
2004 Estimate	4,196.3	926.8	0.0	153.0	215.9	9.8	3.8	5,505.5
2005 Request	4,340.4	752.0	0.0	207.9	286.6	9.9	3.9	5,600.6



NSF Twenty Year Budget History
In Millions of Current Dollars
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4,000
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1,000
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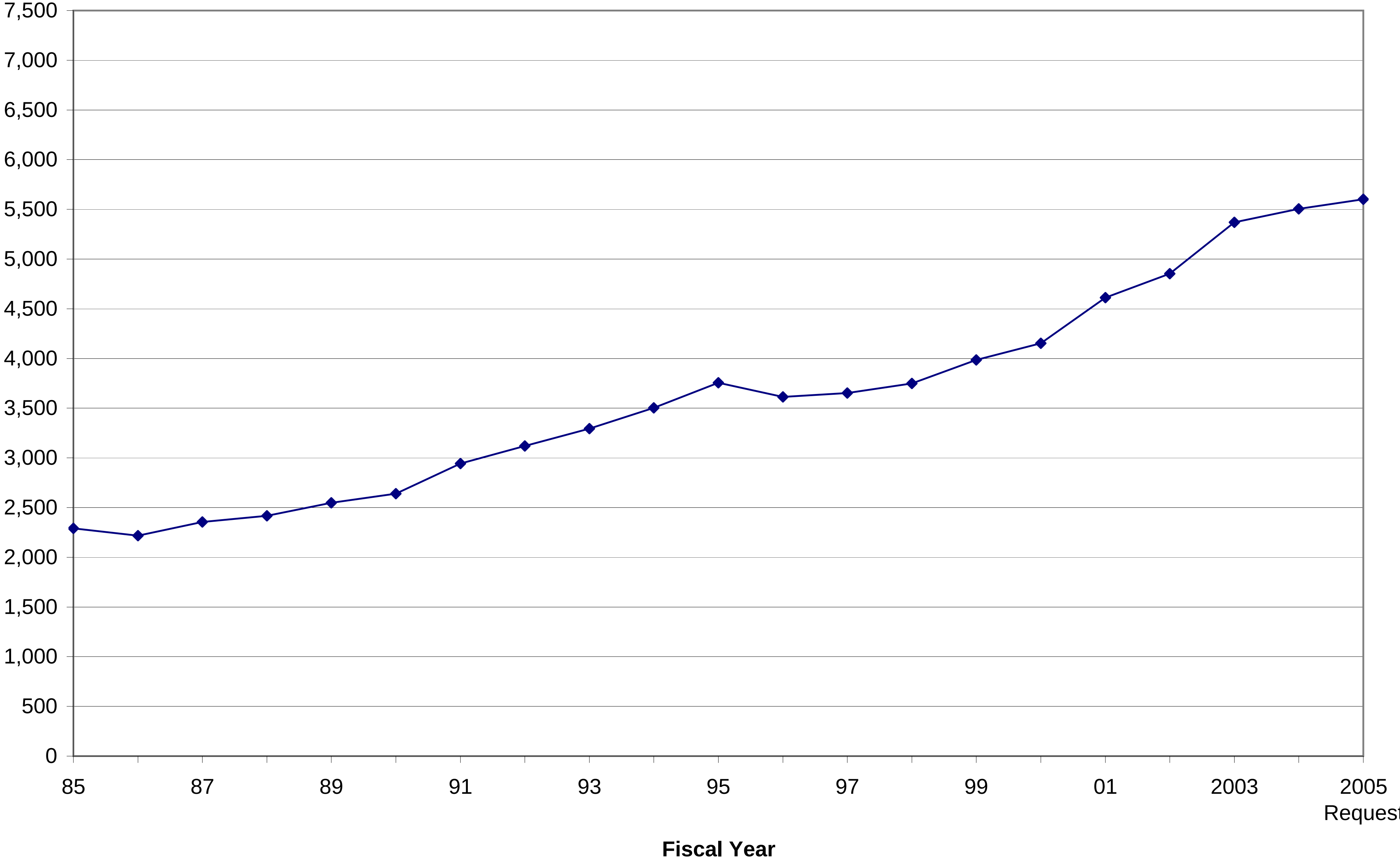
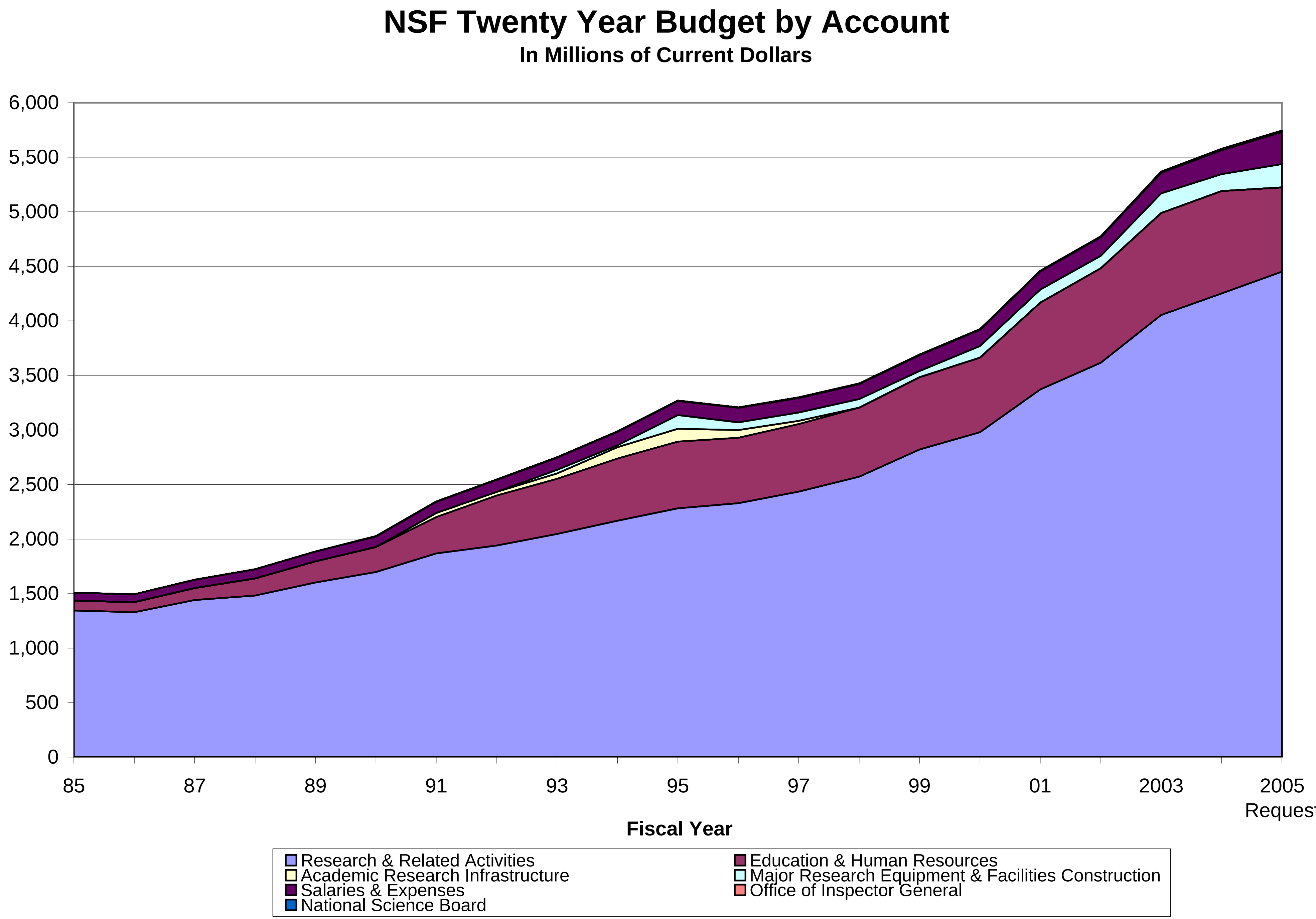
2005
Request
Fiscal Year

NSF Twenty Year Budget History

In Millions of Constant FY 2003 Dollars




NSF Twenty Year Budget by Account
In Millions of Current Dollars
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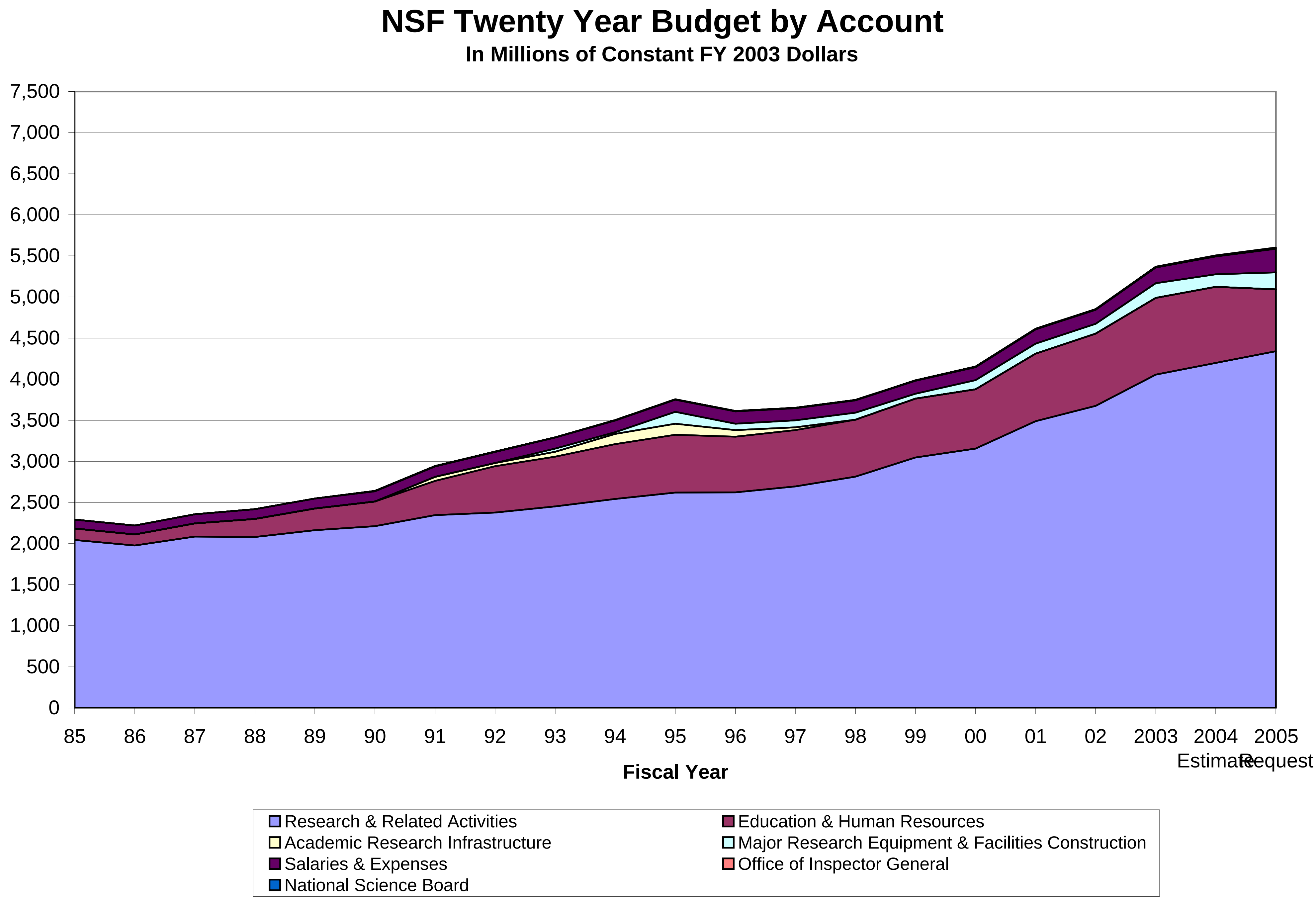
2003
2005
Request
Fiscal Year
Research & Related Activities
Education & Human Resources
Academic Research Infrastructure
Major Research Equipment & Facilities Construction
Salaries & Expenses
Office of Inspector General
National Science Board


NSF Twenty Year Budget by Account
In Millions of Constant FY 2003 Dollars
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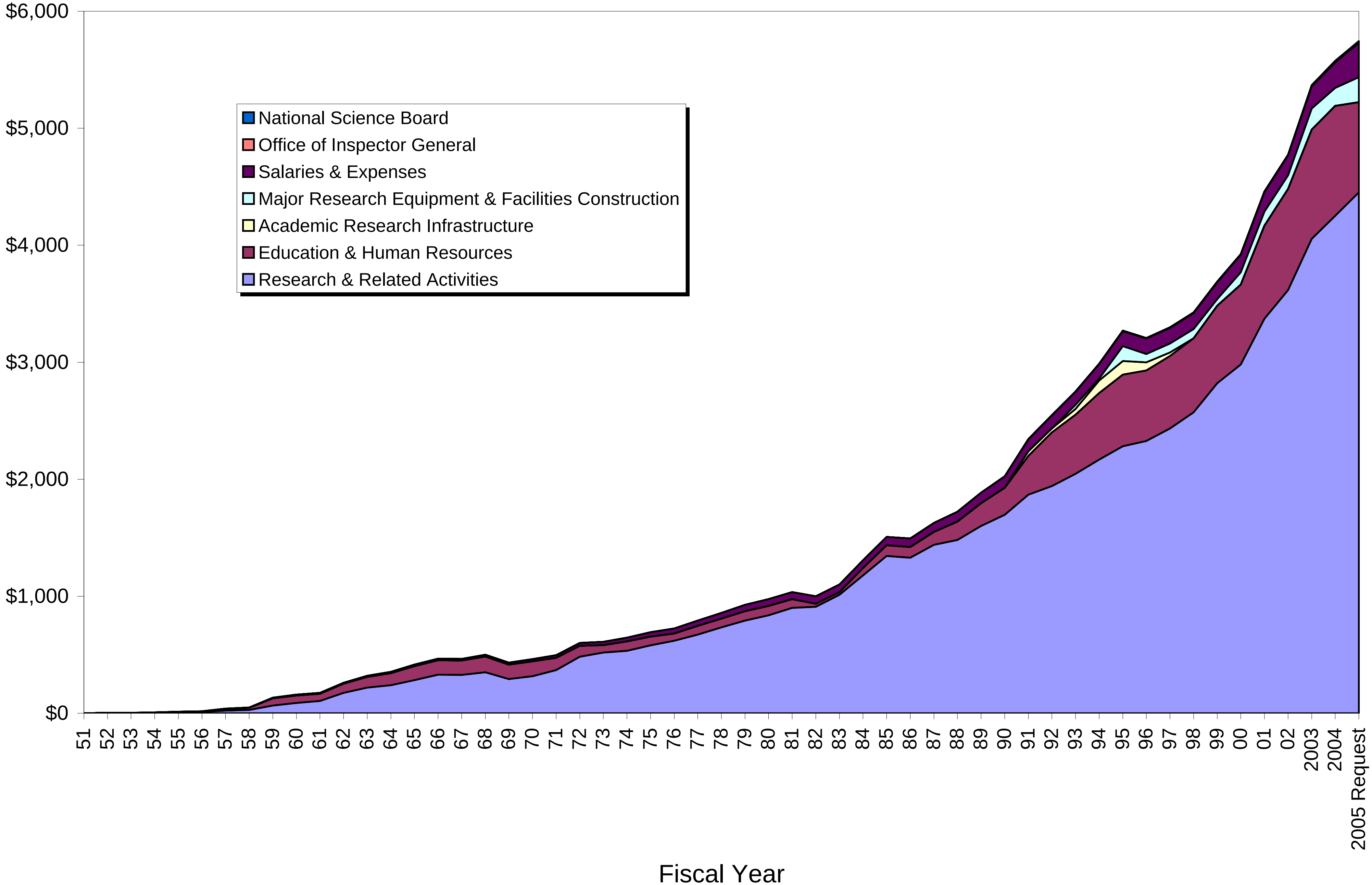
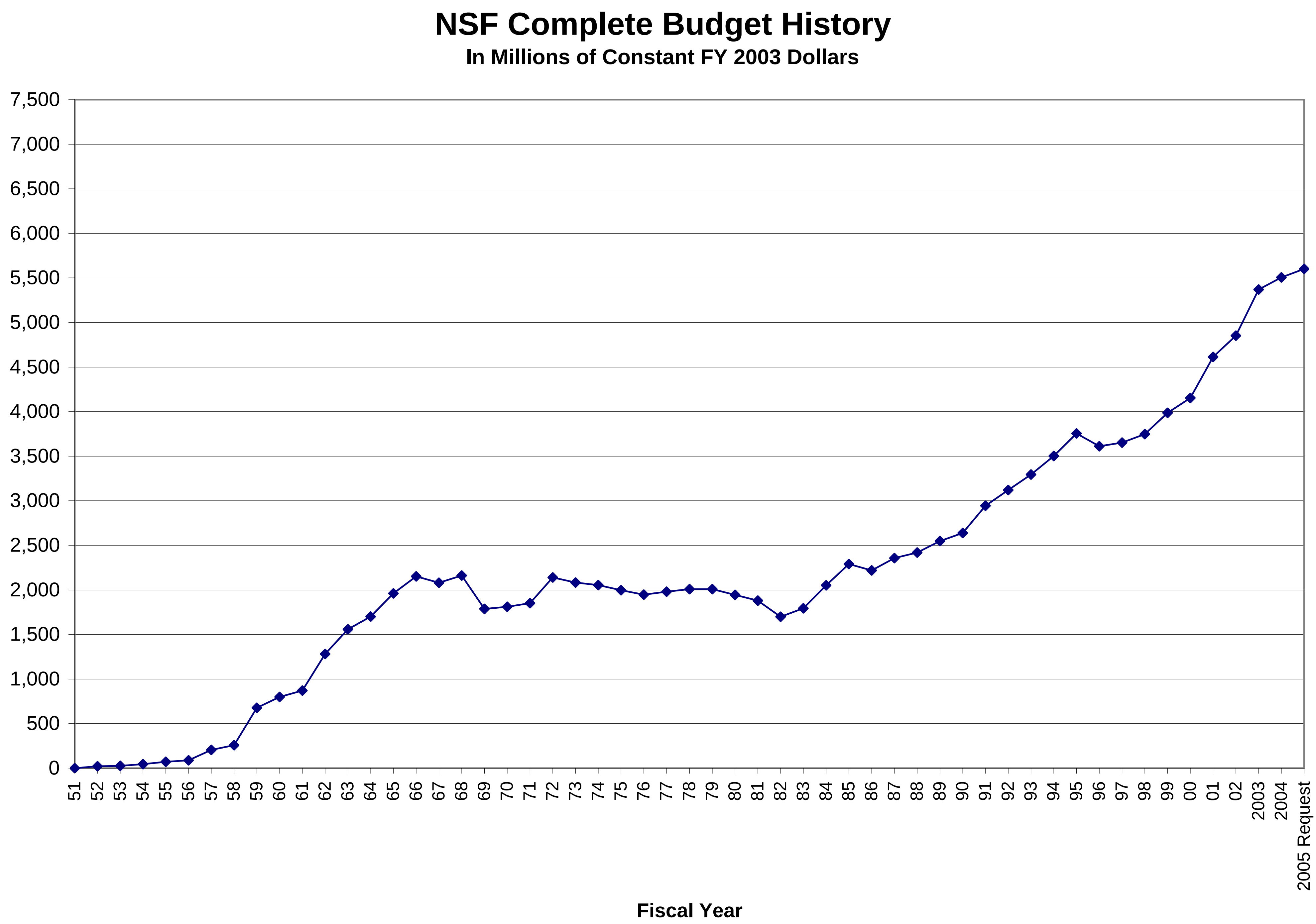
Estimate
2005
Request
Fiscal Year
Research & Related Activities
Education & Human Resources
Academic Research Infrastructure
Major Research Equipment & Facilities Construction
Salaries & Expenses
Office of Inspector General
National Science Board

NSF Complete Budget History by Account

In Millions of Current Dollars




NSF Complete Budget History
In Millions of Constant FY 2003 Dollars
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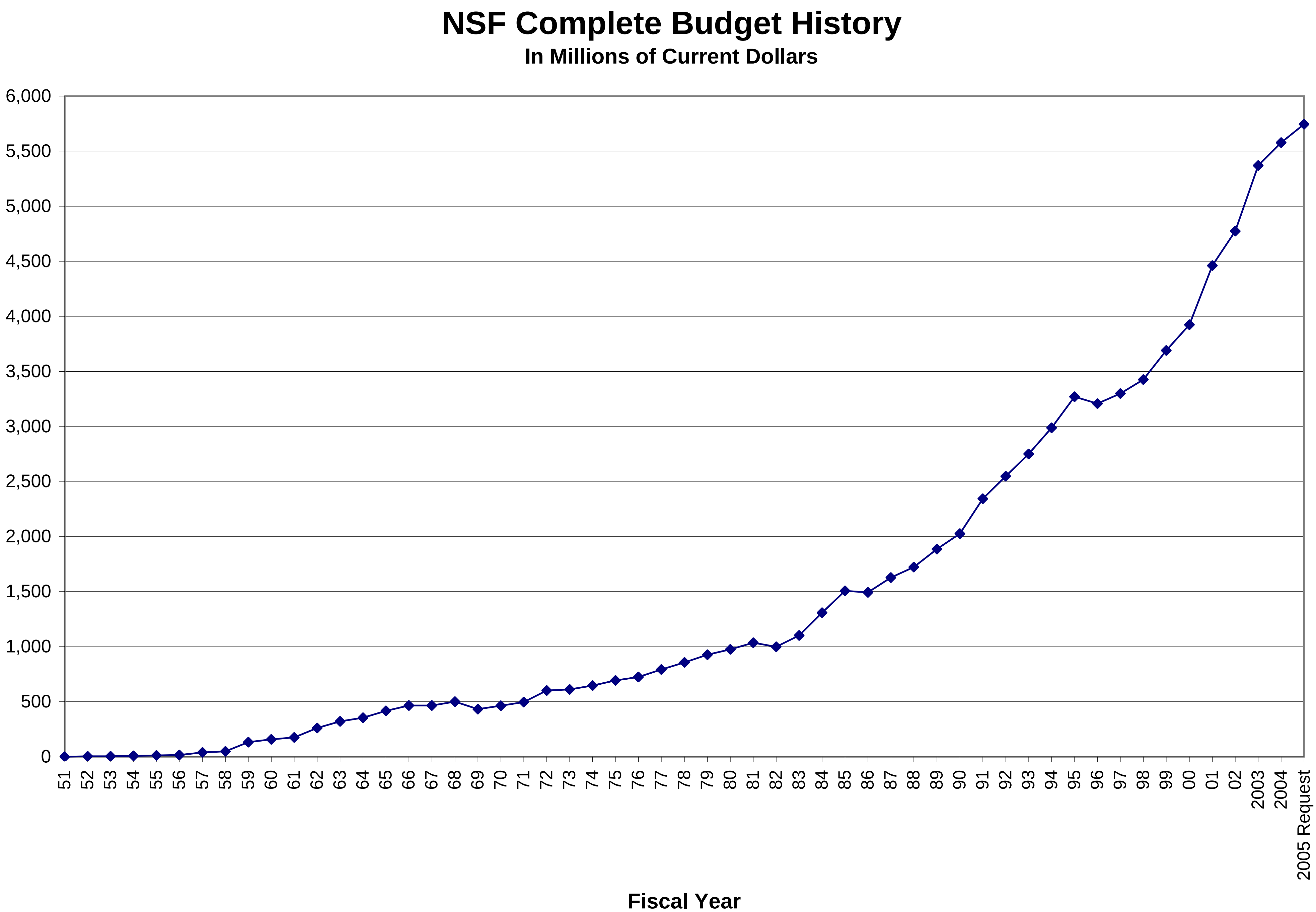
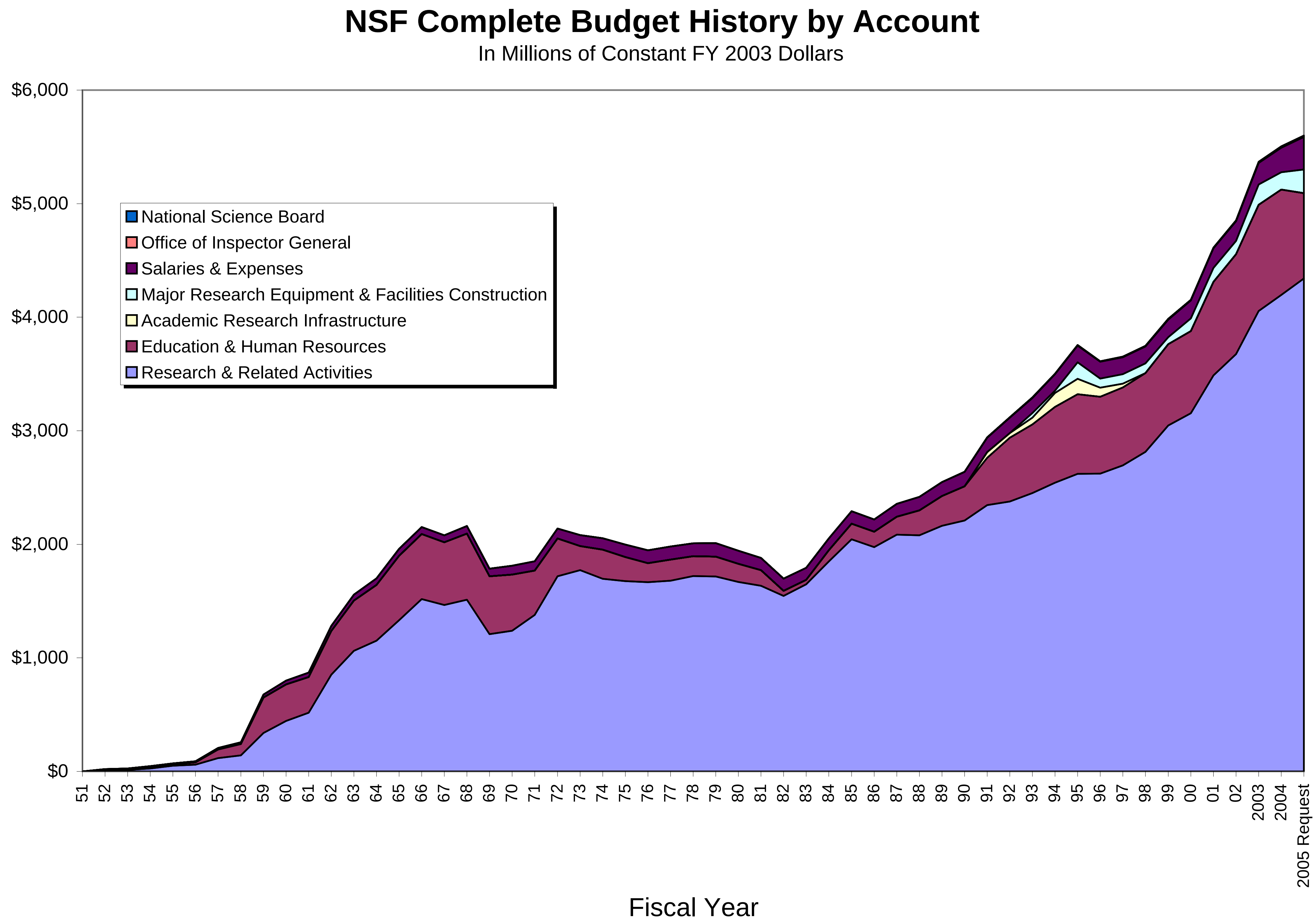
500
0
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 2003 2004 2005 Request
Fiscal Year


NSF Complete Budget History
In Millions of Current Dollars
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 2003 2004 2005 Request
Fiscal Year



NSF Complete Budget History by Account
In Millions of Constant FY 2003 Dollars
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
National Science Board
Office of Inspector General
Salaries & Expenses
Major Research Equipment & Facilities Construction
Academic Research Infrastructure
Education & Human Resources
Research & Related Activities
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 2003 2004 2005 Request
Fiscal Year

NSF By Account (Current Dollars)

(Estimated Dollars in Millions)

Fiscal Year	NSF	Dollar Increase	Percent Increase
51	0.15		
52	3.47	3.32	2201%
53	4.43	0.95	27%
54	7.96	3.53	80%
55	12.49	4.53	57%
56	15.99	3.51	28%
57	38.63	22.64	142%
58	49.51	10.88	28%
59	132.88	83.37	168%
60	158.60	25.72	19%
61	174.99	16.39	10%
62	260.82	85.84	49%
63	320.75	59.93	23%
64	354.58	33.83	11%
65	415.97	61.38	17%
66	466.02	50.06	12%
67	465.10	-0.92	0%
68	500.29	35.18	8%
69	432.50	-67.79	-14%
70	462.49	29.99	7%
71	496.14	33.64	7%
72	600.72	104.59	21%
73	610.27	9.54	2%
74	645.65	35.39	6%
75	693.13	47.47	7%
76	724.42	31.30	5%
77	791.77	67.35	9%
78	857.25	65.48	8%
79	926.93	69.68	8%
80	975.13	48.20	5%
81	1035.27	60.14	6%
82	999.14	-36.14	-3%
83	1101.69	102.56	10%
84	1306.92	205.22	19%
85	1507.07	200.15	15%
86	1493.17	-13.90	-1%
87	1627.62	134.45	9%
88	1722.57	94.95	6%
89	1885.88	163.31	9%
90	2026.06	140.18	7%
91	2343.49	317.43	16%
92	2547.13	203.64	9%
93	2749.73	202.60	8%
94	2987.21	237.49	9%
95	3270.27	283.06	9%
96	3206.33	-63.95	-2%
97	3298.82	92.49	3%
98	3425.73	126.91	4%
99	3690.28	264.55	8%
2000	3923.36	233.08	6%
2001	4459.87	536.51	14%
2002	4774.06	314.19	7%
2003 Request	5369.34	595.28	12%
2004 Request	5577.83	208.49	4%

NSF By Account (Constant FY 2000 Dollars)

(Estimated Dollars in Millions)

Fiscal Year	NSF	Dollar Increase	Percent Increase
51	0.93		
52	20.52	19.59	2112%
53	25.67	5.15	25%
54	45.62	19.95	78%
55	70.97	25.35	56%
56	88.57	17.59	25%
57	206.21	117.64	133%
58	256.53	50.32	24%
59	677.86	421.33	164%
60	799.41	121.55	18%
61	869.59	70.18	9%
62	1281.71	412.12	47%
63	1556.69	274.99	21%
64	1700.61	143.92	9%
65	1961.24	260.63	15%
66	2151.27	190.03	10%
67	2079.90	-71.37	-3%
68	2160.57	80.67	4%
69	1786.19	-374.37	-17%
70	1811.14	24.94	1%
71	1850.45	39.32	2%
72	2139.51	289.06	16%
73	2081.75	-57.77	-3%
74	2054.18	-27.57	-1%
75	1997.48	-56.70	-3%
76	1947.18	-50.30	-3%
77	1979.89	32.71	2%
78	2008.41	28.52	1%
79	2009.75	1.33	0%
80	1943.84	-65.91	-3%
81	1879.65	-64.19	-3%
82	1697.84	-181.81	-10%
83	1792.96	95.12	6%
84	2051.26	258.30	14%
85	2291.01	239.75	12%
86	2218.27	-72.74	-3%
87	2356.50	138.23	6%
88	2417.90	61.40	3%
89	2548.12	130.23	5%
90	2639.48	91.36	4%
91	2942.57	303.08	11%
92	3119.80	177.24	6%
93	3293.26	173.46	6%
94	3502.40	209.14	6%
95	3755.25	252.85	7%
96	3612.45	-142.80	-4%
97	3652.89	40.45	1%
98	3747.94	95.05	3%
99	3985.07	237.13	6%
2000	4152.88	167.81	4%
2001	4612.83	459.95	11%
2002	4851.99	239.15	5%
2003 Request	5369.34	517.35	11%
2004 Request	5505.53	136.19	3%

Table 10.1—GROSS DOMESTIC PRODUCT AND DEFLATORS USED IN THE HISTORICAL TABLES: 1940–2007
(Fiscal Year 1996 = 1.000)

Year	GDP Deflator	FY1997=1	FY1998=1	FY1999=1	**FY 2000=1**	FY 2001=1	FY 2002=1	FY 2003=1
1951	0.1816	0.1781	0.1756	0.1734	0.1723	0.1684	0.1654	0.1628
1952	0.1887	0.1851	0.1825	0.1802	0.1792	0.1751	0.1721	0.1693
1953	0.1923	0.1886	0.1860	0.1836	0.1825	0.1783	0.1752	0.1724
1954	0.1946	0.1909	0.1882	0.1858	0.1846	0.1804	0.1772	0.1744
1955	0.1962	0.1924	0.1898	0.1873	0.1862	0.1819	0.1788	0.1759
1956	0.2014	0.1975	0.1948	0.1923	0.1911	0.1867	0.1835	0.1805
1957	0.2089	0.2049	0.2021	0.1994	0.1983	0.1938	0.1904	0.1873
1958	0.2152	0.2111	0.2081	0.2055	0.2043	0.1996	0.1962	0.1930
1959	0.2187	0.2145	0.2115	0.2088	0.2075	0.2028	0.1992	0.1960
1960	0.2212	0.2170	0.2139	0.2112	0.2100	0.2052	0.2016	0.1984
1961	0.2243	0.2200	0.2169	0.2141	0.2130	0.2081	0.2045	0.2012
1962	0.2268	0.2225	0.2194	0.2165	0.2154	0.2105	0.2068	0.2035
1963	0.2298	0.2254	0.2223	0.2194	0.2181	0.2131	0.2094	0.2060
1964	0.2325	0.2281	0.2249	0.2220	0.2207	0.2157	0.2119	0.2085
1965	0.2366	0.2321	0.2288	0.2259	0.2245	0.2194	0.2156	0.2121
1966	0.2417	0.2371	0.2338	0.2308	0.2293	0.2241	0.2202	0.2166
1967	0.2494	0.2446	0.2412	0.2381	0.2367	0.2313	0.2273	0.2236
1968	0.2584	0.2535	0.2499	0.2467	0.2451	0.2395	0.2353	0.2316
1969	0.2701	0.2649	0.2612	0.2579	0.2563	0.2504	0.2461	0.2421
1970	0.2849	0.2795	0.2756	0.2720	0.2703	0.2641	0.2595	0.2554
1971	0.2992	0.2935	0.2894	0.2857	0.2838	0.2773	0.2725	0.2681
1972	0.3132	0.3072	0.3029	0.2990	0.2972	0.2904	0.2854	0.2808
1973	0.3271	0.3208	0.3164	0.3123	0.3103	0.3032	0.2979	0.2932
1974	0.3504	0.3437	0.3389	0.3345	0.3327	0.3251	0.3194	0.3143
1975	0.3867	0.3793	0.3740	0.3692	0.3673	0.3589	0.3527	0.3470
1976	0.414	0.4061	0.4004	0.3953	0.3938	0.3848	0.3781	0.3720
1977	0.4451	0.4366	0.4305	0.4250	0.4233	0.4136	0.4064	0.3999
1978	0.4756	0.4665	0.4600	0.4541	0.4518	0.4415	0.4338	0.4268
1979	0.5142	0.5044	0.4973	0.4909	0.4882	0.4770	0.4687	0.4612
1980	0.5599	0.5492	0.5415	0.5346	0.5310	0.5189	0.5098	0.5017
1981	0.6142	0.6025	0.5941	0.5864	0.5830	0.5697	0.5598	0.5508
1982	0.6572	0.6446	0.6357	0.6275	0.6229	0.6087	0.5981	0.5885
1983	0.6861	0.6730	0.6636	0.6551	0.6504	0.6355	0.6245	0.6145
1984	0.7114	0.6978	0.6881	0.6792	0.6744	0.6590	0.6475	0.6371
1985	0.7349	0.7208	0.7108	0.7016	0.6963	0.6804	0.6686	0.6578
1986	0.7526	0.7382	0.7279	0.7185	0.7125	0.6962	0.6841	0.6731
1987	0.7733	0.7585	0.7479	0.7383	0.7311	0.7144	0.7020	0.6907
1988	0.7986	0.7833	0.7724	0.7625	0.7541	0.7369	0.7241	0.7124
1989	0.8293	0.8134	0.8021	0.7918	0.7834	0.7655	0.7522	0.7401
1990	0.8605	0.8440	0.8323	0.8216	0.8125	0.7939	0.7801	0.7676
1991	0.894	0.8769	0.8647	0.8535	0.8430	0.8237	0.8094	0.7964
1992	0.9174	0.8999	0.8873	0.8759	0.8642	0.8444	0.8298	0.8164
1993	0.9393	0.9213	0.9085	0.8968	0.8838	0.8636	0.8486	0.8350
1994	0.9596	0.9412	0.9281	0.9162	0.9028	0.8822	0.8668	0.8529
1995	0.9804	0.9616	0.9483	0.9360	0.9218	0.9007	0.8851	0.8709
1996	1	0.9809	0.9672	0.9547	0.9395	0.9180	0.9021	0.8876
1997	1.0195	1	0.9861	0.9734	0.9559	0.9340	0.9178	0.9031
1998	1.0339	1.0141	1	0.9871	0.9675	0.9454	0.9289	0.9140
1999	1.0474	1.0274	1.0131	1	0.9802	0.9578	0.9411	0.9260
2000	1.069	1.0486	1.0339	1.0206	1	0.9771	0.9602	0.9447
2001	1.0937	1.0728	1.0578	1.0442	1.0234	1	0.9826	0.9668
2002 estimate	1.1	1.0790	1.0639	1.0502	1.0415	1.0177	1	0.9839
2003 estimate	1.6	1.5694	1.5475	1.5276	1.0585	1.0343	1.0163	1
2004 estimate	1.2	1.1770	1.1607	1.1457	1.0724	1.0479	1.0297	1.0131
2005 estimate	1.3	1.2751	1.2574	1.2412	1.0858	1.0610	1.0425	1.0258
2006 estimate	1.5	1.4713	1.4508	1.4321	1.1021	1.0769	1.0582	1.0412
2007 estimate	1.7	1.6675	1.6443	1.6231	1.1204	1.0948	1.0758	1.0585
2008 estimate	2	1.9617	1.9344	1.9095	1.1419	1.1158	1.0964	1.0788
2009 estimate	2	1.9617	1.9344	1.9095	1.1651	1.1385	1.1187	1.1007

Centers Supported by NSF in FY 2003

Center	Institution
Engineering Research Centers	
Advanced Engineering Fibers and Films	Clemson U
Bioengineering Educational Technology	Vanderbilt U
Biomimetic Microelectronic Systems	U of Southern California
Biotechnology Process Engineering	Mass Institute of Tech
Collaborative Adaptive Sensing of the Atmosphere	U of Mass, Amherst
Computer-Integrated Surgical Systems and Technologies	Johns Hopkins U
Engineered Biomaterials	U of Washington
Engineering of Living Tissue	Georgia Institute of Tech
Environmentally Beneficial Catalysis	U of Kansas
Environmentally Benign Semiconductor Manufacturing	U of Arizona
Extreme Ultraviolet Science and Technology	Colorado State U
Integrated Media Systems	U of Southern California
Low Cost Electronic Packaging	Georgia Institute of Tech
Marine Bioproducts Engineering	U of Hawaii
Neuromorphic Systems Engineering	California Institute of Tech
Particle Science & Technology	U of Florida
Power Electronic Systems	Virginia Tech U
Reconfigurable Machining Systems	U of Michigan
Subsurface Sensing and Imaging Systems	Northeastern U
Wireless Integrated MicroSystems	U of Michigan
Engineering Research Groups	
Nano Modeling and Simulation Groups:	
Computational Nano-Engineering for Patterned Magnetic Nanostructures	Stanford U
Evolution of Nanoscale Film Morphology	Kansas State U
Molecular Nanoelectronics: Simulation from Molecules to Circuits	Purdue U
Molecular Transport in Nanostructured Materials	U of Delaware
Nanoengineered Materials: Polymer Composites to Structured Adsorbents	U of Pittsburgh
Nanoscale Modeling of Flow of Macromolecules through Microfluidic Devices	U of Wisconsin-Madison
Nanoscale Simulation by Quantum Computation	Mass Institute of Tech
XYZ-on-a-Chip Groups:	
Assembly of Integrated Near-field Optical Microfluidic Devices by Thin-film Transfer and Micromachining of Teflon, Group-III Nitrides and Silicon	U of California-Berkeley
Biomolecular Motor/Nanotube Integration for Actuator Nanotechnology	U of North Carolina-Chapel Hill
Cellular Electrophysiology on a Chip	U of Missouri-Columbia
Development and Fabrication of Three-Dimensional Microdevices	Boston College
Large Area Biosensing Electronics	Carnegie Mellon U
Micromachined Magnetically Reconfigurable Frequency Selective Surfaces	U of California-Los Angeles
A Nanomaterials/Nanoelectrochemical Route for Communication Between Biochemical Processes and IC Chips	U of Florida
Patterning Flow at the Microscale: Open Architecture Design for Integrated Fluidic Chips	Princeton U
UV Fluorescence/Absorption Micro-Analysis System	Texas Tech U

Science and Technology Centers

Adaptive Optics	U of California-Santa Cruz
Advanced Materials for Water Purification	U of Illinois
Behavioral Neuroscience	Georgia State Univ
Biophotonics Science and Technology	U of California-Davis
Earth Surface Dynamics	U of Minnesota
Embedded Networked Sensing	U of California-Los Angeles
Environmentally Responsible Solvents and Processes	U of North Carolina
Integrated Space Weather Modeling	Boston U
Materials and Devices for Information Technology Research	U of Washington
Nanobiotechnology	Cornell U
Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona

Plant Genome Virtual Centers

A Protein Interaction Database for Rice Protein Kinases	U of Nebraska-Lincoln
A Rice Oligononucleotide Array	U of California-Davis
Chromatin-based Control of Gene Expression	U of Arizona
Comparative and Functional Genomics of Tomato	Cornell U
Comparative Evolutionary Genomics of Cotton	Iowa State U
Functional and Comparative Genomics of Disease Resistance Genes	U of California-Davis
Deep Transcriptional Profiling of Rice Using Signature Sequencing	U of Delaware
Dissecting Phytophthora Resistance in Soybean using Expression Profiling and Analysis of Quantitative Train Loci	VA Polytechnic Inst & St U
Finishing the Rice Genome	Cold Spring Harbor Lab
Functional Analyses of Genes Involved in Maize Leaf Initiation	U of Georgia
Functional Genomic Analysis of Tomato Fruit Flavor and Nutrition Pathways	U of Florida
Functional Genomics of Hemicellulose Biosynthesis	Michigan State U
Functional Genomics of Maize Centromeres	U of Georgia
Gene Inventory and Function of the Model Legume	U of California-Davis
Grass Genome Biodiversity Maize and *Arabidopsis* using Novel Spectroscopies	U of Georgia
High Density Genetic Map of Maize Transcripts	Iowa State U
Identification and Characterization of Plant Cell Wall Mutants	Purdue U
Vitis vinifera: Abiotic Stress and Wine Quality	U of Nevada-Reno
Microarray Resources for Maize Research	U of Arizona
Molecular and Functional Diversity in the Maize Genome	U of Wisconsin-Madison
Oryza Map Alignment Project	U of Arizona
Plant Genes Involved in Plant Transformation	Purdue U
Sequencing the Gene Space of a Model Legume	U of Minnesota
Systematic Transposon Mutagenesis of the Maize Gene	Cold Spring Harbor Lab
Techniques for Efficient Finishing and Mapping of Gene Enriched Sequences	U of Arizona
The Floral Genome Project	Penn State U
The Plant Ontology Consortium	Cold Spring Harbor Lab
Understanding Plastid Differentiation in Maize Through Expression Analysis	Cornell U
Potato Functional Genomics:Analysis of Growth, Development, Metabolism and Responses to Stress	U of California-Berkeley

Materials Centers

Advanced Carbon Materials Center	U of Kentucky
Center for Complex Materials	Princeton U
Center for Materials for Information Science	U of Alabama

Center for Materials Research	Cornell U
Center for Materials Science and Engineering	Mass Institute of Tech
Center for Micro- and Nanomechanics of Materials	Brown U
Center for Nanoscopic Materials Design	U of Virginia
Center for Nanomagnetic Structures	U of Nebraska
Center for Nanoscale Science	Pennsylvania State U
Center for Nanostructured Materials	U of Wisconsin
Center on Nanostructured Materials	Johns Hopkins U
Center for Oxide Thin Films, Probes and Surfaces	U of Maryland
Center for Polymer Science and Engineering	U of Massachusetts
Center for Polymers at Engineered Interfaces	SUNY-Stony Brook/ CUNY/ Polytechnic U
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford U/ UC-Davis/IBM
Center for Response-Driven Polymeric Films	U of Southern Mississippi
Center for Science and Engineering of Materials	California Institute of Tech
Center for Semiconductor Physics in Nanostructures	U of Oklahoma/ U of Arkansas
Center for Sensor Materials	Michigan State U
Center for Thermal Spray Research	SUNY-Stoney Brook
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder
International Materials Institute: Advanced Neutron Scattering Network for Education and Research	U of Tenn/Oak Ridge Nat Lab
International Materials Institute: Materials Informatics and Combinatorial Materials Science	Rennselaer Poly/U of
Laboratory for Research on the Structure of Matter	U of Pennsylvania
Materials Research Center	U of Chicago
Materials Research Center	Harvard U
Materials Research Center	Northwestern U
Materials Research Science and Engineering Center	U of California-Santa Barbara
Materials Research Science and Engineering Center	U of Minnesota
Materials Research Science and Engineering Center	Carnegie Mellon U
Materials Research Science and Engineering Center	Columbia U
US/Africa Materials Institute	Princeton U
Center for Ecological Analysis and Synthesis	U of California-Santa Barbara
Long Term Ecological Research Sites	
Arctic Tundra: Toolik Field Station	Marine Biological Lab
Bonanza Creek Experimental Forest	U of Alaska
Cedar Creek Natural History Area	U of Minnesota
Central Arizona-Phoenix Urban LTER	Arizona State U
Coweeta Hydrologic Laboratory	U of Georgia
Florida Coastal Everglades	Florida International U
Georgia Coastal Ecosystems	U of Georgia
H.J. Andrews Experimental Forest	Oregon State U
Harvard Forest	Harvard U
Hubbard Brook Experimental Forest	Syracuse U
Jornada Experimental Range	Duke U
Kellogg Biological Station	Michigan State U
Konza Prairie Research Natural Area	Kansas State U
Luquillo Experimental Forest	U of Puerto Rico-Rio Piedros
McMurdo Dry Valleys, Antarctica	Desert Research Institute
Metropolitan Baltimore Urban LTER	Institute of Ecosystem Studies
Niwot Ridge-Green Lakes Valley	U of Colorado
North Temperate Lakes	U of Wisconsin
Palmer Station, Antarctica	U of California
Plum Island Sound	Woods Hole

Santa Barbara Coastal LTER	U of California-Santa Barbara
Sevilleta National Wildlife Refuge	U of New Mexico
Shortgrass Steppe	Colorado State U
Virginia Coast Reserve	U of Virginia
Earthquake Engineering Research Centers	
Mid-America Earthquake Center	U of Illinois-Champaign-Urbana
Multidisciplinary Center for Earthquake Engineering Research	State U of NY-Buffalo
Pacific Earthquake Engineering Research Center	U of California-Berkeley
Chemistry Centers	
Chemical and Microbial Interactions at Environmental Interfaces	Stanford U
Environmental Redox-Mediated Dehalogenation Chemistry	Johns Hopkins U
Fundamental Studies of Nonparticle Formation in Air Pollution	Worcester Polytechnic Inst
Institute for Environmental Bioinorganic Chemistry	Princeton U
Laboratory for Molecular Sciences	California Institute of Tech
Molecular Environmental Chemistry of Mn Oxide Biomineralization	U of California-San Diego
Molecular Isotopic Tools for Environmental Research	Woods Hole
Molecular Level Analysis of Macromolecule-Surface Interactions in Bacterial Adhesion	Penn State U
Molecular Structure and Microstructure of PM2.5 Derived from Stationary and Mobile Fossil Fuel Sources	U of Kentucky
Role of Environmental Molecular Interfaces on the Chemical and Biological Reactivity of Pollutants	Ohio State U
Moderate Resolution Protein Structures by Chemical Cross-Linking and Mass Spectrometry	U of California-San Francisco
Center for Environmental Molecular Science (CEMS)	SUNY-Stony Brook
Role of Environmental Molecular Interfaces on the Chemical and Biological Reactivity of Pollutants	Ohio State U
Actinides and Heavy Metals in the Environment - The Formation, Stability, and Impact of Nano- and Micro-Particles	U of Notre Dame
Atom and Group Transfer Reactions: A Combined Synthetic, Structural, Theoretical, Kinetic, and Solution Calorimetry Investigation	Mass Institute of Tech
Next Generation Aromatics	U of Georgia
Multi-dimensional Molecular Metals, Crystal Design, and Superconductivity	Cornell U
An Integrated Approach to Understanding the Air-Water Interface in Atmospherically Relevant Systems	U of California-Irvine
Micro Imaging for Sensory and Materials Applications	Mass Institute of Tech
Synthesis and Characterization of New Molecular Clusters of Tetrels	U of California-Davis
Alternative Chemistries for Barrier Materials in Cu Metallization	U of Florida
Multiply Bound Polymer Chains:Novel Chemistry for Improved Interfacial Properties	U of Tennessee
Synthesis and Characterization of Fluorescent Porphyrinoid Bioconjugates for Imaging and Bioanalyses	Louisiana State Univ
Lanthanide Binding Tags:New Chemical Tools for Proteomics	Mass Institute of Tech
Mathematical Sciences Research Institutes	
American Institute of Mathematics	Palo Alto

Institute for Mathematics and Its Applications	U of Minnesota
Institute for Pure and Applied Mathematics	U of California-Los Angeles
Mathematical Biosciences Institute	Ohio State U
Mathematical Sciences Research Institute	Berkeley
Statistical and Applied Mathematical Sciences Institute	Duke U

Information Technology Centers

A Mobile Sensor Web for Polar Ice Sheet Measurements	U of Kansas
Active Information Spaces Based on Ubiquitous Computing	U of Illinois-Champaign-Urbana
Adaptable Voice Translation for Minority Languages	Carnegie Mellon U
Adaptive Software for Field-driven Simulations	Cornell U
An Ensemble Approach to Data Assimilation in the Earth Sciences	Mass Institute of Tech
An International Virtual-Data Grid Laboratory for Data Intensive Science	U of Florida
Building the Framework of the National Virtual Observatory	Johns Hopkins U
Building the Tree of Life -- A National Resource for Phyloinformatics and Computational Phylogenetics	University of New Mexico
Capturing, Coordinating and Remembering Human Experience	Carnegie Mellon U
Center for Applied Algorithms	Carnegie Mellon U
Center for Bits and Atoms	Mass Institute of Tech
Center for Computational Biophysics	U of California - San Diego
Cognitive and Social Design of Robotic Assistants	Carnegie Mellon U
Collaborative Research for a National Center for Empirical Software Engineering Research	U of Maryland-College Park
Collaborative Research: Modular Ocean Data Assimilation	Oregon State U
Computational Geometry for Structural Biology and Bioinformatics	Duke U
Computational Infrastructure for Microfluidic Systems with Applications to Biotechnology	U of California-Santa Barbara
Computational Learning and Discovery in Biological Sequence, Structure and Function Mapping	Carnegie Mellon U
Computational Logic Tools for Research and Education	Stanford U
Computational Tools for Modeling, Visualizing and Analyzing Historic and Archaeological Sites	Columbia U
Creating the Next Generation of Intelligent Animated Conversational Agents	U of Colorado-Boulder
Data Centers - Managing Data with Profiles	Brown U
Design and Simulation of Biologically-inspired Nanolattice	U of Florida
Design Conformant Software	Mass Institute of Tech
Digital Clay for Shape Input and Display	GA Tech Res Corp-GIT
Discrete Models & Algorithms in the Sciences	U of California-Berkeley
Dynamic Cooperative Performance Optimization	U of Massachusetts-Amherst
Enabling the Science Environment for Ecological Knowledge	U of New Mexico
Flexible Environments for Grand-Challenge Climate Simulation	U of Chicago
Foundations of Hybrid and Embedded Software Systems	U of California - Berkeley
Foundations of Solid-State Quantum Information Processing	U of Urbana-Champaign
FrameNet++: An On-Line Lexical Semantic Resource and its Application to Speech & Language Understanding	Int'l Computer Sci Inst
From Bits to Information: Statistical Learning Technologies for Digital Information Management and Search	Mass Institute of Tech
From the Web to the Global InfoBase	Stanford U

The GriPhyN Project: Towards Peta-Scale Virtual Data Grids	U of Florida
Heterogeneous System Integration in System-on-a-Chip Designs	U of Washington
Hierarchical and Reconfigurable Schemes for Distributed Control over Heterogeneous Network	U of Illinois-Champaign-Urbana
High-Speed Wavelength-Agile Optical Networks	U of Urbana-Champaign
Institute for Quantum Information	California Institute of Tech
Interacting with the Visual World: Capturing, Understanding, and Predicting Appearance	Columbia U
Interaction and Participation in Integrated Land Use, Transportation, and Environmental Modeling	U of Washington
Investigation of a Model for Online Resource Creation and Sharing in Educational Settings	Michigan State U
ITR Linked Environments for Atmospheric Discovery (LEAD)	U of Oklahoma
Latent Semantic Analysis: Theory and Technology	U of Colorado-Boulder
Learning-Centered Design Methodology: Meeting the Nation's Need for Computational Tools for K-12 Science Education	U of Michigan-Ann Arbor
Low Frequency Array (LOFAR) - A Digital Radio Telescope	Northeast Radio Obs Corp
Methodologies and Tools for Designing and Implementing Large Scale Real-Time Systems	Vanderbilt U
Molecular Computation in Ciliates	Princeton U
Multilingual Access to Large Spoken Archives	Survivors of the Shoah Visual History Foundation
Multimodal Human Computer Interaction: Toward a Proactive Computer	U of Illinois-Champaign-Urbana
A Multiresolution Analysis for the Global Internet	U of Wisconsin-Madison
Networked Infomechanical Systems (NIMS)	U of Cal Los Angeles
New Approached to Human Capital Development through Information Technology Research	Northeastern U
Next Generation Bio-Molecular Imaging and Information Discovery	U of Cal Santa Barbara
A 100 Megabits per second to 100 Million Households	Carnegie Mellon University
The Open Source Quality Project	U of California-Berkeley
Personalized Spatial Audio via Scientific Computing and Computer Vision	U of Maryland-College Park
A Petabyte in Your Pocket	U of Wisconsin-Madison
Procedural Representation and Visualization Enabling Personalized Computational Fluid Dynamics	Purdue U
Quality-Scalable Information Flow Systems for Environmental Observation and Forecasting	Oregon Health Sciences U
Quantum Computing using Electrons on Helium Films	Case Western Reserve U
Real-Time Long-Distance Terascale Computation for Full Bandwidth Tele-Immersion	U of North Carolina-Chapel Hill
A Research Project to Create Cyberinfrastructure for the Geosciences	U of California - San Diego
Responding to the Unexpected	U of Cal Irvine
Responsive Virtual Human Technology Research	Research Triangle Inst
Robust Large-Scale Distributed Systems	Mass Institute of Tech
Self-Assembly of DNA Nano-Scale Structures for Computation	Duke U
Sensitive Information in a Wired World	Stanford University
Simulation of Flows with Dynamic Interfaces on Multi-	Carnegie-Mellon U

Teraflop Computers	
Social and Economic Implications of IT: What is Really Happening?	Mass Institute of Tech
Societal Scale Information Systems: Technologies, Design and Applications	U of California-Berkeley
Statistical Data Mining for Cosmology	Carnegie Mellon U
Sustainable and Generalizable Technologies to Support Collaboration in Science	U of Michigan-Ann Arbor
Taming the Data Flood: Systems that Evolve, are Available, and Maintainable (SEAM)	U of California-Berkeley
The Impacts of IT on Individuals and Their Organizations: Conditions of Change and Transformation.	U of California-Irvine
The OptIPuter	U of California - San Diego
The SCEC Community Modeling Environment: An Information Infrastructure for System-Level Earthquake Research	U of Southern California
The System Architecture of a Computing Utility	Stanford U
Understanding the Social Impact of the Internet: A Multifaceted Multidisciplinary Approach	U of Maryland-College Park
Virtual Grid Application Development Software (VGrADS)	Rice Univ
Virtual Instruments: Scalable Software Instruments for the Grid	U of California-San Diego
Visualization of Multi-Valued Scientific Data: Applying Ideas from Art and Perceptual Psychology	Brown U
Nanoscale Science and Engineering Centers	
Integrated Nanopatterning and Detection Technologies	Northwestern U
Nanoscale Systems in Information Technologies	Cornell U
Science of Nanoscale Systems and their Device Applications	Harvard U
Electronic Transport in Molecular Nanostructures	Columbia U
Nanoscience in Biological and Environmental Engineering	Rice U
Directed Assembly of Nanostructures	Rensselaer Polytechnic Inst
Center for Integrated and Scalable Nanomanufacturing	U of Calif-Los Angeles
Nanoscale Chamical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Champaign-Urbana
Physics Frontiers Centers	
Center for Cosmological Physics	U of Chicago
Center for Gravitational-Wave Phenomenology	Pennsylvania State U
Frontiers of Optical, Coherent Ultrafast Science	U of Michigan
Center for the Study of the Origin and Structure of Matter	Hampton U
Center for Theoretical Biological Physics	U of California-San Diego
Research Centers on the Human Dimensions of Global Change	
Center for Integrated Study of the Human Dimensions of Global Change	Carnegie Mellon U
Center for the Study of Institutions, Population, and Environmental Change	Indiana U
National Consortium for Violence Research	Carnegie Mellon U
Children's Research Centers	
Children's Digital Media Center	Georgetown U
North Carolina Child Development Research Collaborative	U of North Carolina
Cornell Center for Research on Children	Cornell U
Center for Research on Culture, Development and Education	New York U
Center for the Analysis of Pathways from Childhood to	U of Michigan

Adulthood

RESEARCH AND RELATED ACTIVITIES

RESEARCH AND RELATED ACTIVITIES $4,452,310,000

The FY 2005 Budget Request for the Research and Related Activities (R&RA) Appropriation is $4,452.31 million, an increase of $200.95 million, or 4.7 percent more than the FY 2004 Estimate of $4,251.36 million. Support from the R&RA Appropriation enables U.S. leadership and accelerated progress across the expanding frontiers of scientific and engineering research and education. In turn, these activities support areas of inquiry critical to long-term U.S. economic strength, security, and quality of life.

NSF investments in R&RA reflect the Foundation's four strategic outcomes:

- **People -** developing a diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens.
- **Ideas -** enabling discovery across the frontier of science and engineering, connected to learning, innovation and service to society.
- **Tools -** providing broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation.
- **Organizational Excellence** – enabling an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.

Research activities spur the knowledge, ideas, tools and approaches that increase understanding, solve problems, and stimulate opportunities for economic growth. The productive exchange of knowledge, information and technology can accelerate innovation, often yielding new insights into the underlying research. Researchers from different disciplines increasingly transcend traditional boundaries to solve complex problems. Students work with senior scientists performing research, fostering the natural integration of research and education, and obtaining the skills needed for the next generation's workforce of scientists and engineers.

Research and Related Activities Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biological Sciences	570.49	586.89	599.93	13.04	2.2%
Computer & Information Science & Engineering	589.29	604.65	618.05	13.40	2.2%
Engineering	541.70	565.13	575.90	10.77	1.9%
Geosciences	691.84	713.10	728.50	15.40	2.2%
Mathematical & Physical Sciences	1,040.70	1,091.51	1,115.50	23.99	2.2%
Social, Behavioral & Economic Sciences	158.63	175.67	190.67	15.00	8.5%
Office of International Science & Engineering	39.97	28.12	34.04	5.92	21.1%
U.S. Polar Research Programs	255.41	274.08	281.66	7.58	2.8%
U.S. Antarctic Logistical Support Activities	68.55	68.07	68.07	0.00	0.0%
Integrative Activities	97.86	144.14	239.99	95.85	66.5%
Total, Research and Related Activities	$4,054.43	$4,251.36	$4,452.31	$200.95	4.7%

Totals may not add due to rounding.

BIOLOGICAL SCIENCES

BIOLOGICAL SCIENCES $599,930,000

The FY 2005 Budget Request for the Biological Sciences Activity (BIO) is $599.93 million, an increase of $13.04 million over the FY 2004 Estimate of $586.89 million.

Biological Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Molecular & Cellular Biosciences	121.89	121.77	124.98	3.21	2.6%
Integrative Biology & Neuroscience	107.47	107.41	110.63	3.22	3.0%
Environmental Biology	108.28	108.26	111.48	3.22	3.0%
Biological Infrastructure	75.03	80.22	85.47	5.25	6.5%
Emerging Frontiers	73.37	79.76	77.90	-1.86	-2.3%
Plant Genome	84.45	89.47	89.47	0.00	0.0%
Total, BIO	$570.49	$586.89	$599.93	$13.04	2.2%

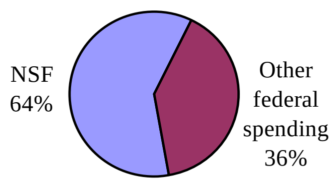
Totals may not add due to rounding.

The mission of the Biological Sciences Activity (BIO) is to support the vitality of the biological sciences at U.S. colleges and universities, especially in those areas where NSF has a major responsibility. BIO supports research, infrastructure, and education.

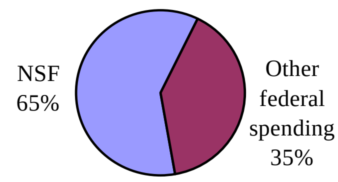
RELEVANCE

BIO is the dominant federal supporter of basic research in non-medical aspects of the biological sciences at academic institutions – providing over 65 percent of the support for these activities. Because most federal support for the life sciences – over 85 percent – goes to health-related research funded by the National Institutes of Health, NSF's contribution to the broader array of the biological sciences is significant and strategically focused – particularly in such areas as environmental biology and plant sciences.

Federal Support for Basic Research in Environmental Biology at Academic Institutions

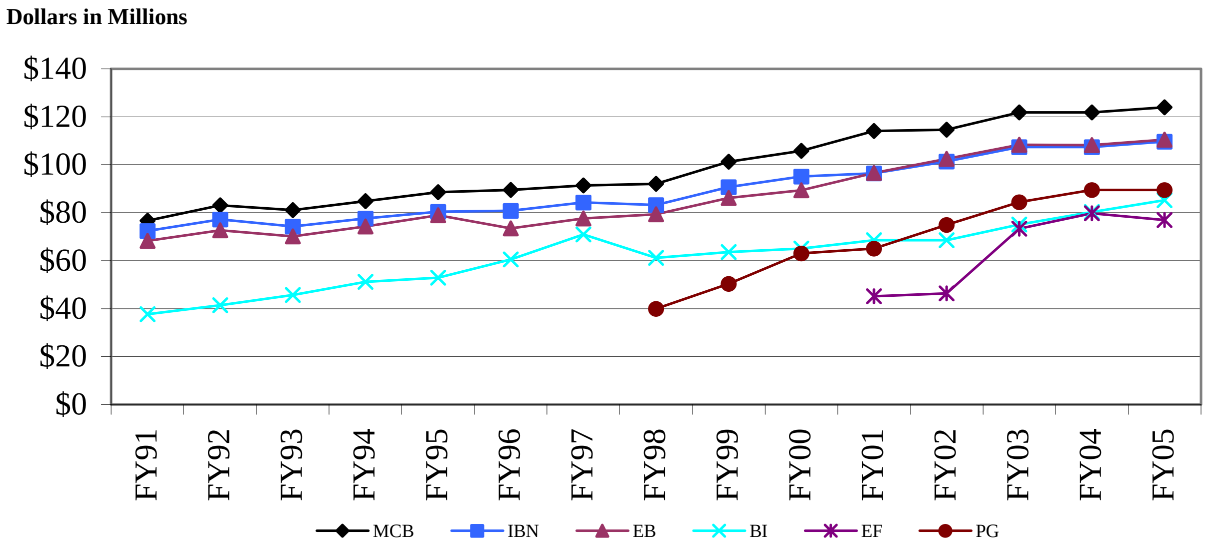


Federal Support for Basic Research in Non-Medical Biological Sciences at Academic Institutions



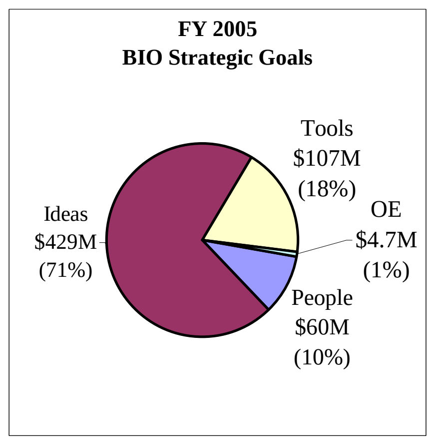
Fundamental research on understanding all aspects of "life" – from the cell to whole ecosystems is supported within NSF – where the ability to integrate the range of biological sub-disciplines is unique. BIO support represents 64 percent of all federal funding for basic research in environmental biology and an estimated 55 percent of support in plant biology at academic institutions. Additionally, NSF plays a special role in supporting interdisciplinary biological research, since collaborations among disciplines represented by the various R&RA Activities are possible. Issues of national importance related to the environment, economy and human welfare require an understanding of how living organisms function and interact with non-living systems. BIO supported research enhances this understanding.

BIO Subactivity Funding
(Dollars in Millions)



STRATEGIC GOALS

Four aims guide BIO's activities:



- PEOPLE: Improvement of the quality of biological sciences education and training and enhancement of diversity in all the fields of biology. BIO will continue to advance education and training for current biological scientists, increase the diversity of the biological sciences community, facilitate education and training for future generations of biological scientists, and enhance the general public's knowledge about biology.

- IDEAS: Advancement of understanding of major biological questions from a multidisciplinary view, including both maintaining adequate base support across all biological fields and identifying opportunities where more focused support can play a catalytic role in advancing scientific progress. 21st Century Biology is multidimensional, multidisciplinary, integrative, data-driven, education-oriented and global, encompassing conceptual and experimental approaches broader than those of the last Century.

- TOOLS: Enhancement of the infrastructure for the conduct of biological research. BIO will invest in instrumentation and facilities, including cyberinfrastructure; biological research resources; and genomics technologies.

- ORGANIZATIONAL EXCELLENCE: Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its strategic goals. This includes the cost of Intergovernmental Personnel Act appointments and contractors performing administrative functions.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	57.65	57.18	59.68	2.50	4.4%
Ideas	406.98	419.15	428.82	9.67	2.3%
Tools	101.74	106.44	106.71	0.27	0.3%
OE	4.12	4.12	4.72	0.60	14.6%
Total, BIO	$570.49	$586.89	$599.93	$13.04	2.2%

Totals may not add due to rounding.

PEOPLE (+ $2.50 million, for a total of $59.68 million)

BIO programs promote a diverse, internationally competitive workforce of scientists, engineers, educators and knowledgeable citizens. These programs also seek to achieve participation in biology that reflects the diversity of the U.S. population.

BIO People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Individuals	46.82	46.26	48.26	2.00	4.3%
Institutions	2.49	2.71	2.71	0.00	0.0%
Collaborations	8.34	8.21	8.71	0.50	6.1%
Total, BIO	$57.65	$57.18	$59.68	$2.50	4.4%

Totals may not add due to rounding.

Enhancement of multidisciplinary education, teaching, and training activities including:

<u>INDIVIDUALS</u>

- A total of $13.20 million, a $2.0 million increase, is provided to enhance support for the Integrative Graduate Education and Research Training (IGERT) program. NSF developed this agency-wide program to enhance the development of innovative, research-based graduate education and training programs in Ph.D.-granting institutions and to meet the need for a cadre of broadly prepared Ph.D.s with the technical, professional, and personal skills essential to address the varied career demands of the future. The IGERT program will support projects based on multidisciplinary research themes and organized by diverse groups of investigators with appropriate research and teaching expertise. The use of a multidisciplinary research theme provides a framework for the integration of research and educational activities, and for collaborative efforts in training that span many disciplinary areas.

- A total of $35.06 million is provided for other support to individuals, which includes Faculty Early Career Development (CAREER) Awards, Postdoctoral Research Fellowships, Research Experience for Undergraduates (REU) Supplements, Undergraduate Mentoring in Environmental Biology (UMEB), Cross-disciplinary Research at Undergraduate Institutions (CRUI), and Research Experiences for Teachers (RET).

INSTITUTIONS

- Support for the ADVANCE program, designed to help institutions increase the participation and advancement of women in academic sciences and engineering careers, will continue at $2.71 million.

COLLABORATIONS

- A total of $1.64 million, a $500,000 increase, is provided for the NSF Graduate Teaching Fellows in K-12 Education (GK-12). This program supports fellowships and associated training that enable graduate students and advanced undergraduates in science, technology, engineering, and mathematics to serve as knowledgeable resources in K-12 schools.

- A total of $7.07 million is provided for other collaborative programs such as Research Experiences for Undergraduates (REU) Sites, and Minority Institutions of Excellence.

IDEAS (+ $9.67 million, for a total of $428.82 million)

BIO Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	331.84	339.48	346.53	7.05	2.1%
Centers Programs	57.54	61.85	64.47	2.62	4.2%
Capability Enhancement	17.60	17.82	17.82	0.00	0.0%
Total, BIO Ideas	$406.98	$419.15	$428.82	$9.67	2.3%

Totals may not add due to rounding.

The Biological Sciences Activity provides support for research to advance understanding of the underlying principles and mechanisms governing life; it provides research support for enhancement of multidisciplinary research activities, interagency partnerships, and international activities. BIO's support for discovery spans all the biological disciplines. BIO-supported research effectively builds the knowledge base needed to address societal interests in areas as diverse as food, nutrition, agriculture, and the environment.

FUNDAMENTAL SCIENCE AND ENGINEERING

- A total of $346.53 million, a $7.05 million increase, will support awards central to 21st Century Biology. As research breakthroughs are realized from recent advances in genomics, proteomics, informatics, computer science, mathematics, physics, chemistry, engineering and the earth and social sciences, a new biology has emerged that is multidimensional, multidisciplinary, information-driven, education-oriented, and internationally engaged.

- Frontiers in Biological Research (FIBR) is a key component of the Subactivity, Emerging Frontiers, a division established in FY 2003 to serve as an incubator for 21st Century Biology activities. FIBR is designed to support ideas and approaches that do not fit within the boundaries of the subdisciplinary areas. Through FIBR, BIO intends to support groups of researchers to capitalize on synergistic interactions and to employ diverse tools to achieve an integrative understanding of clearly defined, important biological questions.
- BIO will support projects to utilize the latest genomics tools and techniques to gain an understanding of the biological diversity and functioning of complex environmental systems.
- Molecular-Level Understanding of Life Processes: BIO will continue to identify new opportunities, for example comparative or trans-kingdom genomics, that take full advantage of current molecular, computational and bioinformatics technologies to better understand plants, animals and microorganisms.
- Support for cyberinfrastructure will increase by $7.0 million to focus on domain-specific cyberinfrastructure and services enabling biological research and education. Support across BIO will focus on: access to information networks linking researchers worldwide; hardening software; software portability; enabling software development for the National Ecological Observatory Network (NEON); and data integration.

CENTERS PROGRAMS

BIO Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Science and Technology Centers	3.99	4.00	4.00	0.00	0.0%
Centers for Analysis and Synthesis	2.86	6.15	6.47	0.32	5.2%
Long Term Ecological Research Program	14.69	15.70	18.00	2.30	14.6%
Plant Genome Virtual Centers	36.00	36.00	36.00	0.00	0.0%
Total, BIO Centers	$57.54	$61.85	$64.47	$2.62	4.2%

Support for the BIO Centers and Center-like programs, totaling $64.47 million, an increase of $2.62 million over the FY 2004 Estimate, includes: the Center for Ecological Analysis and Synthesis (CEAS); Plant Genome Virtual Centers; the Center for Synthesis in Biological Evolution; the Center for Behavioral Neuroscience; and the Long Term Ecological Research program (LTER).

- Following recommendations from the “Twenty-Year Review of the NSF LTER Program,” LTER will be increased by $2.30 million in FY 2005 to provide incentives for interdisciplinary collaborations at LTER sites.
- The Center for Ecological Analysis and Synthesis (CEAS) promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. A small scheduled increase of $320,000, for a total of $3.47 million, is included in the FY 2005 Request.
- Plant Genome Virtual Centers (centers without walls) are collaboratories where coordinated, multi-investigator teams pursue comprehensive plant genome research programs relevant to

economically important plants or plant processes. In the FY 2005 Request, Plant Genome Virtual Centers will be funded at $36.0 million, equal to the FY 2004 Estimate.

CAPABILITY ENHANCEMENT

- Support for Capability Enhancement activities such as Research Opportunity Awards (ROA) and Research at Undergraduate Institutions (RUI) will continue at $17.82 million in FY 2005.

TOOLS (+$270,000, for a total of $106.71 million)

BIO Tools Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004	
				Amount	Percent
Facilities	1.20	5.20	5.20	0.00	0.0%
Infrastructure and Instrumentation	100.54	101.24	101.51	0.27	0.3%
Total, BIO Tools	$101.74	$106.44	$106.71	$0.27	0.3%

FACILITIES

- In FY 2004, the NEON Coordinating Consortium (NCC) and Project Office development is proposed to be initiated. These units will refine the NEON project, scope, budget, and schedule for research infrastructure. In FY 2005, $4.0 million in R&RA will provide support for finalizing development of the NCC and Project Office, and for funding research on enabling technologies.

INFRASTRUCTURE AND INSTRUMENTATION

- Funding for Research Resources, totaling $101.51 million, provides essential support for the core infrastructure needs of the community supported by the BIO Activity. This support includes: multi-user instrumentation, development of instrumentation and new techniques, living stock centers, marine laboratories and terrestrial field stations, databases and support for development of informatics tools and techniques.

ORGANIZATIONAL EXCELLENCE (+$600,000, for a total of $4.72 million)

Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its strategic goals. Requested funding for FY 2005 is $4.72 compared to $4.12 for FY 2004. This includes support for Intergovernmental Personnel Act appointments (IPAs), IPA's travel and the administrative contracts necessary to conduct program activities.

PRIORITY AREAS

In FY 2005, BIO will support research and education efforts related to broad, Foundation-wide priority areas in Biocomplexity in the Environment, Nanoscale Science and Engineering, Mathematical Sciences, and Human and Social Dynamics.

Biological Sciences Investments in NSF Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	26.00	39.86	39.86	0.00	0.0%
Nanoscale Science and Engineering	2.98	5.31	5.85	0.54	10.2%
Mathematical Sciences	0.91	2.21	2.21	0.00	0.0%
Human and Social Dynamics	N/A	0.50	0.50	0.00	0.0%

Information Technology Research as an NSF Priority Area will be terminated in FY 2004. In keeping with the incubating mission of Emerging Frontiers (EF), resources formerly associated with ITR will be distributed across all BIO divisions and used to support cyberinfrastructure activities such as database development and management and information networking. The remaining NSF Priority Areas will be enhanced by $540,000 for a total of $48.42 million.

Biocomplexity in the Environment: A total of $39.86 million will continue support for the Ecology of Infectious Disease, Microbial Genome Sequencing, Tree of Life, and the NSF-wide joint competition.

Nanoscale Science and Engineering: The increase of $540,000, for a total of $5.85 million, will continue support to emphasize development of nano-sensors.

Mathematical Sciences: A total of $2.21 million will continue support for interdisciplinary science and engineering through research on mathematical and statistical challenges posed by large data sets, managing and modeling uncertainty, and modeling complex nonlinear systems; and to foster curriculum development to incorporate mathematics into the study of biology.

Human and Social Dynamics: A total of $500,000 will be provided to support a focus on Modeling Human and Social Dynamics.

QUALITY

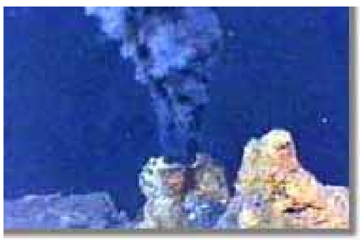
BIO maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The percent of research funds that were allocated to projects that undergo external merit review was 97 percent in FY 2003, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, BIO convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

The Directorate also receives advice from the Advisory Committee for Biological Sciences (BIOAC) on such issues as: the mission, programs, and goals that can best serve the scientific community; how BIO can promote quality graduate and undergraduate education in the biological sciences; and priority investment areas in biological research. The BIOAC meets twice a year. Members represent a cross section of biology and include members from institutions and industry. The Committee includes a balanced representation of women, under-represented minorities and geographic regions.

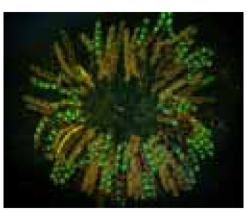
PERFORMANCE

Recent Research Highlights



BIO researchers pushed back the boundary for the existence of life in extreme environments by discovering a **single-celled microbe from a deep-sea hydrothermal vent** in the Pacific Ocean, which survives at temperatures previously thought impossible. The organism thrives at 121° Celsius, or about 250° Fahrenheit, which is well above the 100° C boiling point of water. This discovery provides a clue as to when and where life may have first appeared on Earth and portends a new generation of heat stabile enzymes for industry.

Using advanced infrared and Doppler radar imaging, BIO-supported researchers modeled the population density and foraging behavior of **Brazilian free-tailed bats** in south-central Texas. These aerial predators feed on insects in both natural and managed eco-systems. Using these combined methods, researchers determined that bats from two Texas caves provide pest control service for a number of crops, including cotton and corn. The estimated value of the protection afforded the cotton crop by bats from the two caves amounts to as much as 500 tons of cotton, or $258.0 million dollars annually. This suggests that protecting bat diversity and habitat is not only biologically but also economically desirable.



Neurospora spore cases

Fungi – slime molds and mushrooms among them – are used for food and for the production of industrial chemicals and enzymes. They also rot wood, damage fabric, obscure optics and, as pathogens, injure animals and plants. The recent completion of the **sequencing of the first filamentous fungus (*Neurospora crassa)* genome**, through the cooperative efforts of more than 70 scientists, will facilitate new insights into fungal growth and the production of compounds such as pigments, antibiotics and toxins.

An LTER site used computer modeling and long-term field observations to predict the effect of wildlife management decisions on northern temperate lakes in Wisconsin. The **model integrates long-term field observations and management decision-making** using a simulated lake that can switch between alternate states of lake productivity. Managers used two different models and as they observed variations from year-to-year, estimated how well each of the models was supported by observed data and then developed policies that responded to environmental conditions to maximize the expected economic value of the lakes.

When a chewing bug bites into a potato, the plant not only produces chemicals that deter the bug from further feeding but also produces volatile compounds that waft to nearby plants and trigger their anti-bug defenses. Chewing triggers this process by stimulating release of a protein called systemin from the chewed tissues. Researchers recently isolated **the sensor protein that detects systemin from damaged tissue**. Furthermore, the gene for the sensor protein from potato was similar to genes in *Arabidopsis*, even though *Arabidopsis* appeared to lack the systemin response. This suggests that systemin-type defenses are more widespread in plants than thought previously. This finding is a key advance in understanding how plants defend against insect attack, and holds immediate promise for reducing pesticide use in agriculture.

A BIO-supported CAREER researcher developed a model to predict multi-scale interactions and ecological consequences of human activities and then used it to **model the loss of panda habitat in China**. A significant finding was that human population growth alone was not a good index of local resource consumption. Rather, changing demographic and socioeconomic factors contribute disproportionately to environmental degradation. These results can guide biodiversity management with regard to the impact of human social dynamics.

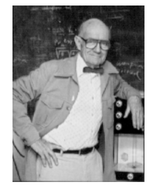
Two basic hypotheses have arisen to explain **forest biodiversity**. One theory holds that stabilizing forces are required for many species to coexist, i.e. if one species is limited by light, and another by moisture, they coexist because their competition is minimal. The alternative 'neutral model' hypothesizes that time is the critical factor in competition between similar species but eventually the better competitor would drive the other species to extinction. Direct observations to distinguish which model is correct would take centuries, so researchers used a clever blend of long-term data on tree pollen extracted from ancient lake sediments and statistical modeling to test the opposing hypotheses. Their findings indicate that stabilizing processes are more important than previously thought, and that the human-caused loss of species could upset that stability in ways that remain poorly understood.

How reptiles evolved into flying birds has been hotly debated since the 1800's. One theory holds that ground-dwelling animals developed feathered wings to allow them to become airborne while the opposing theory is that as tree-dwelling animals leapt from limb to limb they eventually developed gliding structures to soften their landings. Recently researchers discovered that the transition from ground travel to flight may have involved a “ramp-up” phase in which the rapid movement of the animals appendages was used to gain more foot traction as they ran up vertical slopes. The researchers observed hatchlings that could not yet fly used “wing-assisted incline running” (WAIR) to climb a 50-degree incline. Adult birds used their wings to defy gravity keeping their bodies secured to the underside surface of a 105-degree overhang. Thus, WAIR in modern-day birds may be a remnant from prehistoric ancestors and represent the intermediate stage in the development of flight-capable wings.

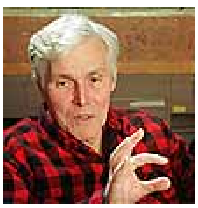
One ITR project of note is **SEEK (Science Environment for Ecological Knowledge),** a project involving an international multidisciplinary team of ecologists, computer scientists, and technologists focused on inventing and implementing a global computing infrastructure for environmental biology. This project is yielding fundamental improvements on how researchers can gain global access to data and information, rapidly locate and utilize distributed computational services, and exercise powerful new methods for capturing, reproducing, and extending the analysis process itself.

Awards to BIO researchers

MIT researcher, Dr. Angelika Amon, received the NSF Waterman Award in May 2003 for her groundbreaking research on cell cycling. Born in Austria in 1967, she earned her bachelor's and doctoral degrees at the University of Vienna. She first came to the U.S. in 1994 for postdoctoral studies. Her research helped to identify the means by which yeast cells precisely regulate the replication of chromosomes during cell division.



Dr. John Fenn, from the Virginia Commonwealth University, received the 2002 Nobel Prize for the development of methods for identification and structure analyses of biological macromolecules. BIO supported Dr. Fenn's research to develop and use mass spectroscopic methods for research on the conformation of protein molecules.



Dr. Carl R. Woese, professor of microbiology at the University of Illinois at Urbana-Champaign, won the 2003 Crafoord Prize for Biosciences for his discovery of the third domain of life, called Archaea. The traditional paradigm of life contained two domains, prokaryotes (e.g. bacteria) and eukaryotes (protests, fungi, plants and animals). Using comparative sequence analysis of ribosomal RNA, Dr. Woese was able to determine that within prokaryotes there existed an evolutionarily distinct group. Dr. Woese also won the National Medal of Science for this research.

Dr. Dick McCombie, Cold Spring Harbor Laboratory, right, received the award on behalf of IRGSP

On June 25, 2003 the World Technology Network (WTN), which is comprised of over 700 individuals and organizations from over 50 countries focused on the business or science of bringing emerging technologies into reality, selected the International Rice Genome Sequencing Project (IRGSP) as the winner of the 2003 World Technology Award in Biotechnology (Corporate Division). The IRGSP is a collaboration of 10 countries or regions, including BIO-supported U.S. researchers. In December 2002, this consortium announced the completion of a high-quality draft sequence of the rice genome. The sequence data, now freely available on the Internet, is expected to induce innovative research on rice, which serves as the staple food for over half the world's population.

Other Performance Indicators

The tables below show the change in the number of people benefiting from BIO funding, and trends in the award size, duration and number of awards.

Number of People Involved in BIO Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	3,346	3,332	3,264
Other Professionals	1,729	1,722	1,676
Postdoctorates	1,455	1,469	1,469
Graduate Students	2,704	2,750	2,795
Undergraduate Students	2,854	2,687	2,690
K-12 Students			
K-12 Teachers	36	125	125
Total Number of People	12,124	12,085	12,019

BIO Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	1,448	1,443	1,404
Funding Rate	26.0%	25.9%	24.9%
Statistics for Research Grants:			
Number of Research Grants	871	868	845
Funding Rate	21.0%	20.0%	19.0%
Median Annualized Award Size	$126,900	$138,066	$140,250
Average Annualized Award Size	$177,392	$181,667	$190,750
Average Award Duration, in years	3.2	3.2	3.3

MOLECULAR AND CELLULAR BIOSCIENCES $124,980,000

The FY 2005 Request for the Molecular and Cellular Biosciences (MCB) Subactivity is $124.98 million, an increase of $3.21 million, or 2.6 percent, above the FY 2004 Estimate of $121.77 million.

Molecular and Cellular Biosciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Molecular & Cellular Biosciences Research Projects	121.89	121.77	124.98	3.21	2.6%
Total, Molecular & Cellular Biosciences	$121.89	$121.77	$124.98	$3.21	2.6%

The overarching goal of **21st Century Biology** is to understand life at both its most fundamental level and in all its complexity. MCB supports research on the fundamental properties and dynamics of living cells and their components and how those components work together to carry out the complex processes of life. The research supported by MCB addresses questions about how living cells are organized, communicate, and respond to internal and environmental signals, and explores subjects ranging from the diversity of microbes that populate every imaginable habitat on Earth, to the cells that make up the specialized tissues of multi-cellular plants and animals.

Exciting advances in genomics, informatics, computer science, mathematics, physics, chemistry, and engineering offer the tools that make it possible to realize these ambitious goals. MCB is forging partnerships across disciplines to introduce new analytical and conceptual tools, especially cyberinfrastructure tools, to the biological scientist, as well as to provide unique training environments for the scientists of the future.

Research and education at the interface of biology and the physical sciences: MCB core activities support research on the structure, mechanisms of action, and control of the molecules that represent the machinery of the living cell. Partnerships generated among the core activities of MCB and Mathematical and Physical Sciences (MPS) subactivities will emphasize support for beginning investigators whose integrated research and teaching activities bridge this interface.

Living Networks: Theoretical, computational, and mathematical modeling approaches are playing increasingly critical roles in all areas of the molecular and cellular biosciences - in formulating and testing physical and mathematical models of the structure and function of complex molecules and cellular processes; in analysis of genome data; and in addressing one of the greatest computational challenges facing 21st Century Biology, creating multi-scale models that can integrate our understanding of biological structure, function, and interactions at all levels into a predictive whole. MCB is partnering with programs in the Engineering Directorate to promote research and training in this area.

In FY 2005, core activities in the MCB Subactivity are increased by $3.21 million, or 2.6 percent. Within the constraints of this increase current emphases will be maintained.

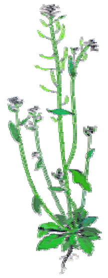
Highlights of areas supported:

Research and education at the interface of molecular and environmental biology: Originally imported from Europe, the spotted knapweed has now become widely distributed over millions of acres of rangeland. Its advance is threatening ranches in the Midwest and the West. A plant biochemist and two ecologists worked together to unlock the secret of the mechanism behind the successful invasion of this weed. They found that this plant with beautiful purple flowers has a deadly effect on its neighbors by secreting a chemical, catechin, from its roots. Catechin is deadly to most plants, but not to the knapweed itself. The researchers found that the mechanism of catechin's toxicity is that in susceptible plants it activates a signaling pathway that produces toxic "reactive oxygen" that kills their roots. Turning to the tools of genomics the researchers found in the genome of the model plant, Arabidopsis, a gene that determines sensitivity to catechin. This work offers clues to strategies for interfering with the spread of this invasive species.

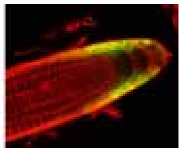
Spotted Knapweed

Microbial Biology: Core activities and the Microbial Observatories program encourage research on microbes at all levels of biological organization. Genome-enabled and biochemical approaches are being used to identify and characterize attributes of microbes, most of which have never before been described. Analysis of microbial genomes is leading to discovery of new organisms and to appreciation of the diversity of their metabolic functions that enable them to occupy diverse habitats and to interact in complex communities. These efforts are consistent with priorities of the interagency effort, "The Microbe Project."

It has long been assumed that in winter when the tundra is covered with snow the microbes living in the soil are dormant. Research from one of the Microbial Observatories has shown that the opposite is true. Populations of fungi covered by snow in the Colorado mountains are more active in winter. The metabolism of snow-covered microbes serves as an important "sink" for nitrogen. Release of nitrogen from the microbial sink in the spring may serve as ready fertilizer for the tundra-dwelling plants, which have a short growing season. In addition, the fungi discovered in this study belong to totally new groups, thus our appreciation for the diversity of fungi has been expanded by this project.



"2010 Project:" Unsolicited research led to the discovery of the value of *Arabidopsis thaliana* as a model flowering plant. Recently published research has provided a gene expression map of the Arabidopsis root. This map shows where and when about 22,000 of the estimated 28,000 total genes of Arabidopsis are active within the root. This level of resolution of gene expression on a global basis has not thus far been achieved for any other organism. The MCB Subactivity will continue to support research enabled by the availability of the complete genome sequence of *Arabidopsis* to determine the functions of all the genes of this model flowering plant by the year 2010.



Arabidopsis root tip

INTEGRATIVE BIOLOGY AND NEUROSCIENCE $110,630,000

The FY 2005 Budget Request for the Integrative Biology and Neuroscience (IBN) Subactivity is $110.63 million, an increase of $3.22 million, or 3.0 percent, above the FY 2004 Estimate of $107.41 million.

Integrative Biology and Neuroscience Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Integrative Biology & Neuroscience Research Projects	107.47	107.41	110.63	3.22	3.0%
Total, Integrative Biology & Neuroscience	$107.47	$107.41	$110.63	$3.22	3.0%

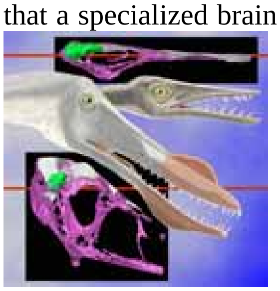
Totals may not add due to rounding.

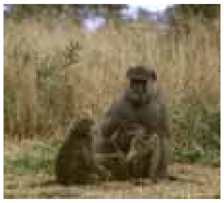
Research supported by the Integrative Biology and Neuroscience Subactivity focuses on organisms, with particular emphasis on the mechanisms by which organisms develop, grow, reproduce, regulate their physiological activity, respond to their environment, and evolve. Understanding organisms requires integration of molecular, subcellular, cellular, and functional genomics information gathered in both laboratory and natural settings. It can also require advanced computational techniques and interdisciplinary perspectives from other areas of biology, the physical sciences, mathematics, engineering, and computer science. The development and use of a wide diversity of organisms contributes to both identifying unifying principles common to all organisms and documenting the variety of mechanisms that have evolved in specific organisms.

In FY 2005, core activities in the IBN Subactivity are increased by $3.22 million. IBN will emphasize 21st Century Biology projects that are multidimensional, multidisciplinary, and integrative, to understand the development, physiology, neurobiology, behavior, and evolution of living organisms. Because these projects will be data-driven, IBN will increase support for new ways to manage and analyze data.

Highlights of areas supported:

Brain scans of extinct reptiles. Pterosaurs, which emerged as the first flying vertebrates during the age of dinosaurs, could grow as large as an airplane but soared through the skies with ease. Research suggests that a specialized brain and inner ear structure helped these ancient reptiles to fly and target their prey, a finding that could give scientists insight into the evolution of the brain and visual system. Fossils of pterosaurs, which lived during the Mesozoic Era, are being examined by running fossil skulls through a high-resolution CT scanner and using sophisticated computer graphics software to reconstruct the brain cavity and inner ear canals. These scans can be compared with skulls of alligators and birds, which are the closest living relatives of pterosaurs, to test hypotheses on how evolutionarily similar, but still quite distinct, animals adapted to live in the air.





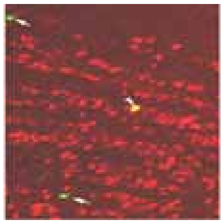
Paternal care as an ancient trait in primates: Behavior plays a pivotal role in survival and reproduction. Baboons in east Africa are providing a comprehensive picture of how behavior shapes fitness outcomes and population processes. Adult males and females do not form permanent bonds, and males have no easy way to tell which infants in the group are their own offspring. When biologists and anthropologists, jointly supported by BIO and SBE, performed DNA paternity tests, they surprisingly found that males provided far more care to their own offspring than to non relatives. This project also provides research and educational opportunities for American and Kenyan students and supports active collaborations between researchers in both countries.

Plants make their own aspirin to fight disease: Plant disease causes an estimated loss worldwide of $100 billion annually. A variety of strategies are being developed to protect plants against disease, including induction of the plant's own defense. Gaining an understanding of the mechanisms of acquired immunity against pathogens could reduce the effects of disease in agricultural systems and in managed forests. Research has established that acetylsalicylic acid (aspirin) is made inside Arabidopsis cells in response to viral attack and that it plays a critical role in providing immunity to the entire plant. This research breakthrough shows that plant immuno-response systems share traits with animal immuno-response systems. From a practical perspective, plant immunity has tremendous implications for the resistance of plants to pathogens. To control these pathogens we currently apply chemicals on our fields. Insight into how the immunity process works suggests ways to amplify this immune response, so that chemical use may be decreased.

Identifying the signal from mother to embryo that initiates pregnancy: Failure to implant is a major cause of doomed pregnancies in mammals. Research on basic reproductive physiology will improve our knowledge of embryo implantation. One characteristic of many carnivorous species is tight control of the

timing of implantation. In the black bear and spotted skunk, for example, embryo implantation occurs months after fertilization, with the blastocyst in an inactive state in the interim, a phenomenon called delayed implantation. Because of their domestication and relative abundance, domestic ferrets provide an excellent model to study implantation in carnivores. Researchers have identified a protein called GPI, produced by the female, that triggers the implantation of the embryo into her uterus. In addition, this research is helping to train students in new methodologies by combining whole-organism and molecular approaches to answer important questions in reproductive endocrinology.

New cells in adult mammalian brain can make functional connections: Previously, researchers had made the startling discovery that the adult brain can produce new cells and that cells made in particular regions of the brain migrated within the forebrain and differentiated into neurons. But did the new cells make functional connections and respond to environmental factors? Using adult male hamsters, researchers recently discovered that new brain cells made functional connections and were activated when females were placed near the males. Apparently, testosterone produced in response to the proximity of the females was important for activation and survival of the new cells. These discoveries significantly enhance our understanding of neuron production, migration and death.



Arrows indicate new cells in adult hamster brain

ENVIRONMENTAL BIOLOGY $111,480,000

The FY 2005 Request for the Environmental Biology (DEB) Subactivity is $111.48 million, an increase of $3.22 million, or 3.0 percent, above the FY 2004 Estimate of $108.26 million.

Environmental Biology Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Environmental Biology Research Projects	108.28	108.26	111.48	3.22	3.0%
Total, Environmental Biology	$108.28	$108.26	$111.48	$3.22	3.0%

The Environmental Biology Subactivity supports fundamental research to inventory life in the biosphere, comprehend its origins and evolutionary history, and understand the interactions and dynamics of biological communities and ecosystems. Studies can address the species of or genealogical relationships among plants, animals, fungi, and microbes; the flux of energy and materials in ecosystems; and the principles or rules by which species function in communities and evolve through time.

In FY 2005, core activities in the DEB Subactivity are increased by $3.22 million to enhance support for research that addresses the continuum of questions from evolutionary processes to ecosystem services, consistent with present community strengths and future science and cyberinfrastructure needs. Priority will be given to leveraging new cyberinfrastructure capabilities and bringing innovative tools into the toolkits of environmental biologists. In order to take the information generated by these investigations and transform it into knowledge – within the scientific community and throughout the citizenry – a high priority will be placed on integrating education with research through activities that engage students at all levels from "K to gray."

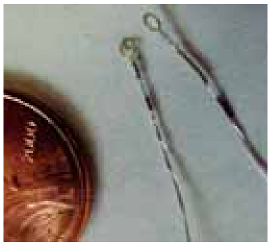
Twenty-first century biology is by its nature anticipatory. Pioneering studies often identify biological questions that later — in the short or long term — become compelling research areas that attract talented investigators across many fields of inquiry. In this context, DEB-supported activities will continue to balance disciplinary and multidisciplinary research needs; focus on what NSF supports uniquely, or uniquely well; provide for ecological and evolutionary synthesis; and diversify and educate the next generation of environmental biologists.

Highlights of areas supported:

Biodiversity Discovery at a Global Scale. With at most one in ten living species known to science, biodiversity inventories are a time-critical research endeavor. A project funded by the new Planetary Biodiversity Inventory (PBI) activity in 2003 brings together more than 200 scientists from 31 countries to inventory the world's catfishes. Results will enhance fundamental knowledge about the earth's biota and help decision makers prioritize areas for protection and make informed freshwater management decisions. PBI grants will transform how scientists discover and document the diversity of entire branches of the tree of life.

CAREER awardee and team develop an Extinction Modeling Toolkit (EMT). This computational modeling toolkit identifies the types of wildlife species and populations at greatest risk of extinction. This allows researchers to investigate the risks of habitat fragmentation, harvest, and deleterious mutations on wildlife populations. Wildlife managers cannot use vast amounts of biodiversity data directly. They require specialized computing tools such as the EMT to focus the data on questions of interest.

Endangered Checkerspot Butterfly



Glucose Sensors

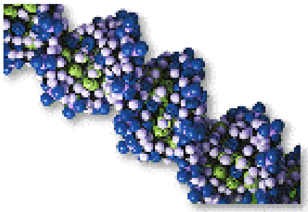
New Tool for Soil Carbon Analysis. Ecologists seek to understand the patterns observed in nature. The addition of molecular and genomics tools, new sensors, broad new informatics capabilities and other advanced techniques are helping investigators explain much variation that exists in ecological processes over space and time. For example, one investigator adapted miniaturized glucose sensors (originally designed for diabetics) for use in non-invasive carbon studies in root zones (rhizospheres).

Studies that cross multiple spatial scales as well as disciplines are increasing. One study of how fish and fisheries depend on watershed inputs and human impacts has linked biology with nuclear physics to apply proton-induced x-ray emission analysis to the study of movements and environmental events in a fish's life. This research is addressing whether incremental economic activities at the watershed level can alter the stability of an ecosystem. Unexpectedly, researchers discovered the heavy metal, selenium, in fish from Onondaga Lake in New York. This lake is known for its severe mercury contamination, and the discovery of selenium in the fish suggests that there may be a second element of concern.

Bursera fagaroides

Molecular tools help researchers tease apart plant/insect interactions. For hundreds of millions of years, there has been a coevolutionary "arms race" between plants and the animals that eat them. Recent work on the coevolution of the plant *Bursera* and its herbivores combines chemical, ecological and phylogenetic techniques. Not only is this work the first to use rigorous molecular analyses for highly diverse, subtropical tree and insect lineages, but it also has led to new insights about adaptation and counteradaptations.

Evolution at the molecular level. Genomics is bringing together molecular and evolutionary biologists to tackle big questions in comparative evolution. The technological advances made in DNA sequencing coupled with the development of algorithms for analyzing gene order rearrangements have allowed construction of new family trees for a broad range of organisms. These new analysis tools will be important for making the best use of the large data sets produced by comparative sequencing projects. Studies of organismal relationships are critical to comparative studies of animal evolution, and provide useful models for understanding plant, fungal, and microbial evolution.



BIOLOGICAL INFRASTRUCTURE $85,470,000

The FY 2005 Budget Request for the Biological Infrastructure (DBI) Subactivity is $85.47 million, an increase of $5.25 million, or 6.5 percent, above the FY 2004 Estimate of $80.22 million.

Biological Infrastructure Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Research Resources	42.41	48.63	51.38	2.75	5.6%
Human Resources	32.62	31.59	34.09	2.50	7.9%
Total, Biological Infrastructure	$75.03	$80.22	$85.47	$5.25	6.5%

Totals may not add due to rounding.

The goal of the Biological Infrastructure Subactivity is to ensure that essential infrastructure for contemporary research is available to scientists in all areas of biological science for both disciplinary and interdisciplinary efforts. Innovations in infrastructure support, including cyberinfrastructure, are vital to the advancement of 21st Century Biology across the BIO Activity. Resources supported range from physical infrastructure, such as multi-user instrumentation, to research training for students at all levels. In addition, teams of scientists including biologists, mathematicians, physicists, chemists, computer scientists, and engineers are supported to develop new research tools such as software, new algorithms, and novel instrumentation.

Research Resources supports a range of activities including support for the proposed National Ecological Observatory Network (NEON); multi-user instrumentation; the development of instruments with new capabilities, improved resolution or sensitivity; upgrades to biological field stations and marine laboratories; support of living stock collections ranging from microbes to plants and animals; development of biological databases and informatics tools; and research collections in biological sciences. These various research resources provide the essential platforms and tools for effective research in modern biology.

Research Resources will provide infrastructure support of $51.38 million, an increase of $2.75 million above FY 2004, for:

- Support for research resources, totals $51.38 million, an increase of $2.75 million over FY 2004. BIO will expand support for research tools development for the 21st Century Biology, expanding the instrument development activities to include research technique/method development that has the potential to revolutionize biological research.

- Support for NEON totals $4.0 million, equal to the FY 2004 Estimate. Funding will be used for the NEON Coordinating Consortium and Project Office (proposed to begin in FY 2004), NEON project execution planning, and enabling technologies. Construction and instrumentation costs for NEON are discussed in the Major Research Equipment and Facilities Construction chapter.

Human Resources supports a range of activities centered on ensuring adequately and appropriately trained scientists for the future, broadening participation, and fostering the integration of research and education. A total of $34.09 will be provided in FY 2005, an increase of $2.50 million above the FY 2004 Estimate.

- An increase of $2.50 million will be provided for the Integrative Graduate Education and Research Training (IGERT) program, Graduate Teaching Fellows in K-12 Education (GK-12), and Research Experience for Teachers (RET).

- Support will continue for NSF-wide activities such as Research Experiences for Undergraduates (REU) Sites projects and ADVANCE, and for the Undergraduate Mentorship in Environmental Biology (UMEB), and the Cross-disciplinary Research at Undergraduate Institutions (C-RUI) programs, designed to encourage interdisciplinary research experiences for faculty and students at predominantly undergraduate institutions.

Highlights of areas supported:

Federated Distributed Databases. Several crucial database infrastructure communities are being developed within the biological sciences. One is the DiGIR distributed database community. The DiGIR software and community is now the engine behind such broad reaching federated database resources as HerpNet and Manis. The program has also funded similar systems for the genomics/proteomics community such as MOBY. Taken together these projects have been the major force in biology both in making enormous amounts of essential data available to researchers and in supplying an alternative to large, expensive centralized databases by providing broad access through federation and interoperability.

Unique Site for Field Research and Education. The Archbold Biological Station in Central Florida, according to Archbold's director, is "Florida's attic, where we have this assemblage of species and communities found really nowhere else on Earth." In this scrub of nearly 9,000 acres are more than 40 rare species of plants and animals. Biologists now manage the environment these plants and animals inhabit. Understanding of the habitats and the organisms ranges from extracting DNA to identify the plants and animals, tracking diseases such as West Nile Virus, and investigating the processes that created the habitats. Facilities such as this field station allow biologists to offer programs for public education.

Research Experiences Expose Diverse Students to Science. An example of investment in students under the REU program is a project that targets children of migrant farm workers to encourage them to consider a career in scientific research. During the past summer, ten 1st generation college students who are children of migrant farm worker families successfully completed an intensive summer research in plant science. Students who have never been exposed to research have benefited from the program and view plants from a different perspective.

Students Discover Fish Habits While Learning Scientific Process. The Cross-disciplinary Research at Undergraduate Institutions (C-RUI) program supports a project designed to demonstrate the applicability of using fish otoliths ("ear stones") to determine the environments in which freshwater brown trout have lived. Otoliths "record" the life histories in fish through deposition of minerals, just as tree rings provide information on the life history of trees. The study can have major implications both as a useful scientific tool and in the management of freshwater fish. In the process, students are exposed to principles of biology, hydrology, and chemistry.

EMERGING FRONTIERS $77,900,000

The FY 2005 Budget Request for the Emerging Frontiers (EF) Subactivity is $77.9 million, a decrease of $1.86 million, or 2.3 percent, from the FY 2004 Estimate of $79.76 million.

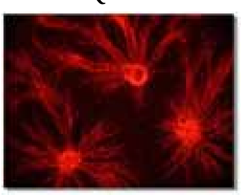
Emerging Frontiers Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Emerging Frontiers	73.37	79.76	77.90	-1.86	-2.3%
Total, Emerging Frontiers	$73.37	$79.76	$77.90	-$1.86	-2.3%

The Emerging Frontiers Subactivity is an incubator for 21st Century Biology. EF supports multidisciplinary research opportunities and networking activities that arise from advances in disciplinary research. By encouraging synergy between disciplines, Emerging Frontiers provides a mechanism by which new initiatives will be fostered and subsequently integrated into core programs.

Reduced funding in EF is a result of the termination of Information Technology Research (ITR) as an NSF Priority Area. In keeping with the incubating mission of EF, $7.0 million from ITR will be distributed to all BIO divisions in FY 2005 and used to support cyberinfrastructure activities such database development and management and information networking.

In FY 2005 BIO will increase support for Frontiers in Integrated Biological Research (FIBR). FIBR invites new ideas for integrative research on major biological questions from a multidisciplinary point of view. Questions addressed in the first FIBR awards in 2003 include: How do species arise? Do species



matter among microbes? Why do some individual cells in the community of slime molds pictured here give up their chance to reproduce so others can? The projects employ boldly creative approaches and draw upon recent breakthroughs in genomics, information technology, high-throughput instrumentation, imaging and wireless technologies, sophisticated sensors, improved GIS systems and other recent advances.

BIO continues support for Research Coordination Networks (RCN), which supports groups of investigators to coordinate their research efforts across disciplinary, organizational, institutional and geographical boundaries. Networks are formed around a focal theme and can involve a broad research question, group of organisms, or particular technologies or approaches.

NSF-wide Priority Areas will be supported out of EF in order to introduce new ideas into these model 21st Century Biology activities and to provide a mechanism through which the priority areas can be integrated with disciplinary activities. Support includes:

Biocomplexity in the Environment (BE) supports research on the dynamics that occur within biological systems and between these systems and the physical environment. Support will continue at the FY 2004 Estimate of $39.86 million for the NSF-wide BE competition as well as for the Tree of Life Project, and two interagency programs, Ecology of Infectious Disease and Microbial Genome Sequencing.

Nanoscale Science and Engineering (NSE) research, focused on studying the structure and regulation of macromolecular machines and macromolecular complexes that are capable of self-replication and self-assembly, will increase by $540,000 to $5.85 million in FY 2005. The increase will specifically support research on nanoscale biosensors and information processors that could provide new tools for understanding cellular communication and detection of environmentally important signals.

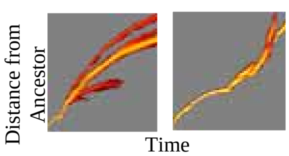
Mathematical Sciences (MSI) will continue to support interdisciplinary research involving mathematics, science and engineering, and focus on mathematical and statistical challenges posed by large data sets, managing and modeling uncertainty, and modeling complex, non-linear systems. Funding will remain at the FY 2004 Estimate of $2.21 million.

Human and Social Dynamics (HSD) will support research in behavior, cognition, development and neuroscience. Funding will remain at the FY 2004 Estimate of $500,000.

Highlights of areas supported:

Multidisciplinary team tackles how plant cell walls form. WallBioNet is a RCN that fosters interactions among biologists, chemists, physicists, and informaticists to understand the biosynthesis of the plant cell wall, an extremely complicated matrix of carbohydrates and proteins. This coordinated effort to address cell wall biosynthesis will lead to fundamental discoveries about plant development and to improvements of cell-wall based products such as fiber, paper, and wood.

Evolution in silico. A team of microbiologists, computer scientists and a philosopher, used an artificial life computer program to create a road map detailing the evolution of complex organisms, an old problem in biology. They found that the path to complex functions is built up from simpler functions, each unremarkable if viewed in isolation. The computer program called Avida, not only reproduces but also performs mathematical calculations to obtain rewards; more computer time that they use for making copies of themselves. Avida is a way to watch evolution, which for living organisms would require thousands of years, in real time. Many computer scientists and engineers are now using processes based on principles of genetics and evolution to solve complex problems, design robots, and more.

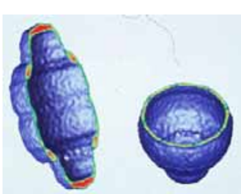


Evolution of Digital Life

Overturning a Paradigm. Humans rely on green plants for food, shelter, clothing, and even the oxygen we breathe. As one of the oldest and most diverse branches of the Tree of Life, green plants provide an unparalleled system in which to approach questions concerning the diversification of life on earth. Tree of Life supported research revealed that the traditional belief that the so-called "land-plant invasion" was led by seawater plants is wrong. Instead, primitive freshwater plants were the ancestors of all green land plants, whether extant or extinct.

Freshwater Elodea plants

One NSE project has studied vaults, small, intracellular particles made of RNA and protein that were discovered almost 20 years ago, but whose cellular function is still a mystery. Recent work has clarified that the structure of these unique, naturally occurring nano-capsules is a hollow cage, with a very thin (about 2 nanometer) shell (see image). The interior volume is large enough to enclose hundreds of proteins. This work points the way to controlled assembly of vaults loaded with small molecules or enzymes useful for measuring or altering metabolism within specific cells. Such modified vaults could be targeted to specific cell types or even to specific sites within cells, and may prove useful both in basic studies of cellular function, and in applications such as biosensing and drug delivery.



PLANT GENOME RESEARCH $89,470,000

The FY 2005 Budget Request for the Plant Genome Research (PGR) Subactivity is $89.47 million, equal to the FY 2004 Estimate.

Plant Genome Research Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Plant Genome Research Projects	84.45	89.47	89.47	0.00	0.0%
Total, Plant Genome Research	$84.45	$89.47	$89.47	$0.00	0.0%

The Plant Genome Research Subactivity was initiated in FY 1998, building upon an existing base of genome research supported throughout the BIO Activity. PGR supports projects that make significant contributions to our understanding of plant genome structure and function. Emphasis is placed on plants of economic importance, as well as plant processes of potential economic value. Long-term benefits of this research include fundamental breakthroughs in our understanding of plant biology and practical applications to crop improvement, and the development of novel, plant-based products.

The program was established as part of the National Plant Genome Initiative (NPGI). NSF plays a major role in the NPGI. Other participating agencies are USDA, DOE, USAID, and NIH. The NSF program is managed according to the guidelines and objectives of the NPGI, and it works closely with the other agencies in coordinating funding activities.

The National Plant Genome Initiative has issued its new five-year plan for 2003-2008. The FY 2005 Budget Request for PGR will support activities to meet the goals of the new NPGI plan, including:

- **Functional Genomics including Rice Functional Genomics**: Taking advantage of the recently completed sequence of the rice genome by an international consortium, PGR will support efforts to identify the function of all the rice genes and to develop functional genomics tools for rice. These efforts will be coordinated across agencies as well as internationally. Functional genomics research in other plant systems will continue to be supported.

- **Large-scale Sequencing of Genomes of Economically Important Plants**: The recent success in using new methods to concentrate gene-rich regions of large genome species, like maize, for sequencing will likely lead to increased efforts to sequence gene-rich regions of several other economically important plant species.

- **Informatics Tools Development**: Enormous amounts of data on many different aspects of plant genomics are rapidly accumulating. It is critical that seamless ways to access and make use of them by biologists be developed. Training that integrates informatics technologies and plant genomics research is also needed.

- **Interagency Activity on Research Collaboration with Scientists in Developing Countries:** As an important outreach activity for the NPGI, PGR plans to participate in the interagency program to support research collaboration between U.S. scientists and scientists in developing countries with a focus on plant genomics and plant biotechnology. Research will focus on crops important to developing countries such as banana and cassava, and traits critical to developing countries such as drought tolerance and disease resistance.

Highlights of areas supported:

Variants of Maize

An integrated physical and genetic map of the maize genome. Research resources and research tools have been developed that now make it possible for scientists located anywhere in the U.S. to participate in plant genome research. For example, a five-year project to develop a detailed integrated physical and genetic map for maize has been completed and the map is allowing basic researchers to rapidly locate and clone genes of interest.

Sequencing the maize gene space. Maize is the most economically important crop in the US and knowledge of its genome sequence can help improve crop yield and nutritional quality, and expand its uses. The maize genome is large (about the same size as the human genome at almost 3 billion base pairs) and complex, containing islands of genes among the sea of repetitive DNA sequences. Genes account for 1/4 to 1/3 of the genome.

Two Virtual Center projects funded in 2002 are trying several methods to isolate and sequence regions of the maize genome containing genes. Those projects have already released over a million sequences. Many new genes have been discovered in this collection, including genes involved in economically important processes such as flowering and disease resistance. The maize sequencing effort is also pioneering a novel method to sequence large genomes more efficiently.

Studying gene expression in individual cells. A new method, laser capture microdissection, is being used by two projects to select individual cells from specific plant tissues. This method allows for more precise analysis of gene expression than had previously been possible. The data from these studies will be used to develop a gene-expression atlas for rice plants, and to dissect the expression patterns of genes regulating the development of maize shoot meristems, the part of the plant that gives rise to the leaves.

International collaboration in legume genomics. PGR has supported large-scale genome projects that will enable scientists to address major biological questions in plants, such as plant responses to environmental and biological stresses. Many of the projects are conducted by Virtual Centers each of which involves scientists from multiple institutions and disciplines. NSF's investment in plant genome research has stimulated international collaboration, including the international wheat genome research group, the international rice functional genomics consortium, the international tomato sequencing consortium, and the international *Medicago trancatula* (a model legume) research consortium. An international project to sequence the gene-rich portions of the Medicago genome was initiated in FY 2003 with support from PGR and the European Union (EU).

Bringing the excitement of genomics to the classroom. High school teachers are being trained in genomics as part of a project studying the rice pathogen Magnaporthe. Teachers gain hands-on experience in cutting edge genomics research and develop new classroom materials to take back to their schools. The curricular materials are developed in line with state standards.

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING $618,050,000

The FY 2005 Request for the Computer and Information Science and Engineering Activity is $618.05 million, an increase of $13.40 million, or 2.2 percent, above the FY 2004 Estimate of $604.65 million.

Computer and Information Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Computer and Networked Systems	117.15	114.93	132.39	17.46	15.2%
Computing and Communication Foundations	81.15	78.93	91.41	12.48	15.8%
Information and Intelligent Systems	82.15	80.05	92.54	12.49	15.6%
Shared Cyberinfrastructure	95.07	112.63	123.60	10.97	9.7%
Information Technology Research	213.77	218.11	178.11	-40.00	-18.3%
Total, CISE	$589.29	$604.65	$618.05	$13.40	2.2%

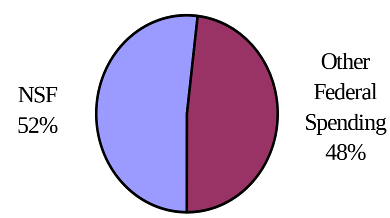
Totals may not add due to rounding.

The Computer and Information Science and Engineering (CISE) Activity supports research, infrastructure, and education in the computer science, computer engineering, information science, networking, and computational science disciplines. It also supports shared cyberinfrastructure that enables cyber-science across the full range of NSF-supported science and engineering disciplines.

RELEVANCE

CISE is the principal source of federal funding for university-based basic research in the computer science, computer engineering, information science, networking, and computational science disciplines, providing over half of the total federal support in this area. The CISE Activity exerts a lead role in the multi-agency Networking Information Technology Research and Development program by providing 36% of total NITRD funding in FY 2003 and by chairing many of the working groups that promote interagency coordination. Building on past accomplishments, such as developing the Internet and supporting fundamental advances in numerical methods, digital libraries, data mining, computer languages, and computer systems, CISE is positioning its activities for the future with new efforts to address the most prominent challenges and opportunities of information technology:

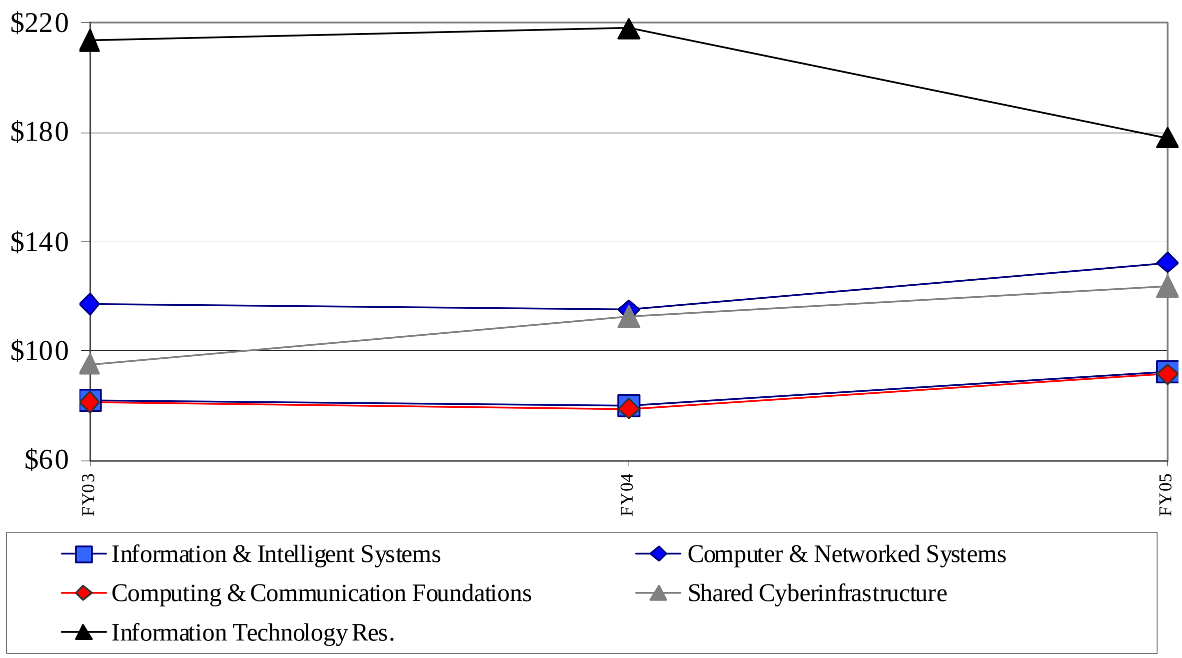
Federal Support of Basic Research in Computer & Info Science & Engineering at Academic Institutions



- Cyber Trust: Growing concerns about the vulnerability and trustworthiness of computers, networks and information systems have led to increased CISE investments in Cyber Trust (also called cybersecurity) research, education and training.
- Cyberinfrastructure: CISE will manage and support the creation of a widely shared cyberinfrastructure that will revolutionize the conduct of research and education across the science

and engineering enterprise, and will invest in research to develop new generations of cyberinfrastructure CISE will provide broadly accessible and well-supported high-end computing, communications, storage, and analysis resources. CISE will also support the provision of services to support the effective use of these resources by domain scientists and engineers; and will support the education, outreach and training to take full advantage of or to support this new infrastructure-Workforce. Continuing needs for a U.S. workforce with the world's leading Information Technology (IT) skills drive CISE efforts to broaden participation of all people, regions, and institutions in IT education and career paths.

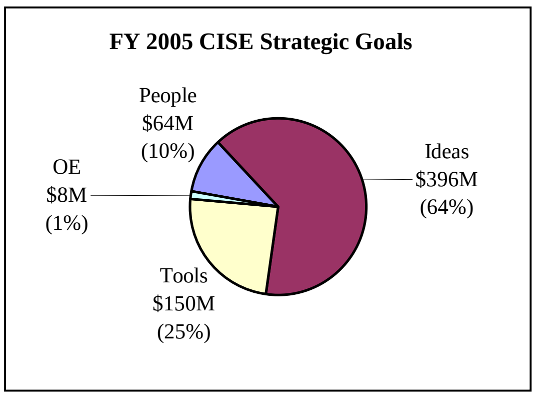
CISE Subactivity Funding
(Dollars in Millions)



Note: CISE subactivities have been reorganized; crosswalk data prior to FY 2003 do not exist.

STRATEGIC GOALS

NSF's four strategic outcome goals guide CISE activities.



- PEOPLE: CISE advances education and training for current computer and information scientists and engineers, increases the diversity of these communities, facilitates education of future generations of computer and information scientists and engineers, and enhances the public's knowledge of IT-related disciplines.

- IDEAS: CISE supports advances in knowledge across the computer science and engineering spectrum, providing core support for all IT fields and identifying opportunities where focused investments can play a catalytic role in advancing scientific progress.

- TOOLS: Provision of advanced tools to support CISE research and the development and support of an integrated cyberinfrastructure to support all areas of NSF science and engineering research and education, are CISE priorities in FY 2005. To provide tools for computer and information science and engineering research, CISE supports infrastructure at the small to mid-scale level that enables research in such areas as computer systems, information systems, robotics, and networking. In support of the full range of NSF-supported research and education, CISE will identify, develop, and support a shared cyberinfrastructure. Cyberinfrastructure will integrate sensors and instruments, data archives, digital libraries, high-end computing platforms, and visualization facilities, to enable completely new ways to advance science and engineering in the long-term.

- Organizational Excellence (OE): Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

CISE's support for ongoing core and new activities contributes to NSF's efforts to achieve its strategic goals, and to the organizational excellence activities necessary to achieve these goals.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	54.64	56.67	63.51	6.84	12.1%
Ideas	385.70	408.37	396.24	-12.13	-3.0%
Tools	142.00	132.50	150.34	17.84	13.5%
OE	6.95	7.11	7.96	0.85	12.0%
Total, CISE	$589.29	$604.65	$618.05	$13.40	2.2%

PEOPLE (+ $6.84 million, for a total of $63.51 million)

CISE Investments in People
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	42.34	42.74	44.91	2.17	5.1%
Institutions	9.99	9.77	14.44	4.67	47.8%
Collaborations	2.31	4.16	4.16	0.00	0.0%
Total, CISE People	$54.64	$56.67	$63.51	$6.84	12.1%

Special emphasis in FY 2005 will be on broadening participation of U.S. citizens, including women and minorities, in the CISE enterprise and on reaching a wider range of institutions more effectively.

INDIVIDUALS

- An increase of $2.0 million to $7.39 million for IGERT and will support about 40 additional graduate students. Graduate Research Fellowships funding is maintained at $1.66 million.
- Support for Research Experiences for Undergraduates will increase by $170,000 to a total of $2.92 million for supplements. This will support participation of approximately 70 additional students in CISE-funded projects.
- Support for education and training for cyberinfrastructure totals $5.37 million. This will prepare individuals to effectively use these new integrated facilities.

INSTITUTIONS

- An additional $3.99 million to a total of $7.49 million will support demonstration projects that effectively link research and education and use best practices to attract more women and minorities to CISE fields; these projects will support recruiting and retaining students in computing science and engineering tracks along with improved outcomes for all students. Efforts will build on prior CISE awards that create new understanding on the reasons for the low participation of women and minorities in computer and information science and engineering activities.

COLLABORATIONS

- Funding for GK-12 will increase by $80,000 to a total of $240,000.

IDEAS (-$12.13 million, for a total of $396.24 million)

CISE Investments in Ideas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Fundamental Science and Engineering	305.10	329.77	316.74	-13.03	-4.0%
Centers Programs	80.16	78.00	79.00	1.00	1.3%
Capability Enhancement	0.44	0.60	0.50	-0.10	-16.7%
Total, CISE Ideas	$385.70	$408.37	$396.24	-$12.13	-3.0%

Particular cross-cutting CISE emphases for FY 2005 are Cyber Trust, research to create new IT technologies for cyberinfrastructure, Science of Design, and Information Integration.

FUNDAMENTAL SCIENCE AND ENGINEERING

Funding for fundamental science and engineering will decrease by $13.03 million to a total of $316.74 million. In FY 2004, CISE reorganized its subactivities to better mirror the research communities supported and to position itself to take advantage of new research opportunities. In FY 2004 and 2005, the CISE directorate will focus its investments in eight clusters that position the Activity to manage its activities more strategically. To support research priorities in the eight clusters, funding is redirected from the ITR subactivity to other subactivities. This also enables the clusters to increase award size and duration, and to support larger-scale projects. Within the clusters, FY 2005 emphases will be:

- Systems in Context: research to improve the security of data intensive applications.
- Data Inference and Understanding: a new effort on shared data resources such as archives of annotated speech, videos and web logs (blogs) that will leverage existing research on digital libraries and accelerate research on human language and communication; and a new cross-cutting thrust on Information Integration that will create capabilities for the meaningful fusion of information from disparate sources.
- Science and Engineering Informatics: a new research focus on the collection, annotation, archiving, access, and analysis of all types of scientific data.
- Formal and Mathematical Foundations: support new efforts on parallel computing architectures and computation, algorithms for computational science, integrated sensing, and signal processing.
- Foundations of Computing Processes and Artifacts: new efforts on software design, parallel methods for computing, and graphics and visualization. Science of Design will also be emphasized.
- Emerging Models and Technologies for Computation: new efforts on computational methods for nano-scale design and computational neuroscience.
- Computing Systems: focus on scalable systems that are representative of the challenges of large-scale, modern systems of the future. Cyber Trust will also be emphasized.
- Network Systems: multi-institutional projects and projects that provide results that will scale to future networks.

CENTERS PROGRAMS

CISE-supported centers include the Information Technology Centers and the Science and Technology Centers (STCs).

CISE Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Information Technology Centers	76.16	74.00	75.00	1.00	1.4%
Science and Technology Centers	4.00	4.00	4.00	0.00	0.0%
Total, CISE Centers	$80.16	$78.00	$79.00	$1.00	1.3%

CISE will continue its support of the Information Technology Centers. These center-scale awards have allowed CISE to support projects with ambitious goals and complex efforts that enrich both research and the training of students. New centers started in FY 2003 include "Sensitive Information in a Wired World" led by Stanford University researchers and Linked Environments for Atmospheric Discovery led by University of Oklahoma researchers. These projects are focusing on important IT issues and drawing on both traditional disciplinary as well as interdisciplinary expertise.

In FY 2005, CISE will continue support of the Science and Technology Center for Embedded and Networked Sensing (CENS) at UCLA. CENS is developing Embedded Networked Sensing Systems and applying this revolutionary technology to critical scientific and social applications. Embedded networked sensing systems will form a critical infrastructure resource for society - they will monitor and collect information on such diverse subjects as plankton colonies, endangered species, soil and air contaminants, medical patients, and the health of buildings, bridges and other man-made structures. Across this wide range of applications, embedded networked sensing systems promise to reveal previously unobservable phenomena.

During FY 2004, CISE expects to make new center-scale awards in the area of Cyber Trust. Support for these awards will continue in FY 2005.

CAPABILITY ENHANCEMENT

- CISE will maintain participation in special programs such as RUI in FY 2005. Additionally, CISE-based special programs such as digital government, and research infrastructure will focus on developing new capabilities and fields to support innovations in IT research and to support IT research applications.

TOOLS (+$17.84 million, for a total of $150.34 million)

CISE Investments in Tools
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Facilities	95.38	109.44	127.44	18.00	16.4%
Infrastructure and Instrumentation	46.62	23.06	22.90	-0.16	-0.7%
Total, Tools Support	$142.00	$132.50	$150.34	$17.84	13.5%

Totals may not add due to rounding.

FACILITIES

In FY 2005, the NSF's shared Cyberinfrastructure efforts will build on the successes of prior CISE-supported programs. The emerging cyberinfrastructure will incorporate data archives, instruments and sensors, visualization, and enabling software, and will be managed in the new Shared Cyberinfrastructure subactivity.

CISE Facilities
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
PACI / Shared Cyberinfrastructure Facilities	73.24	87.00	90.00	3.00	3.4%
Terascale Computing Systems	11.17	10.00	25.00	15.00	150.0%
Other CISE Facilities[1]	10.97	12.44	12.44	0.00	0.0%
Total, CISE Facilities	$95.38	$109.44	$127.44	$18.00	16.4%

[1]Other CISE facilities include equipment support programs for CISE disciplinary research providing equipment such as experimental cluster computers, Networking testbeds, and visualization equipment.

Cyberinfrastructure activities build on the successes of:

- PACI. The Partnerships for Advanced Computational Infrastructure program will end in FY 2004. The support for high-end computing will be provided through the new integrated cyberinfrastructure investments.
- Terascale Computing. Construction of the Extensible Terascale Facility (ETF), funded by the MREFC account, will be completed in FY 2004. The ETF will also become part of the coordinated cyberinfrastructure effort. Cyberinfrastructure, funded at $20.0 million in FY 2004, will be incorporated in FY 2005 as part of this coordinated effort.
- Advanced Networking Infrastructure, described below in Infrastructure and Instrumentation will also become part of the enabling cyberinfrastructure.

The Directorate also manages other CISE Facilities supporting CISE-focused research.

- The Computing Research Infrastructure cluster will support mid-scale instrumentation needed by all CISE research and education programs. The program supports many types of institutions and projects. Funding will remain at $12.44 million.

<u>INFRASTRUCTURE AND INSTRUMENTATION</u>

CISE Investments in Infrastructure and Instrumentation
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Advanced Networking Infrastructure	46.62	23.06	22.90	-0.16	-0.7%
Total, Infrastructure & Instrumentation	$46.62	$23.06	$22.90	-$0.16	-0.7%

Advanced Networking Infrastructure, which formerly included an applied research component, has been split into research (IDEAS) and advanced development and infrastructure (TOOLS) components. The development and infrastructure activities will be coordinated in the cyberinfrastructure efforts. The research component will be carried out in the Computer and Network Systems subactivity.

ORGANIZATIONAL EXCELLENCE (+$850,000, for a total of $7.96 million)

Organizational Excellence supports Intergovernmental Personnel Act appointments, IPA's travel, and the administrative contracts necessary to conduct the level of program activity at the Request Level.

PRIORITY AREAS

In FY 2005, CISE will support research and education efforts related to broad, Foundation-wide priority areas in Biocomplexity in the Environment, Nanoscale Science and Engineering, Mathematical Sciences, Human and Social Dynamics, and Workforce for the 21st Century.

CISE Investments in NSF Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biocomplexity in the Environment	7.36	8.00	8.00	0.00	0.0%
Nanoscale Science and Engineering	11.14	15.79	19.40	3.61	22.9%
Mathematical Sciences	2.29	2.29	2.29	0.00	0.0%
Human and Social Dynamics	N/A	3.00	3.00	0.00	0.0%
Workforce for the 21st Century	N/A	N/A	2.56	2.56	N/A

- **Biocomplexity in the Environment**: In FY 2005, CISE will maintain investment in the Biocomplexity in the Environment priority area at $8.0 million. These funds will contribute to NSF's coordinated central competition and will support focused environmental informatics activities such as multi-scale modeling and simulation, dynamic data analysis and interpretation, synthesis studies, and data mining and data management.
- **Nanoscale Science and Engineering:** CISE support totals $19.40 million in FY 2005, an increase of $3.61 million over the FY 2004 Estimate of $15.79 million, for research on quantum computing, simulation of atomic and molecular scale systems, self-assembly of bio-molecular computer components, nano-robotics, and design automation to support a new approach to molecular architectures.
- **Mathematical Sciences:** CISE support totals $2.29 million in FY 2005, continuing the same level of support as FY 2004. CISE support will emphasize interdisciplinary research bridging IT and mathematical disciplines with focus on algebraic and geometric algorithms, algorithms for scalable scientific computation, algorithms for visualization, and statistical learning algorithms
- **Human and Social Dynamics:** CISE support totals $3.0 million in FY 2005, unchanged from FY 2004. Research will focus on improving use of IT systems including visualization, human-computer interaction, and language interfaces; modeling uncertainty, representing uncertainty of data objects, reasoning with uncertain objects, and semantics of distributed reasoning on uncertain objects; and mechanisms for how humans and groups interact with them. The Vulnerabilities Analysis, Consequence Management, and Threat Reduction program will initiate research that creates and manages integrated multidisciplinary and multi-sector resources for response to extreme events, including: data repositories, tools for planning and decision-making, communications infrastructures, sensor infrastructures, and real-time data-driven simulations.
- **Workforce for the 21st Century:** CISE support totals $2.56 million in FY 2005 with emphasis on increasing the capacity and quality of the nation's IT workforce.

QUALITY

CISE maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The percent of basic and applied research funds that were allocated to projects that undergo merit review was 97 percent in FY 2003, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, CISE convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

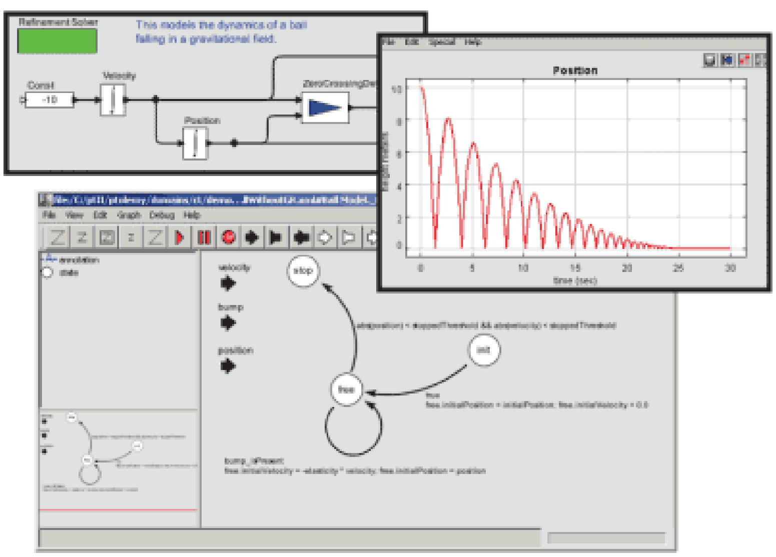
The Directorate also receives advice from the Advisory Committee for Computer and Information Science and Engineering (CISEAC) on such issues as: the mission, programs, and goals that can best serve the scientific community; how CISE can promote quality graduate and undergraduate education in the computer and information science and engineering disciplines; and priority investment areas in CISE research. The CISEAC meets twice a year and members represent a cross section of computer and information science and engineering with representatives from many different sub-disciplines within the field; a cross section of institutions including industry; broad geographic representation; and balanced representation of women and under-represented minorities. The CISE directorate also received advice from an advisory committee on Cyberinfrastructure, which in early 2003 issued the report, *Revolutionizing Science and Engineering through Cyberinfrastructure: Report of the National Science Foundation Advisory Panel on Cyberinfrastructure* (available from the NSF).

PERFORMANCE

Recent Research Highlights

A New System Science: Bridging Physical and Computational Systems

Teams from the University of California at Berkeley and Vanderbilt University have united to build new foundations for computational, physical, and engineered systems science. The Center for Hybrid and Embedded Software and Systems (CHESS) was established as the focal point for this NSF Large ITR project. This center is aimed at developing model-based and tool-supported design methodologies for real-time fault tolerant software that must execute on heterogeneous distributed platforms, and must control or otherwise interact with physical and engineered systems. The research seeks to bridge the gap between computer science and systems science by developing the foundations of a modern systems science that is simultaneously computational and physical. This represents a major departure from the current, separated structure of computer science (CS), computer engineering (CE), and electrical engineering (EE): it reintegrates information and physical sciences.



The center has convened a "curriculum council," which is an advisory board consisting of deans and department chairs of several California universities and community colleges to develop a strategy for propagating curriculum reform in systems science. The objective is to develop and disseminate courses that bridge the gap between physical system modeling and design and computational system modeling and design.

This project aims to revolutionize system science, integrating physical and computational aspects of systems on a new foundation of hybrid systems theory. The educational framework seeks also to revolutionize engineering education. This is done through an educational consortium for outreach to regional and minority-serving institutions.

Graph-Based Data Mining

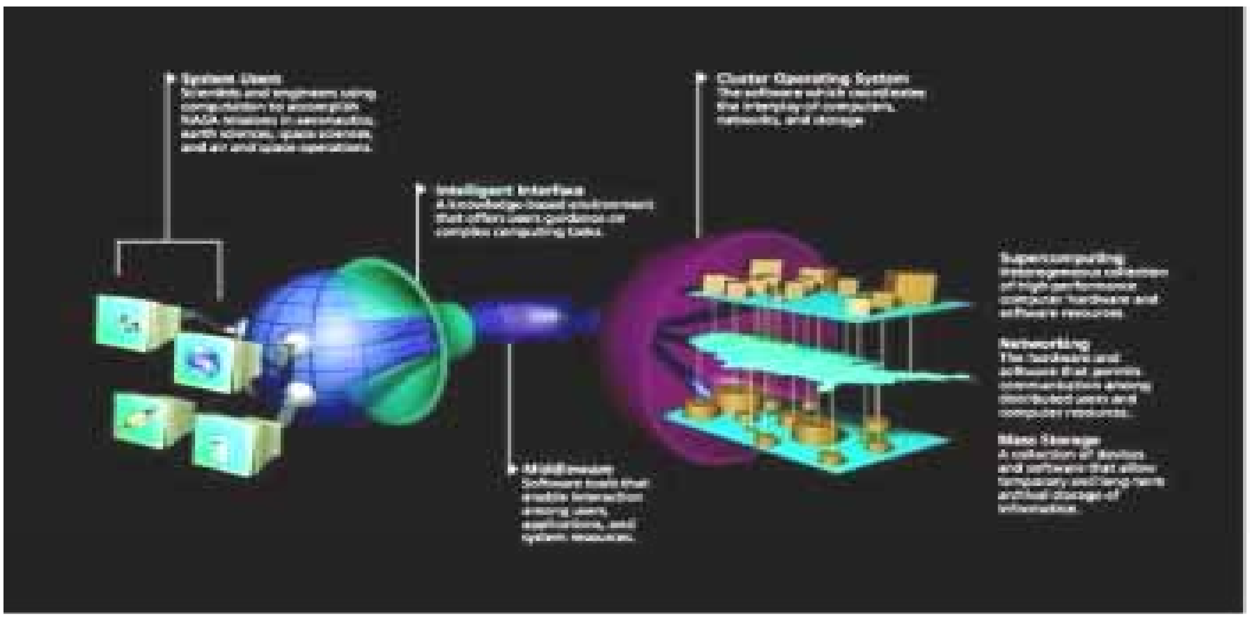
Current methods for extracting knowledge from databases are deficient in handling the growing amount of structural data expressing relationships among data objects. A CISE-supported research project, based at the University of Texas – Arlington, investigates a method for discovering knowledge in structural data. The main objective of this project is to design, implement and evaluate new methods for performing pattern learning on structured data represented as graphs and evaluate their application to structural, relational databases. The research team implemented the SUBDUE substructure discovery system that discovers interesting and repetitive subgraphs in a labeled graph representation using the minimum description length principle. The team is investigating approaches for using probabilistic graphs instead of deterministic graphs as the pattern language used by SUBDUE.

Experiments show SUBDUE's applicability to several domains, such as molecular biology, discovery of patterns in protein secondary structure, DNA gene transcription sites, carcinogenic chemical compounds, toxicology application, aviation incident reports, seismic events, image analysis, computer-aided design and program source code. The SUBDUE system is available to the research community at: http://cygnus.uta.edu/subdue/index.html.

NSF Middleware Initiative's GRIDS Center

Advances in science and engineering are driven increasingly by collaborations that focus on sharing data, computing, code, and access to experimental facilities. Network-driven computers, storage, data collections and scientific instruments are now central to the day-to-day practice of many research disciplines and are emerging as a model for cyberinfrastructure.

For example, NSF's Grid Physics Network (GriPhyN) project uses an international network of computational systems and data collections to address next-generation particle physics experiments at the Large Hadron Collider (LHC), while the NSF-funded Network for Earthquake Engineering Simulation (NEES) is revolutionizing seismology via network enabled access to experimental facilities, data, and simulations. GriPhyN and NEES represent not today's standard practice, but five- to ten-year strides for these disciplines. GriPhyN is preparing for a torrent of data from LHC experiments to begin in 2006 with a 15-year duration, while NEES is expected to be in place until 2014. Though these communities are ready now to develop new modes of research, scientists and engineers are frustrated by the scarcity of network-enabled services to suit their applications.



The NSF Middleware Initiative has begun to lead a path toward next-generation infrastructure for flexible resource sharing on national and international scales. The Grid Research Integration Development and Support (GRIDS) Center will define, develop, deploy, and support an integrated national middleware infrastructure for 21st century science and engineering applications. GRIDS involves the University of Southern California's Information Sciences Institute, the National Center for Supercomputing Applications at the University of Illinois, the University of Chicago, the San Diego Supercomputer Center at the University of California-San Diego and the University of Wisconsin-Madison.

In 2002, two NMI software releases were made. These software releases were built on widely used middleware such as the Globus Toolkit (the de facto standard for G rid environments), Condor-G and Network Weather Service, heavily leveraging open protocols based on IETF and W3C standards. In addition to GRIDS, the releases also included tools from a second NMI team called EDIT (for "Enterprise and Desktop Integration Technologies"), led by the University Corporation for Advanced Internet Development (UCAID), EDUCAUSE and the Southeastern Universities Research Association. The EDIT project focuses on security and directory service middleware for applications involving inter-campus collaborations. The GRIDS Center and EDIT team are also working closely with the NSF Partnerships for Advanced Computational Infrastructure and private industry to define and create an open, extensible architecture that integrates extant middleware.

Other Performance Indicators

The tables below show the number of people benefiting from CISE funding, and trends in growth of award size, duration, and number of awards.

Number of People Involved in CISE Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	4,160	4,200	4,400
Other Professionals	1,330	1,400	1,200
Postdoctorates	501	500	500
Graduate Students	4,602	4,700	4,800
Undergraduate Students	774	810	1,000
Total Number of People	11,367	11,610	11,900

CISE Funding Profile

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
Statistics for Competitive Awards:			
Number	872	880	900
Funding Rate	22%	22%	26%
Statistics for Research Grants:			
Number of Research Grants	1,030	1,030	1,040
Funding Rate	20%	22%	23%
Median Annualized Award Size	$116,193	$116,000	$116,000
Average Annualized Award Size	$160,174	$163,604	$165,000
Average Award Duration, in years	3.0	3.0	3.1

COMPUTER AND NETWORK SYSTEMS $132,390,000

The FY 2005 Budget Request for the Computer and Network Systems (CNS) Subactivity is $132.39 million, an increase of $17.46 million, or 15.2 percent, above the FY 2004 Estimate of $114.93 million.

Computer and Network Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Computer and Network Systems	117.15	114.93	132.39	$17.46	15.2%
Total, CNS	$117.15	$114.93	$132.39	$17.46	15.2%

The CNS subactivity supports research and education activities that invent new computing and networking technologies and that explore new ways to make use of existing technologies. The Division seeks to develop a better understanding of the fundamental properties of computer and network systems and to create better abstractions and tools for designing, building, analyzing, and measuring future systems. The Division also supports the computing infrastructure that is required for experimental computer science, and it coordinates cross-divisional activities that foster the integration of research, education, and workforce development.

The CNS Division is organized into four clusters, each of which is responsible for a related set of activities.

- **Computing Systems:** Future computing systems will be required to control a greater variety of computing, communication, storage, and external devices; to support a broader range of increasingly demanding applications; and to manage hundreds of asynchronous activities correctly, securely, and reliably. This cluster supports research and education activities that address these requirements in a variety of systems, including distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; parallel systems; and trusted systems.
- **Network Systems:** Future networks are likely to exhibit unpredictable and complex behavior and dynamics; to span a broad range of technologies and bandwidths, from wireless sensors to a high-performance core; and to carry increasingly large amounts of increasingly demanding traffic. This cluster supports a range of research and education activities in network systems, including networking research, new technologies, and networking research test beds.
- **Computing Research Infrastructure:** An important component of experimental computing is building prototypes and test beds, and this requires having an experimental infrastructure. This cluster provides support for the acquisition, enhancement, and operation of experimental facilities for all CISE research and education areas. Supported facilities range from instrumentation needed by a few projects to major experimental facilities for an entire department. Support is also provided to enhance the computational and human infrastructure in minority-serving institutions and to support the equipment needs of collaborative, distributed research projects. An emphasis is to expand support to include a wider range of infrastructure needs, research projects, and institutions.
- **Education and Workforce Cluster:** Rapid advances in computing technology lead to the need to transfer research results into the classroom. Developing and making effective use of new research results requires a well-educated and diverse workforce that is representative of and can interact with the entire populace. This cluster supports projects that integrate research and education across CISE, study the causes of the current lack of diversity in the information technology workforce, and lead to a broadening of participation by all under-represented groups. The cluster works closely with all

CISE divisions to achieve these goals. It also coordinates the participation by CISE in a portfolio of NSF-wide education and workforce programs.

The following are examples of major research efforts supported by CNS.

Computing Systems Cluster
Computer systems are subject to the ever-increasing demands of the information revolution. Applications are rising in complexity, requiring continuous improvement of software, computational resources, storage, and other devices. Massive quantities of data must be managed accurately, reliably, and securely across an array of disparate systems. The computation required for visualization of very large data sets can be as complex and expensive as the physical experiment or computer simulation that produced the data in the first place. Researchers at the University of California, Davis are exploring ways to optimize the mechanisms and methodologies that generate visualization data using parallel supercomputers. This project is system-level research, examining all stages of the visualization process, from preprocessing and rendering algorithms, to compression for transport and application control for storage.

Computing Research Infrastructure Cluster
Prototypes and testbeds are essential to experimenting with new computing systems. NSF supports the acquisition, enhancement, and operation of infrastructure in order to provide experimental facilities and advance computer and information science and engineering research and education. Research and education at Tuskegee University, an historically black university in Alabama, has been enhanced by an NSF grant that helped establish laboratories and facilities including a multimedia lab, a 4-server cluster, and High Performance Computer lab. These facilities have helped the university attract and retain African American students in computer science and engineering. The university has subsequently undertaken an outreach program that has been effective in creating a continuing interest in computation and computer science in a large number of pre-college African Americans.

Network Systems Cluster
Networks in the future are predicted to become more dynamic, complex, and unpredictable. An increasing amount of traffic with new demands will travel over a diverse set of technologies and bandwidths. Research seeks to improve the ability of network technologies to scale, adapt, and protect data to meet emerging demands. The development of robust and stable ultrascale networking, at gigabit per second (gbps) speeds in the wide area, is critical to support the new generation of high-end computing and Petabyte to Exabyte datasets that promise to drive discoveries in fundamental and applied sciences of the next decade. Researchers at CalTech are developing the theories and the algorithms for such networks of the future. Tests have been successful in transmitting data the equivalent of a full length DVD movie in approximately 7 seconds.

COMPUTING AND COMMUNICATIONS FOUNDATIONS $91,41,000

The FY 2005 Budget Request for the Computing and Communication Foundations (CCF) Subactivity is $91.41 million, an increase of $12.48 million or 15.8 percent, over the FY 2004 Estimate of $78.93 million.

Computing and Communications Foundations Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Computing & Communications Foundations	81.15	78.93	91.41	$12.48	15.8%
Total, CCF	$81.15	$78.93	$91.41	$12.48	15.8%

The CCF subactivity supports research and education activities that explore the foundations of computing and communication devices and their usage. The Division seeks advances in computing and communication theory, algorithms for computer and computational sciences, and architecture and design of computers and software. CCF-supported projects also investigate revolutionary computing paradigms based on emerging scientific ideas and integrate research and education activities to prepare future generations of computer science and engineering workers. The Division is particularly active in CISE' Science of Design and Nanoscale Science and Engineering research efforts.

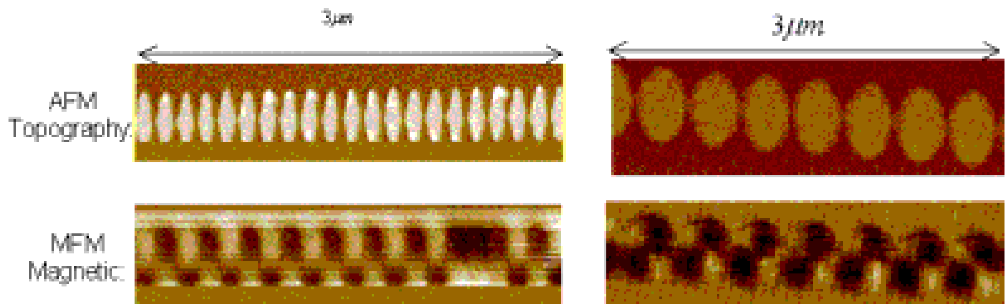
Because of the breadth of research it supports, CCF has identified three clusters of programmatic efforts.

- **Emerging Models and Technologies for Computation:** This cluster seeks to explore computational models, techniques, and systems based on emerging and future technologies. Research and education projects are supported in computing systems based on nanotechnology, quantum computing and communication, and computational devices and architectures inspired by the processing of information in living matter. The portfolio of awards examines concepts in new computing architecture, quantum and biologically inspired computing, as well as micro- and nano-systems. Topical areas include: computational algorithms and simulation techniques for nanoscale systems; design and architecture of systems based on molecular scale devices; quantum algorithms for computation, communication, and coding; realization of quantum computing; algorithms and computational modeling of biological processes; and computing models and systems for future technologies.
- **Formal and Mathematical Foundations:** This cluster seeks to determine inherent limits of computation and communication, and to obtain optimal solutions within those limits. Research and education projects supported examine information representation methods and computational techniques for advancing information technology and all scientific and engineering disciplines. Topical areas include: models of computation; computational complexity; parallel and distributed computation; random and approximate algorithms; algorithmic algebra, geometry, topology, and logic; computational optimization; computational algorithms for high-end scientific and engineering applications; techniques for representing, coding and transmitting information; mobile communication; optical communication; signal processing systems; and analysis of images, video, and multimedia information.
- **Foundations of Computing Processes and Artifacts:** This cluster seeks to advance the science, formalisms, and methodologies for building computing and communication systems. Research and education projects in software engineering, programming language design and implementation, graphics and visualization systems, computer architecture, and design automation are supported. Topical areas include: software design methodologies; tools for software testing, analysis, and

verification; semantics, design, and implementation of programming languages; micro-architectures; memory and I/O subsystems; application-specific architectures; performance metrics; VLSI electronic design; analysis, synthesis and simulation algorithms; system-on-a-chip; and architecture and design for mixed or future media (e.g., nanotechnology).

Some examples of the research promoted by CCF are:

Emerging Models and Technologies for Computation Cluster: The next breakthrough in computation capability may well be very far removed from the known paradigms. Research in areas such as biology, nanotechnology, and quantum physics provides fundamentally different models and inspiration that could lead to faster, more robust computer software, hardware, and architectures. Researchers at Notre Dame University, conducting an NSF-funded project entitled, "Computing Architectures for Coupled Nanomagnets," have discovered that magnetic interactions can be used to communicate complex information between nanoscale elements, in much the way that silicon is used in microprocessors. This finding opens the door to new computing architectures based on nanoscale elements.



Magnetic interactions to communicate information between neighboring quantum dots

Formal and Mathematical Foundations Cluster: The inherent limits of computation and communication are not well understood. Research at the foundational level is attempting to define the limits and optimize the solutions that can be produced in computer science, scientific computing, communication theory, signal processing theory, and mathematics to bring understanding across all science and engineering domains. NSF is sponsoring research at Carnegie-Mellon University that may help to make the difficult task of integrating multiple databases easier. Identifying duplicate entries of the same data from separate data sources is a vexing problem for scientists, engineers, and other data consumers. Using a natural machine-learning algorithmic approach, researchers have automatically identified hand-labeled data duplicates, providing theoretical insight into large-scale data integration.

Foundations of Computing Processes and Artifacts Cluster: NSF is seeking to advance the science, formalisms, and methodologies for building computer and communications systems. From the theoretical frameworks to the technical implementations, consideration is given to the artifacts and processes as they are involved in specifying, designing, and building complex systems. Researchers at the University of Minnesota – Twin Cities are focused on improving parallel computation methods in order to solve large-scale engineering and scientific problems. Advances are being made for three important components of parallel systems: effective and scalable algorithms, effective computer science tools and data structures, and testing and validation. Parallel systems rely on commodity hardware and can greatly reduce the costs and time involved in solving complex science and engineering problems.

INFORMATION AND INTELLIGENT SYSTEMS $92,540,000

The FY 2005 Budget Request for the Information and Intelligent Systems (IIS) Subactivity is $92.54 million, an increase of $12.49 million, or 15.6 percent, above the FY 2004 Estimate of $80.05 million.

Information and Intelligent Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Information and Intelligent Systems	82.15	80.05	92.54	$12.49	15.6%
Total, IIS	$82.15	$80.05	$92.54	$12.49	15.6%

The Division of Information & Intelligent Systems supports research and education that increases the capabilities of human beings and machines to create, discover and reason with knowledge by advancing the ability to represent, collect, store, organize, locate, visualize and communicate information. The Division contributes to interdisciplinary research on how observational data leads to discovery in the sciences and engineering.

The IIS subactivity is organized into three clusters, each of which is responsible for a coordinated strategy across a set of research and education areas.

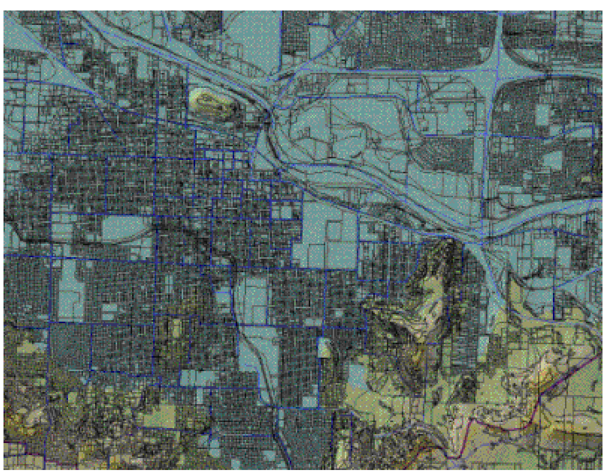
- **Data Inference and Understanding:** This cluster supports basic computer science research and education with the goal of creating general-purpose systems for representing, storing and accessing data, information and knowledge. It also supports research and education in automated methods of drawing conclusions from data and knowledge. Topical areas include: artificial intelligence and cognitive science; information and data management; computer vision; and human language and communication.
- **Science and Engineering Informatics:** This cluster supports research and education focused on advances in information technology that address problems in specific sciences and engineering domains (e.g., biology, geology, chemistry). Traditionally, scientists develop hypotheses, design experiments to test hypotheses, collect observational data, and publish results based on experiments. Data were often published to allow others to build upon or verify the results. In nearly every field of 21st century science, including all of the disciplines funded by NSF, new knowledge is generated by teams of researchers and educators analyzing data sets that are far too large to publish in journals and often collected independently by other scientists with different goals in mind. Characteristics of the research and education activities within this cluster are: integrative; focused on tools and analysis; and supportive of the data infrastructure for science and engineering. As an example, this cluster will be responsible for the Joint NSF/NIH Initiative to Support Collaborative Research in Computational Neuroscience. This project seeks to enhance our understanding of nervous system function by providing analytical and modeling tools that describe, traverse and integrate different levels of information. The Science and Engineering Informatics cluster will support similar projects across all fields of science and engineering.
- **Systems in Context:** This cluster supports research and education on the interaction between information, computation and communication systems and users, organizations, government agencies, the scientific community and the external environment. Research results provide requirements for the design and construction of future systems so that more system deployments are successful by design. The result of the integration of research and education ensures that future generations of researchers

and educators are well prepared to support new discovery over the long run. Topical areas include: human-computer interaction; digital society and technologies; data and applications security; digital government; and robotics.

Among the successes resulting from prior IIS funding are as follows.

Systems in Context Cluster: The International Children's Digital Library. Research by the University of Maryland and the Internet Archive focuses on developing interface technologies for children (ages 3-13) to access an international collection of 10,000 digital children's books (http://www.icdlbooks.org). On November 20, 2002, the first software demonstration, which included 200 books from 27 cultures in 20 different languages, was launched on the Internet with a celebration at the U.S. Library of Congress. A unique aspect of this research is the collaboration and partnership that has been established (http://www.cs.umd.edu/hcil/kiddesign/introduction.shtml). Interdisciplinary researchers from computer science, library studies, education, art, and psychology are working together with children (ages 7-11) to design this new library. Children's ideas are heard throughout the entire technology design process. Therefore, children work in the labs as researchers twice a week during the school year, and for two intensive weeks over the summer. Together this interdisciplinary and intergenerational team brainstorms, sets project directions, tests new ideas, and implements new technologies. The research has advanced understanding of how children access written materials.

Software Architectures for Microsimulation of Urban Development Transportation and Environmental Impact. The UrbanSim project at the University of Washington has developed a software-based simulation model for integrated planning and analysis of urban development, incorporating the interactions between land use, transportation, and public policy. It is intended for use by Metropolitan Planning Organizations and others needing to interface existing travel models with new land use forecasting and analysis capabilities. Based on the successes thus far with the UrbanSim project, researchers Alan Borning and colleagues are researching ways of building a complete, flexible and scalable microsimulation of urban growth. One of the tests applied to UrbanSim was a historical validation, launching the model with 1980 data for Eugene/Springfield, Oregon, and running it through 1994, comparing the simulated results with what actually happened. Results were very encouraging, with a correlation of better than 0.9.



Eugene/Springfield Oregon Input Data: Parcels

SHARED CYBERINFRASTRUCTURE $123,599,000

The FY 2005 Budget Request for the Shared Cyberinfrastructure (SCI) Subactivity is $123.60 million, an increase of $10.97 million, or 9.7 percent, over the FY 2004 Estimate of $112.63 million.

Shared Cyberinfrastructure Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Shared Cyberinfrastructure	95.07	112.63	123.60	$10.97	9.7%
Total, SCI	$95.07	$112.63	$123.60	$10.97	9.7%

The Shared Cyberinfrastructure (SCI) subactivity supports design, development and deployment of a coherent set of interconnected computational engines, data repositories, digital libraries, sensors and field-specific instruments known as cyberinfrastructure. Such resources are widely shared across multiple scientific and engineering domains and enable shared digital knowledge environments in which researchers and educators create and promulgate new knowledge across distance, time and fields of expertise.

The Shared Cyberinfrastructure subactivity has a single cluster with several areas that together provide the foundation for the shared elements of Cyberinfrastructure.

- **Infrastructure Planning, Construction & Operations Cluster:** SCI supports acquisition, operation and upgrading of national infrastructure in support of high-end computation for the academic research and education community. These resources may include: supercomputers; high-capacity mass-storage systems; system software suites and programming environments; productivity software libraries and tools; large-scale data repositories; and the experts and support staff that create and maintain the facilities.

Advanced Networking Technologies and Infrastructure: SCI supports networks of various reach and granularity from high-speed backbone networks that connect high-performance computational resources and high-end instrumentation sites, to wireless networks that connect embedded sensor nodes in remote scientific field sites. SCI fosters deployment of networks as well as development and fielding of networking technologies that enhance cyberinfrastructure. Some of the key areas include end-to-end networking protocols; performance monitoring tools and measurement infrastructure; wireless networks; strategic international collaborations; and testbeds to support trial deployment.

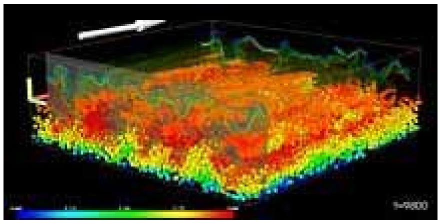
Advanced Services and Cybertools: There is a need for development and support of an array of software tools and services that hide the implementation complexities and heterogeneity while offering clean logical interfaces to users. These tools and services include information management systems and data services, scalable interactive visualization tools, middleware service building blocks for high-end computational resources as well as for networked instrumentations and sensors.

In each of above areas, the subactivity stresses fielding, testing, and ongoing support of advanced technologies beyond basic proof-of-concept demonstrations. The Division collaborates closely with other NSF Directorates and Offices to ensure the advancement of cyberinfrastructure will meet the demands of tomorrow's science and engineering communities.

Examples of SCI supported efforts include:

Tiny Bubbles: SCI-funded computational facilities and innovative application codes are enabling fundamental research on drag reduction for ocean-going vessels that could potentially save substantial fuel costs.

It has long been known that a surface layer of small bubbles on the hull of a large ocean-going vessel reduces the frictional drag as a ship moves through the ocean. However, the physics of this phenomenon has never been well understood. A team with participants from 14 universities led by George Karniadakis of Brown University is advancing understanding of these bubble phenomena. The 20,000 or so simulated bubbles in the Brown team's studies move in a representation of a three-dimensional channel. To produce these models, the Brown team relies on a computational fluid dynamics code called NekTar, created over the years by Karniadakis using NCSA computers and other machines supported by the NSF's Partnerships for Advanced Computational Infrastructure program.



Flow streamline velocity contours for a system of 21,600 microbubbles.

NSF Middleware Initiative's Grid Research Integration Development and Support (GRIDS) Center. The GRIDS Center has been created to define, develop, deploy, and support an integrated national middleware infrastructure in support of 21st century science and engineering applications. GRIDS is a partnership of the University of Southern California's Information Sciences, the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign, the University of Chicago, the San Diego Supercomputer Center at the University of California-San Diego and the University of Wisconsin-Madison. Middleware supports the needs of scientists and engineers to collaborate by sharing data, computing, code, and access to experimental facilities. Network-driven computers, storage, data collections and scientific instruments are made available to the day-to-day practice of many research disciplines.

Several innovative cyberinfrastructure projects are already using products of GRIDS. For example, NSF's GriPhyN project uses an international network of computational systems and data collections to address next-generation particle physics experiments at the Large Hadron Collider (LHC), while the NSF-funded Network for Earthquake Engineering Simulation (NEES) is revolutionizing seismology via network-enabled access to experimental facilities, data, and simulations. GriPhyN and NEES represent not today's standard practice, but five- to ten-year strides for these disciplines. GriPhyN is preparing for a torrent of data from LHC experiments to begin in 2006 with a 15-year duration, while NEES is expected to be in place until 2014.

INFORMATION TECHNOLOGY RESEARCH $178,110,000

The FY 2005 Budget Request for the Information Technology Research (ITR) Subactivity is $178.11 million, a decrease of $40.0 million, or 18.3 percent, from the FY 2004 Estimate of $218.11 million.

Information Technology Research Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Information Technology Research	213.77	218.11	178.11	-40.00	-18.3%
Total, ITR	$213.77	$218.11	$178.11	-40.00	-18.3%

FY 2004 is the last year of Information Technology Research as an NSF priority area. Thus, the CISE activity in FY 2005 focuses on institutionalizing the gains made as a result of ITR investments. Gains of particular note include:

- Enhanced support for cutting edge IT research and related education activities.
- Enhanced support for more focused research in areas of national importance, such as cybersecurity, homeland security, and cyberinfrastructure.
- Enhanced support for larger, more complex projects, including those that are multidisciplinary in nature.

In FY 2005, ITR in CISE will consolidate these gains and continue its transformation of the CISE activity through support of new theme areas that cross the CISE disciplinary areas, require larger and longer duration awards, and that are responsive to national and disciplinary needs. These themes will be multi-year investments and will build on those established in FY 2004 as described below:

Cyber Trust: Networked computers reside at the heart of systems on which people now rely, both in critical national infrastructures and in their homes, cars, and offices. Today, many of these systems are far too vulnerable to cyber attacks that can inhibit their function, corrupt important data, or expose private information.

Cyber Trust promotes a vision of a society in which these systems are:

- more predictable, more accountable, and less vulnerable to attack and abuse;
- developed, configured, operated and evaluated by a well-trained and diverse workforce; and
- used by a public educated in their secure and ethical operation.

To improve national cyber security and achieve the Cyber Trust vision, NSF will support a collection of projects that together: advance the relevant knowledge base; creatively integrate research and education for the benefit of technical specialists and the general populace; and integrate the study of technology with the policy, economic, institutional and usability factors that often determine its deployment and use.

Science of Design: This effort will support science and engineering research and education that develops the foundations of making the design of IT systems a *science*, leading to more effective development, evolution and understanding of systems of large scale, scope and complexity. The emphasis of this program is on software-intensive computing, information and communication systems, (i.e., systems for which software is the principal means to conceptualize, define, model, analyze, develop, integrate, operate, control, and manage such systems). Other disciplines with a longer history than computing and software have scientifically discovered and validated facts, volumes of codified experience, and formalized, teachable principles. Analogous foundations are needed for a Science of Design for software-intensive systems.

Information Integration: The Information Integration theme will focus on advancing the state of the art in the application of advanced information technology to science and engineering problems in specific domains, such as astronomy, biology, the geosciences, public health and health care delivery. Since many scientific problems have common needs for information management and data analysis, the advancement of these technologies is central. Similarly, within computer science, the study of complex distributed computer and network systems requires the collection and analysis of timely, accurate and reliable information. Within this effort, the NSF intends to support a group of projects that will advance the understanding of technology to enable scientific discovery, and that will creatively integrate research and education for the benefit of technical specialists and the general population.

In FY 2005, CISE will reallocate $40.0 million in ITR funds to the other four CISE sub-activities for the purpose of supporting these themes and other emerging IT priorities, as well as to continue support for larger scale, interdisciplinary projects.

ENGINEERING

ENGINEERING $575,900,000

The FY 2005 Budget Request for the Engineering Activity (ENG) is $575.90 million, an increase of $10.77 million, or 1.9 percent, over the FY 2004 Estimate of $565.13 million.

Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Bioengineering and Environmental Systems	49.45	51.02	49.77	-1.25	-2.5%
Chemical and Transport Systems	68.33	68.92	67.21	-1.71	-2.5%
Civil and Mechanical Systems	63.23	67.17	85.51	18.34	27.3%
Design, Manufacture & Industrial Innovation	64.00	65.81	65.88	0.07	0.1%
SBIR/STTR	90.92	103.59	104.09	0.50	0.5%
Electrical and Communications Systems	73.05	74.58	72.73	-1.85	-2.5%
Engineering Education and Centers	132.72	134.04	130.71	-3.33	-2.5%
Total, ENG[1]	$541.70	$565.13	$575.90	$10.77	1.9%

Totals may not add due to rounding.
[1] The large increase appearing in the Civil and Mechanical Systems Subactivity accommodates the Operations phase of NEES, initiating in FY 2005.

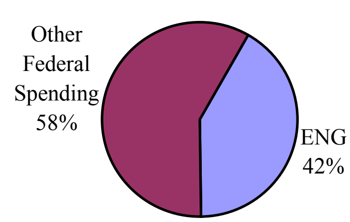
The Engineering Activity (ENG) supports fundamental research on engineering systems, devices, and materials, and their underpinning processes and methodologies. ENG investments help create the engineering workforce and technological innovation vital to the nation's economic strength, security and quality of life.

RELEVANCE

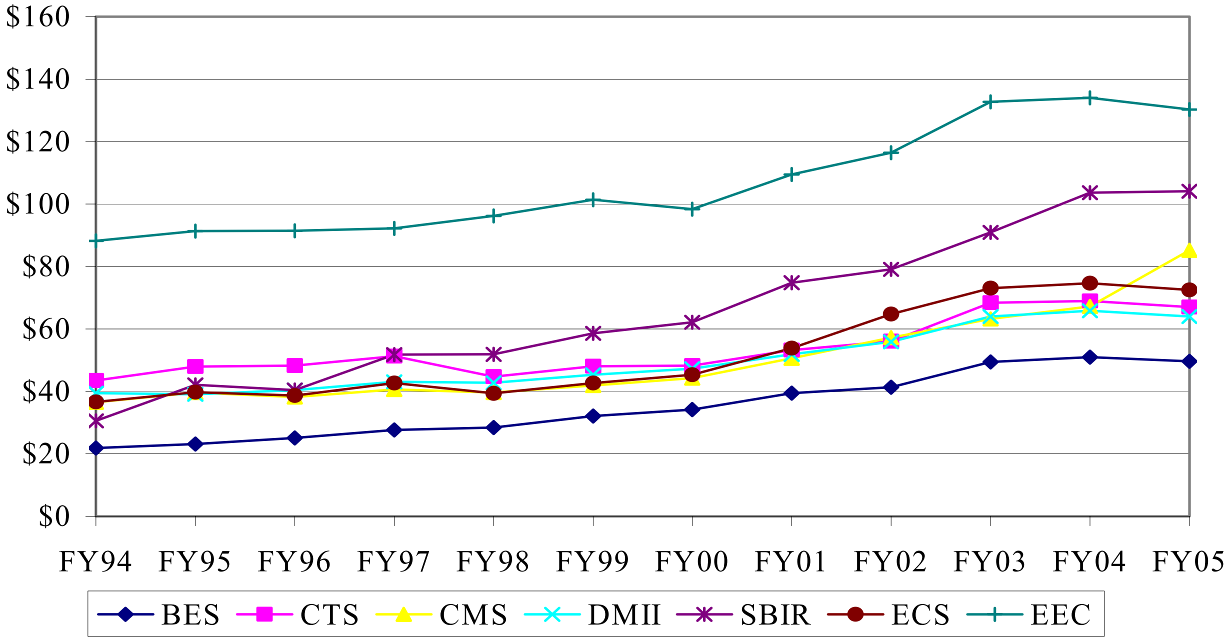
ENG is a principal source of federal funding for university-based fundamental engineering research, providing 42 percent of the total federal support in this area.

ENG promotes the progress of engineering in the United States. Its investments in engineering research and education build and strengthen a national capacity for innovation that leads to the creation of new shared wealth and a better quality of life. A major focus of ENG investments is in emerging technologies—nanotechnology, cyberinfrastructure, network systems and biotechnology. Support for research in these areas contributes to major advances in health care, manufacturing, and national security. The Engineering Directorate leads the Foundation's efforts in the area of nanotechnology and works closely with the other NSF Activities in advancing this exciting field. Nanotechnology has the potential to enable revolutionary technologies that can advance a broad spectrum of science and engineering disciplines.

Federal Support of Basic Research in Engineering at Academic Institutions



ENG Subactivity Funding
(Dollars in Millions)



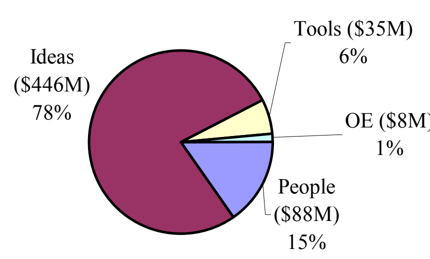
STRATEGIC GOALS

Four strategic outcome goals guide ENG activities:

- People: Activities to better attract students and to ensure the most current and highest quality engineering education. ENG plays a key role in promoting curriculum reform to respond to industry's needs and to emerging technologies that are transforming the economy. ENG supports the engineering graduates who will lead currently emerging technology areas and positions these graduates to be well prepared to push technological frontiers.

- Ideas: Advancement of fundamental engineering knowledge, including support for core research as well as the exploration of new and emerging technologies, high risk and innovative research, and expanding opportunities for discovery.

FY 2005 ENG Strategic Goals



- Tools: Enhancement of infrastructure to conduct engineering research, identifying and developing state-of-the-art tools for increasingly collaborative engineering research activities.

- Organizational Excellence: Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for

Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	86.72	87.78	87.96	0.18	0.2%
Ideas	443.66	458.10	445.53	-12.57	-2.7%
Tools	3.90	11.75	34.66	22.91	195.0%
OE	7.42	7.50	7.75	0.25	3.3%
Total, ENG	$541.70	$565.13	$575.90	$10.77	1.9%

PEOPLE (+$180,000, for a total of $87.96 million)

People are ENG's most important investment. Across its programs, ENG supports about 15,000 people, including students, researchers, post-doctorates, and trainees. ENG is committed to maintaining this number, while progressing with the NSF goal of longer award durations and larger grants. Support for programs specifically addressing NSF's strategic goal, "*People – a diverse, competitive and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens,*" totals $87.96 million in FY 2005, an increase of $180,000 from the FY 2004 Estimate.

ENG also invests in focused human resources development and education activities that shape the next generation engineering and technological workforce, and enhance opportunities for women and minorities. Through these investments, ENG cultivates future leaders in engineering research, prepared to explore new and emerging ideas. In FY 2005, ENG supports such focused activities as Faculty Early Career Development (CAREER), Graduate Research Fellowships (GRF), Integrative Graduate Education and Research Traineeships (IGERT), and Research Experiences for Undergraduates (REU).

ENG People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	54.21	56.00	58.50	2.50	4.5%
Institutions	20.95	19.43	17.11	-2.32	-11.9%
Collaborations	11.56	12.35	12.35	0.00	0.0%
Total, ENG People	$86.72	$87.78	$87.96	0.18	0.2%

Highlights of ENG's People investment include:

<u>INDIVIDUALS</u>

- An increase of $2.0 million over the FY 2004 level of $7.30 million for a total of $9.30 million for the IGERT program, enabling funding for about 40 additional graduate students.

- $35.50 million in support of CAREER, an increase of $500,000 over the FY 2004 level of $35.0 million, enhancing opportunities for junior-level engineering researchers to receive support for developing activities.

INSTITUTIONS
- An investment level of $3.50 million for the ADVANCE program, increasing by $240,000 over the FY 2004 level. This inherently flexible funding opportunity increases academic and professional opportunities for women.
- $13.47 million, a decrease of $2.02 million from the FY 2004 level, to support the Engineering Education Reform program. This level of support, while decreasing emphasis on unsolicited proposals, continues to enable engineering departments to develop innovative curricula, incorporating interdisciplinary knowledge and allowing engineering schools to develop active partnerships with schools of education, for their mutual benefit.

COLLABORATIONS
- A continued investment of $3.22 million for the GK-12 program, supporting $30,000 stipends for engineering graduate students.
- Research Experience for Undergraduates (REU) Sites maintain an investment level of $7.0 million.

IDEAS (-$12.57 million, for a total of $445.53 million)

ENG support for discovery across the frontiers of science and engineering enables continued support of fundamental research in the engineering disciplines and enhanced funding for selected NSF priority areas. It also provides enhanced support for research in areas such as nanotechnology, sensors, and multi-hazard engineering using the Network for Earthquake Engineering Simulation (NEES).

In its core programs, ENG supports fundamental research on sensor technologies related to nano/micro-scale sensors; wireless communications; functional materials with selective adsorption capabilities; nondestructive evaluations and remote sensing. Improved sensor technologies will enhance health and environmental monitoring and the efficiency of industrial processes. It will also augment homeland security capabilities while creating a workforce knowledgeable in the operation and deployment of sensor technologies. These technologies include: sensors with higher sensitivity and a lower rate of false alarms in the detection of chemical and biological agents; sensing material properties and processes at the nano and micro scales under extreme conditions; sensors for detection, monitoring and control of engineering operations; sensor arrays for enhanced observation of natural and social environments; and imaging and sensing of complex systems, such as critical infrastructure, health and the environment.

The Small Business Innovation Research (SBIR) program provides funding at the mandated level of 2.5 percent of extramural research, as required by P.L. 106-554. It will be funded at $93.16 million, an increase of $450,000 over the FY 2004 level of $92.71 million. The program emphasizes commercialization of research results at small business enterprises through the support of high quality research across the entire spectrum of NSF disciplines.

In FY 2005, ENG will provide $10.93 million, an increase of $50,000 over the FY 2004 level of $10.88 million, for the Small Business Technology Transfer (STTR) program, which partners small businesses with academic institutions to promote industrial innovation.

Total ENG support for the National Earthquake Hazards Reduction (NEHRP) program is $41.0 million, an increase of $16.0 million over the FY 2004 level of $25.0 million, including support for fundamental research that leads to more earthquake-resistant buildings and facilities. Foundation-wide, support for NEHRP in FY 2005 is about $53.0 million, including operations funding for the Network for Earthquake Engineering Simulation.

The Engineering Research Centers (ERCs) program provides an integrated environment for academe and industry to focus on next-generation advances in complex engineered systems, with synergy among engineering, science, and industrial practice. ERCs integrate research with education at both the graduate and undergraduate levels, producing curriculum innovations derived from the systems focus of the ERCs' strategic research goals. ERCs aim to build trusted partnerships with industry, develop shared infrastructure, and increase the capacity of engineering and science graduates to contribute to the U.S. competitive edge. They provide a system perspective for long-term engineering research and education, enabling fresh technologies, productive engineering processes, and innovative products and services.

ENG Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Fundamental Science and Engineering	260.87	249.79	235.98	-13.81	-5.5%
Centers Programs	85.71	98.42	99.46	1.04	1.1%
Capability Enhancement	97.08	109.89	110.09	0.20	0.2%
Total, ENG Ideas	$443.66	$458.10	$445.53	-$12.57	-2.7%

FUNDAMENTAL SCIENCE AND ENGINEERING

- Funding for ENG disciplinary research is decreased by $13.81 million in FY 2005 to reallocate funds to ENG's Tools budget, to support operations of the Network for Earthquake Engineering Simulation. Highlighted areas within ENG ongoing disciplinary support include sensor technologies, core nanotechnology investments, and biotechnology.

CENTERS PROGRAMS

ENG Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Engineering Research Centers	65.72	65.55	63.49	-2.06	-3.1%
Earthquake Engineering Research Centers	6.00	6.00	6.00	0.00	0.0%
Nanoscale Science & Engineering Centers	6.10	18.91	22.01	3.10	16.4%
Science and Technology Centers	7.89	7.96	7.96	0.00	0.0%
Total, Centers Support	$85.71	$98.42	$99.46	$1.04	1.1%

The FY 2005 ENG Budget Request for Centers includes:

- $63.49 million to support 19 university-based Engineering Research Centers (ERCs). NSF provides about 30 percent of the total support to the centers, with the remaining funding support coming from industry, other federal agencies, universities, and the states. Engineering Research Centers (ERCs) focus on the definition, fundamental understanding, development, and validation of the technologies needed to realize a well-defined class of engineered systems with the potential to spawn whole new industries or radically transform the product lines, processing technologies, or service delivery methodologies of current industries. ERC faculty, students and industry partners integrate discovery and learning in an interdisciplinary environment that reflects the complexities and realities of real-world technology and product development. Through their inherently broad reach, ERCs add an integrative dimension to their impact, acting as change agents for academic engineering programs and the engineering community at large. ERC innovations in research and education are expected to impact curricula at all levels from pre-college to life-long learning, to employ and reach out to a population that reflects the diversity of the United States, and to be disseminated to and beyond academic and industry partners.

- $6.0 million to support three Earthquake Engineering Research Centers at approximately $2.0 million each per year to provide knowledge to mitigate damage to the built environment; provide outreach to the private, educational, and government sectors; and educate professionals for cross-disciplinary careers.

- $22.01 million to support Nanoscale Science and Engineering Centers (NSEC). Research at these centers aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. These centers have strong partnerships with industry, national laboratories and international centers of excellence.

- $7.96 million to support two Science and Technology Centers (STCs): The University of Illinois' center on Advanced Materials for Water Purification, and Cornell University's STC on Nanobiotechnology.

<u>CAPABILITY ENHANCEMENT</u>

FY 2005 support includes:

- An increase of $450,000 for a total of $93.16 million for the Small Business Innovation Research (SBIR) program, and an additional $50,000 for a total of $10.93 million for the Small Business Technology Transfer (STTR) program. Recent congressional action raised the mandated agency spending target for STTR from .15 percent to .30 percent of the agency's extramural research budget in FY 2004.

- $6.0 million for Industry/University Cooperative Research Centers (I/UCRC). The I/UCRC program will support about 46 I/UCRCs. These highly leveraged centers form close-knit partnerships with their industrial members.

- No investment toward the three State Industry/University Cooperative Research Centers (S/I/UCRCs). FY 2003 marked the final year of funding for these centers.

TOOLS (+ $22.91 million, for a total of $34.66 million)

In FY 2005, ENG support for the enhancement of infrastructure to conduct engineering research is funded at $34.66 million, an increase of $22.91 million over the FY 2004 level of $11.75 million.

ENG Tools Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Facilities	3.90	11.75	34.66	22.91	195.0%
Total, ENG Tools	$3.90	$11.75	$34.66	$22.91	195.0%

FACILITIES

- $20.0 million is invested in operations and maintenance of the George E. Brown, Jr. Network for Earthquake Engineering Simulation, which will become operational in FY 2005. NEES will transform the environment for earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation at several sites distributed throughout the country to improve the seismic design and performance of U.S. civil and mechanical infrastructure systems.

- An increase of $1.41 million, for a total of $10.81 million, for the National Nanotechnology Infrastructure Network (NNIN), an integrated network of user facilities that supports infrastructure needs for research and education in the burgeoning nanoscale science and engineering field.

- An increase of $1.50 million for a total of $3.85 million for the Network for Computational Nanotechnology (NCN). The NCN increase will focus on modeling and simulation of chemical, biological and pharmaceutical systems, and will include additional network nodes that focus on these areas.

ORGANIZATIONAL EXCELLENCE (+$250,000, for a total of $7.75 million)

ENG investments in Organizational Excellence provide funding for Intergovernmental Personnel Act (IPA) appointments, the IPA's travel and the administrative contracts necessary to conduct the level of program activity. These investments complement the work of the ENG staff, bringing new ideas to the table and enabling a closer connection with the ENG scientific community and a broader range of outreach and oversight activities.

PRIORITY AREAS

In FY 2005, ENG will support research and education efforts related to five broad, Foundation-wide priority areas: Biocomplexity in the Environment, Nanoscale Science and Engineering, Mathematical Sciences, Human and Social Dynamics, and Workforce for the 21st Century.

ENG Investments in Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Nanoscale Science and Engineering	94.35	108.88	133.81	24.93	22.9%
Biocomplexity in the Environment	6.00	6.00	6.00	0.00	0.0%
Mathematical Sciences	0.91	2.91	2.91	0.00	0.0%
Human and Social Dynamics	N/A	2.00	2.00	0.00	0.0%
Workforce for the 21st Century	N/A	N/A	1.03	1.03	N/A

Highlights include:

The **Nanoscale Science & Engineering (NS&E)** priority area is increased by $24.93 million, for a total of $133.81 million within ENG. NSF leads the Administration's National Nanotechnology Initiative (NNI) and has primary responsibility for fundamental research, education and provision of research infrastructure. The Engineering Activity leads Nanoscale Science and Engineering within NSF and works closely with the other Activities in advancing these cutting-edge, multidisciplinary areas. With this additional investment, ENG will:

- Enhance funding rates for interdisciplinary research awards (currently below 10%) and increase award size and duration;
- Focus additional resources ($16.08 million) in fundamental research areas such as novel tools for manufacturing, nanoelectronics beyond silicon, converging technologies for enhancing human performance, and nanobiosystems;
- Invest $1.75 million in additional support toward education and societal implications through activities such as K-12 nanotechnology education networks, undergraduate education, new curricula and knowledge transfer to enhance public understanding;
- Provide a significant increase ($2.91 million) to the National Nanotechnology Infrastructure Network (NNIN) and the Network for Computational Nanotechnology (NCN); and
- Invest $3.10 million to increase support to existing Nanoscale Science & Engineering Centers (NSEC).

A maintained investment of $6.0 million will support research in the **Biocomplexity in the Environment (BE)** priority area. Funds will support activities in the Materials, Use: Science, Engineering, and Society (MUSES) program.

The **Mathematical Sciences** priority area is level-funded at $2.91 million. Support will be provided to support synergistic collaborations between mathematicians and engineering researchers to strengthen engineering modeling and experimental work and enhance undergraduate and graduate engineering education.

$2.0 million, unchanged from the FY 2004 level, will support research in the **Human and Social Dynamics** priority area. Funds will be invested in Decision Making Under Uncertainty to support studies on the security and reliability of critical infrastructure networks, and in Dynamics of Human Performance to focus on integration of nanotechnology, biotechnology, information technology and cognitive science for improving human physical and mental abilities, as well as a new generation of tools and processes to achieve this goal.

Initial funding of $1.03 million is provided for the **Workforce for the 21st Century** priority area, to support integrative institutional collaborations that prepare students for the engineering workforce by leveraging, building on and integrating current programs at collaborating institutions. The collaborations are expected to serve a diverse student population, increase student access to research experiences, and incorporate evaluation of program effectiveness.

QUALITY

ENG maximizes the quality of the research it supports through the use of a competitive, merit-based review process. The percent of basic and applied research funds allocated to projects that undergo merit review was 95 percent in FY 2003, the last year for which complete data exist.

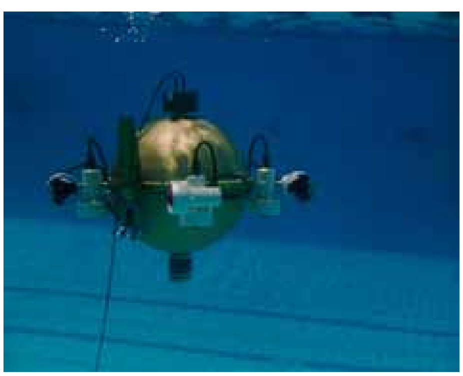
To ensure the highest quality in processing and recommending proposals for awards, ENG convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

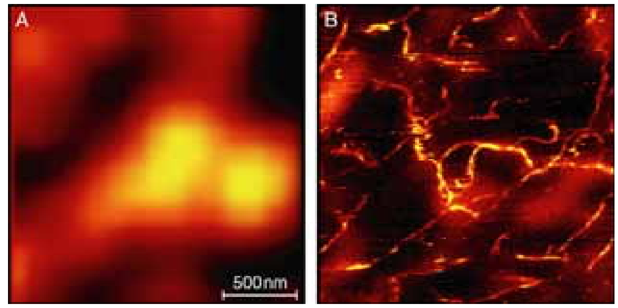
The Directorate also receives advice from the Advisory Committee for Engineering (AC/ENG) on such issues as: the mission, programs, and goals that can best serve the scientific community; how ENG can promote quality graduate and undergraduate education in the engineering sciences; and priority investment areas in engineering research. The AC/ENG meets twice a year and members represent a cross section of engineering with representatives from many different sub-disciplines within the field; a cross section of institutions including industry; broad geographic representation; and balanced representation of women and under-represented minorities.

PERFORMANCE

ENG performance highlights include:

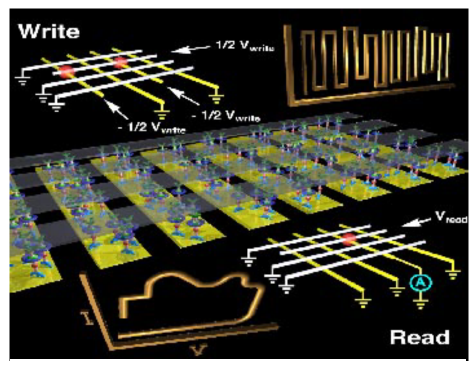
An ENG grant helped develop the **Omni-Directional Intelligent Navigator (ODIN)**, a fully autonomous underwater robot. Featured in Popular Science magazine and on the cover page of IEEE Robotics and Automation magazine, ODIN's primary research objective has been to investigate and develop intelligent control strategies for underwater robotic vehicles (URVs) with manipulator work packages. The motion of the manipulator, attached to the vehicle's main body, affects the motion of the vehicle. Most underwater robot vehicles are built like torpedoes, and cannot perform fine positioning or tracking. ODIN has omni-directional motion in three dimensions, and highly accurate positioning/tracking. The University of Girona in Spain has replicated ODIN's unique features for their vehicle, and the U.S. Coast Guard has expressed interest in this type of robot for harbor/port security.





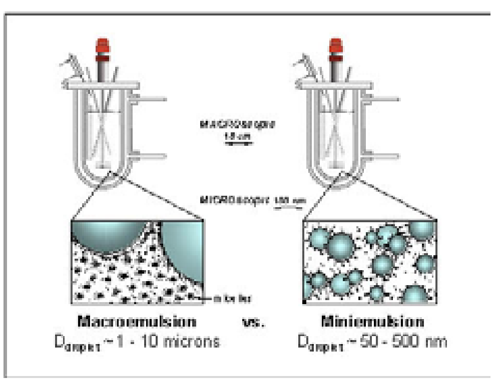
Raman scattering images of carbon nanotubes (A) using standard diffraction limited microscopy and (B) using the near-field Raman microscopy technique developed by Lukas Novotny of the University of Rochester and colleagues. *Credit: The Institute of Optics, University of Rochester*

Lukas Novotny and his University of Rochester team have created the highest-resolution optical image ever, revealing structures as small as carbon nanotubes just a few billionths of an inch across. The new method, developed with colleagues from Portland State University and Harvard University, literally sheds light on previously inaccessible chemical and structural information in samples as small as the proteins in a cell's membrane. This light-based technique, called **near-field Raman microscopy**, allows researchers to glean a great deal of visual information. With it, researchers can determine a material's composition as well as its structure. The grand vision for the project is garnering the information light provides from the proteins on a membrane, which would open the door to designer medicines that could kill harmful cells, repair damaged cells, or even identify never-before-seen strains of disease.



This image depicts a two-dimensional molecular electronic circuit. *Credit: the University of California at Los Angeles*

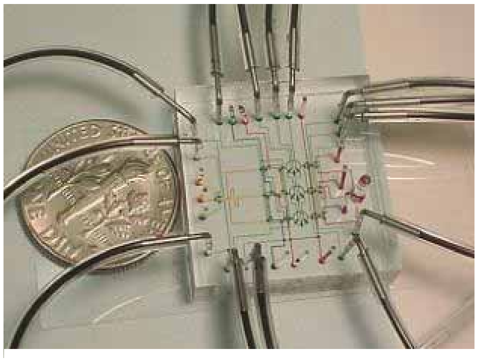
Named *Breakthrough of the Year 2001* by Science magazine, the wiring of the first ever **molecular-scale circuits** pushes the fundamental limits of trends in computing, opening the possibility of a new world of nano-electronics. Computer chips containing components at the molecular scale could accommodate billions of transistors, compared to some 40 million for today's state-of-the-art chips. As the Science article noted, "If researchers can wire these circuits into intricate computer chip architecture, this new generation of molecular electronics will undoubtedly provide computing power to launch scientific breakthroughs for decades."



Featuring small droplet size and exceptional stability, miniemulsions have many important industrial applications, such as pill coatings and encapsulation of pigments in latex paints.

Mohamed S. El-Aasser of Lehigh University has been named recipient of the American Chemical Society's *Roy W. Tess Award* in Coatings 2002 for his pioneering work in developing **miniemulsion polymerization**, a technology that has resulted in nine patents, including coatings for pharmaceutical pills and encapsulation of paint pigments.

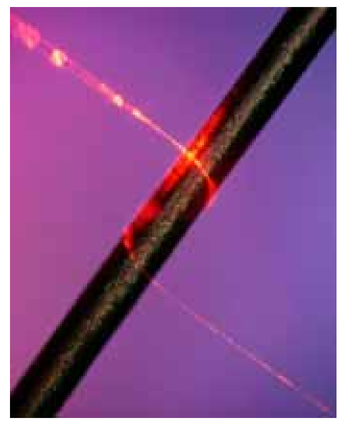
Coined by El-Aasser in 1980, the term "miniemulsions" refers to a type of oil-in-water emulsion characterized by small droplet size (50-500 nanometers) and much higher stability than conventional emulsions (with a typical droplet size of 1-10 microns, i.e., 20 times larger). El-Aasser's research has contributed to fundamental understanding of the mechanics of emulsion polymerization.



Nano-CEMMS pursues nanomanufacturing applications builds on recent advances in microfluidics, such as this integrated microfluidic circuit chip built to isolate DNA. *Credit: Stephen Quake, California Institute of Technology*

The **Center for Nano-Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS)** aims to utilize recent discoveries in nanotechnology to revolutionize the nation's nanomanufacturing capabilities. Nano-CEMMS research will target development of a vanguard commercial-scale manufacturing tool that builds devices and systems at nanometer scale (one inch contains 25.4 million nanometers). Nano-CEMMS, one of two new Nanoscale Science and Engineering Centers, addresses fundamental research barriers to commercial-scale nanomanufacturing. A collaborative effort among the University of Illinois at Urbana-Champaign, the California Institute of Technology, and North Carolina Agricultural & Technical State University (NCAT), Nano-CEMMS will build on two recent discoveries: 'nanogate' technology, and new advances in microfluidics.

Harvard University's Eric Mazur and Limin Tong (also of Zhejiang University in China), with colleagues from Tohoku University in Japan, have developed a process to create **wires only 50 nanometers (one billionth of a meter) thick**. Made from silica, the same mineral found in quartz, the wires carry light in an unusual way: these wires, thinner than the wavelengths of light they transport, serve as a guide around which light waves flow. Smaller fibers will allow devices to transmit more information using less space. The new material may have applications in ever-shrinking medical products and tiny photonics equipment such as nanoscale laser systems, and tools for communications and sensors. Size is of critical importance to sensing—with more, smaller-diameter fibers packed into the same area, sensors could detect many toxins, for example, at once and with greater precision and accuracy.



If suddenly becoming a hospital patient improves a doctor's bedside manner, then coupling engineers with the medical staff that use their products results in better instruments. The Johns Hopkins University Engineering Research Center for Computer-Integrated Surgical Systems and Technology (CISST) and its clinical collaborators proposed this in an innovative course to teach biomedical, mechanical, electrical, and computer science and engineering students the fundamental skills and operative procedures for general surgery. "Surgery for Engineers" engages students in new and exciting learning experiences, fosters relationships between engineers and clinicians, identifies and solves relevant problems with engineering principles, and enhances the undergraduate curriculum for career preparation.

Other Performance Indicators

The tables below show trends in the number of people benefiting from ENG funding, and trends in growth of award size, duration and number of awards.

Number of People Involved in ENG Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	5,146	5,248	5,064
Other Professionals	1,489	1,519	1,466
Postdoctorates	497	507	489
Graduate Students	5,078	5,180	4,999
Undergraduate Students	2,618	2,670	2,577
Total Number of People	14,828	15,124	14,595

ENG Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	1,945	1,984	1,915
Funding Rate	21%	20%	19%
Statistics for Research Grants:			
Number of Research Grants	936	955	920
Funding Rate	17%	16%	15%
Median Annualized Award Size	$99,997	$100,000	$100,000
Average Annualized Award Size	$119,476	$119,500	$119,500
Average Award Duration, in years	2.9	2.9	2.9

BIOENGINEERING AND ENVIRONMENTAL SYSTEMS $49,770,000

The FY 2005 Budget Request for the Bioengineering and Environmental Systems Subactivity is $49.77 million, a decrease of $1.25 million, or 2.5 percent, below the FY 2004 Estimate of $51.02 million.

Bioengineering and Environmental Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Bioengineering and Environmental Systems	49.45	51.02	49.77	-1.25	-2.5%
Total, BES	$49.45	$51.02	$49.77	-$1.25	-2.5%

The Bioengineering and Environmental Systems (BES) Division supports research and education in the rapidly evolving fields of bioengineering and environmental engineering. BES has two principal objectives. The first objective is to enable and facilitate the deployment of new technologies in these fields in service to society for use in the medical, biotechnology, and environmental arenas. The second objective is to advance bioengineering and environmental engineering education, particularly through the development of innovative programs by new faculty.

BES achieves these objectives across its three program clusters:

- Biochemical Engineering/Biotechnology (BEB);
- Biomedical Engineering and Research to Aid Persons with Disabilities (BME/RAPD); and
- Environmental Engineering and Technology (EET).

Current BES high-emphasis research and education areas include post-genomic engineering, tissue engineering, biophotonics, nano-biosystems, and engineering environmental assessment and problem-solving options development. These high-emphasis research areas are built on a continuing base that includes support for research on biosensors, biomaterials, biomechanics, controlled release, bioimaging, medical devices and instrumentation, artificial organs, therapeutic agent bioprocessing, industrial bioproducts bioprocessing, bioremediation, ecological engineering, water and waste treatment, biomining, and food engineering.

Within the U.S. and international research communities, BES support has played a key role in catalyzing and developing highly promising, new, cutting-edge bioengineering and environmental engineering research fields, such as tissue engineering and metabolic engineering. BES has also led the formation of interagency coordination and collaboration in these fields, including the Multi-Agency Tissue Engineering Science (MATES) working group (http://tissueengineering.gov) and the Metabolic Engineering Working Group. The NSF/DARPA/NIH Biophotonics Partnership is another joint effort initiated by BES.

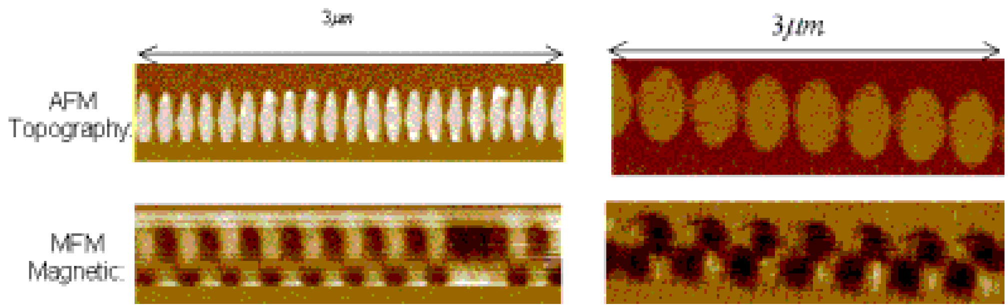
Scientific drivers and opportunity areas for BES include:

Post-Genomic Engineering: As a consequence of the genomics revolution that is underway in the biological sciences, engineers now have an entirely new, and explosively growing database on which to build new engineering developments and innovations that will provide important advances in the medical, biotechnology, and environmental arenas.

verification; semantics, design, and implementation of programming languages; micro-architectures; memory and I/O subsystems; application-specific architectures; performance metrics; VLSI electronic design; analysis, synthesis and simulation algorithms; system-on-a-chip; and architecture and design for mixed or future media (e.g., nanotechnology).

Some examples of the research promoted by CCF are:

Emerging Models and Technologies for Computation Cluster: The next breakthrough in computation capability may well be very far removed from the known paradigms. Research in areas such as biology, nanotechnology, and quantum physics provides fundamentally different models and inspiration that could lead to faster, more robust computer software, hardware, and architectures. Researchers at Notre Dame University, conducting an NSF-funded project entitled, "Computing Architectures for Coupled Nanomagnets," have discovered that magnetic interactions can be used to communicate complex information between nanoscale elements, in much the way that silicon is used in microprocessors. This finding opens the door to new computing architectures based on nanoscale elements.



Magnetic interactions to communicate information between neighboring quantum dots

Formal and Mathematical Foundations Cluster: The inherent limits of computation and communication are not well understood. Research at the foundational level is attempting to define the limits and optimize the solutions that can be produced in computer science, scientific computing, communication theory, signal processing theory, and mathematics to bring understanding across all science and engineering domains. NSF is sponsoring research at Carnegie-Mellon University that may help to make the difficult task of integrating multiple databases easier. Identifying duplicate entries of the same data from separate data sources is a vexing problem for scientists, engineers, and other data consumers. Using a natural machine-learning algorithmic approach, researchers have automatically identified hand-labeled data duplicates, providing theoretical insight into large-scale data integration.

Foundations of Computing Processes and Artifacts Cluster: NSF is seeking to advance the science, formalisms, and methodologies for building computer and communications systems. From the theoretical frameworks to the technical implementations, consideration is given to the artifacts and processes as they are involved in specifying, designing, and building complex systems. Researchers at the University of Minnesota – Twin Cities are focused on improving parallel computation methods in order to solve large-scale engineering and scientific problems. Advances are being made for three important components of parallel systems: effective and scalable algorithms, effective computer science tools and data structures, and testing and validation. Parallel systems rely on commodity hardware and can greatly reduce the costs and time involved in solving complex science and engineering problems.

CHEMICAL AND TRANSPORT SYSTEMS $67,210,000

The FY 2005 Budget Request for the Chemical and Transport Systems Subactivity is $67.21 million, a decrease of $1.71 million, or 2.5 percent, below the FY 2004 Estimate of $68.92 million.

Chemical and Transport Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Chemical and Transport Systems	68.33	68.92	67.21	-1.71	-2.5%
Total, CTS	$68.33	$68.92	$67.21	-$1.71	-2.5%

The Chemical and Transport Systems (CTS) Division supports research and education in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CTS research and education investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy. These include the process industries (chemicals, pharmaceuticals, forest products, materials, petroleum, food, and textiles), utilities, microelectronic component manufacturers, and producers of consumer products of all kinds. CTS-funded research in areas such as fluid flow, combustion, heat transfer, catalysis, fuel cells, sensors, and membranes contribute to advances that are important for the environment, energy, transportation, information technologies, and other areas that impact our daily lives.

CTS will continue to support research in traditionally important areas such as chemical reaction engineering, interfacial phenomena and separations, fluid dynamics and particle processes, and combustion and thermal processing. These areas are essential to ensure continued growth of the fundamental engineering knowledge base, which is the foundation for advances in a wide range of technologies.

In addition to a reallocation of funds within the four core research areas to support high-potential proposals, the FY 2005 Request includes funding in the following key areas:

Nanoscale Science and Engineering: NSE support totals $32.66 million, an increase of $8.76 million over the FY 2004 level of $23.90 million. Funding will allow expansion of research in the synthesis and processing of matter at the nanometer-length scale, producing materials with novel physical, optical, chemical, and biological properties. Understanding structural morphologies and properties from the molecular scale up to bulk scale via new experimental tools and simulation capabilities will permit major advances in many areas central to CTS. The fields of catalysis, microfluidics, electronic materials, membranes and adsorption media for selective chemical and biochemical separations, fuel cells, plasma processing, sensors, and environmental technologies will be significantly impacted. The synthesis of particles, films, and 3D structures with functional nanoscale features by methods involving nucleation, molecular and particle self-assembly, controlled thermal and molecular transport, as well as chemical reactions, is a priority area for CTS. In order to accelerate the benefits from increased investments in fundamental research on these topics, CTS will allocate funds for infrastructure investment to address issues that deal with scale-up of the synthesis processes, development of new instrumentation, and refined methods for characterization.

Environmental Technologies: CTS will continue support of environmentally relevant technologies, primarily projects aimed at pollution prevention and containment of greenhouse gases. Research leading to products and processes that avoid negative environmental impact will be a CTS priority. Examples of CTS interest areas are production processes that minimize undesirable side products, new biocatalysis methods that permit the use of renewable feedstocks, and separation and purification processes that use less energy, as well as environmentally sound solvents, cleaner combustion processes, and reliable process-design methods that reduce or eliminate environmental impact. These topics are strongly embedded in the core of CTS programs. CTS programs participate in the MUSES component of the Biocomplexity in the Environment (BE) priority area, which involves development of new materials, instrumentation and processes. The funding of the Science and Technology Center (STC) on New Materials for Water Purification, a topic that has direct relevance to several of the CTS program areas, is included in the CTS budget.


A laboratory scale reactor system consisting of an anaerobic digester with an external tubular ultrafiltration membrane.

Sensor Technologies: Funding for sensor technologies totals $6.0 million, unchanged from FY 2004. As part of its programs related to chemical-process control as well as interfacial phenomena and catalysis, CTS has invested in development of various types of sensors for monitoring levels of specific chemicals and biochemical materials, temperature, pressure, and flow conditions. With the increased needs for improved sensors arising from security requirements, CTS will expand its investments in this area. Developments in nanotechnology have opened many new opportunities for the creation of more selective and sensitive sensors, including detectors for target biological materials that will be extremely valuable for security applications as well as in the safe and efficient operation of industrial processes.

CIVIL AND MECHANICAL SYSTEMS $85,510,000

The FY 2005 Budget Request for the Civil and Mechanical Systems Subactivity is $85.51 million, an increase of $18.34 million, or 27.3 percent, above the FY 2004 Estimate of $67.17 million.

Civil and Mechanical Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Civil and Mechanical Systems	63.23	67.17	85.51	18.34	27.3%
Total, CMS	$63.23	$67.17	$85.51	$18.34	27.3%

The Civil and Mechanical Systems (CMS) Subactivity has two major goals: to support research and workforce development that provides the fundamental and quantitative basis for civil and mechanical systems and the built environment, and to support the rapid development and deployment of new knowledge and technology for the public to decrease vulnerability to natural and technological hazards.

CMS research increases the knowledge base and intellectual growth in the disciplines of construction, geotechnology, structures, dynamics, sensors and control, engineering mechanics and materials, as well as the application of information technology to enhance reliability and performance of critical infrastructure systems. The CMS mission is to improve understanding and design of materials and structures across all physical scales, from nano-level to mega-system integration-level. CMS research activities include integrated modeling and experiments to enhance the fundamental understanding of complex structures and systems, including nonlinear dynamic behaviors and processes. The linkage between physical model experimentation and computational model simulation demands development of the sensor technologies necessary for measurement and observation of fundamental processes. New sensors are also needed for "smart" civil and mechanical systems and for application of information technology required to sustain the nation's infrastructure. Real-time data acquisition and visualization will enhance critical infrastructure performance analysis and prediction. CMS encourages cross-disciplinary research and education investments to produce innovative and integrated engineered services.

In addition, recent events have brought focus on the nation's increasingly interdependent, complex and vulnerable human, social, natural and physical systems. The nation needs better databases and tools for prediction, risk, decisions and uncertainty, and CMS pursues cross-directorate and interagency partnerships that provide such knowledge enhancement and advanced tools for the evaluation of vulnerability. In support of this and of NSF's mission in the National Earthquake Hazards Reduction Program (NEHRP), CMS invests in research on the impact of natural and technological hazards on constructed, natural, and human environments. CMS funds rapid-response reconnaissance investigations following extreme events in the U.S. or abroad. Interdisciplinary and international studies involving hazard assessment, response, societal and economic impacts, and decision sciences are supported in coordination with the Geosciences and the Social, Behavioral, and Economic Sciences Activities of NSF.

The $18.34 million increase in the CMS budget will be combined with $6.24 million from core funding reallocations to support expanded research in the following areas:

Nanoscale Science and Engineering: Increases by $4.27 million over the FY 2004 level will support integrated design and simulation of the behavior of nanomaterials and nanostructures. Such research is needed for the development of new technologies for use in civil and mechanical systems, and for understanding long-term performance and durability of new materials in new applications and extreme environments. The computational and experimental advances in model-based simulation, when integrated with physical testing and system simulation software in a virtual test environment, will reduce development time and cost.

Laser scan of construction site contains high resolution 3-D "map" of excavation

NEES Operations and Grand Challenge Research: The remaining $20.0 million, together with additional core reallocations, will support the operations and research of the Network for Earthquake Engineering Simulation (NEES). The construction of NEES, funded during FYs 2000-2004 within the Major Research Equipment and Facilities Construction (MREFC) Account, will be completed by October 2004. NEES is a project to construct, upgrade, and network an innovative system of geographically distributed test facilities in earthquake engineering. NEES system integration is accomplished via NEESgrid, which utilizes innovative grid computing technologies. NEES also promotes international collaborations for earthquake engineering research, as well as education and outreach opportunities.

Nine-meter centrifuge at the Center for Geotechnical Modeling at UC Davis, a host facility in the Network for Earthquake Engineering Simulation, funded by the National Science Foundation.

The non-profit NEES Consortium, Inc. has been established to manage, operate and maintain the geographically distributed national NEES facility. With over 500 members, both institutional and individual, and an elected board of representatives, it includes all elements of the research community in earthquake engineering. All research, as well as educational and outreach activities utilizing NEES, will be scheduled through the NEES Consortium. This consortium will be responsible for maintaining the NEES infrastructure, both at the equipment sites, as well as its integration via NEESgrid. The NEES Consortium will also link the U.S. earthquake engineering research community to earthquake engineering research activities/facilities in Japan, Europe, and other nations.

CMS plans to use $9.0 million to support research in multi-hazard engineering involving experimental and theoretical simulations at the NEES facilities. NEES research will enable important new research challenges in earthquake engineering to be addressed. These are described in the recent National Research Council study entitled *Preventing Earthquake Disasters; The Grand Challenge in Earthquake Engineering*, National Academies Press, 2003. The CMS research focus is on basic research aimed at developing new technologies and design tools needed to identify and communicate infrastructure system vulnerabilities under risk of extreme events.

DESIGN, MANUFACTURE, AND INDUSTRIAL INNOVATION $169,970,000

The FY 2005 Budget Request for the Design, Manufacture, and Industrial Innovation Subactivity is $169.97 million, an increase of $570,000, or 0.3 percent, over the FY 2004 Estimate of $169.40 million.

Design, Manufacture, and Industrial Innovation Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Design, Manufacture and Industrial Innovation	64.00	65.81	65.88	0.07	0.1%
SBIR/STTR	90.92	103.59	104.09	0.50	0.5%
Total, DMII	$154.92	$169.40	$169.97	$0.57	0.3%

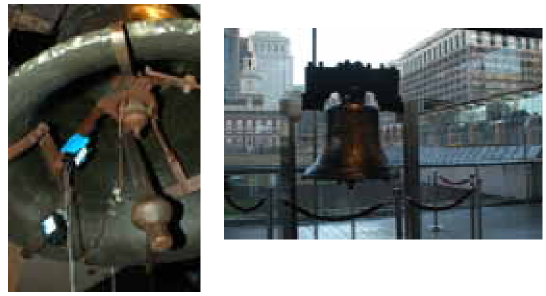
The Design, Manufacture, and Industrial Innovation (DMII) Subactivity supports academic research and education for discovery and innovation in new enterprises, and enhances productivity and global competitiveness in a broad range of U.S. industries. Supporting the development of a diverse human resource base and education of an adaptable and knowledge-enabled workforce complements this vital role in promoting U.S. global competitiveness. The core DMII programs in engineering design, operations research, manufacturing enterprise systems, service enterprise engineering, nanomanufacturing, materials processing and manufacture, and manufacturing machines and equipment, support the discoveries and major advances that create the nation's 21st century manufacturing enterprises. In FY 2005, DMII plans to continue exploring and investing in sustainable environmentally benign design and manufacture systems, engineered service systems for health care delivery, and additive hybrid processes that will be needed for micro and nanoscale products.

Nanomanufacturing, converting the discoveries of nanoscience into new products for the benefit of society, is a key component of the Nanoscale Science and Engineering (NSE) priority area, and is a grand challenge for the National Nanotechnology Initiative. While nanoscience is uncovering novel physical, mechanical, electrical, magnetic, chemical and biological properties and materials, a range of manufacturing discoveries and innovations are needed to design the systems and processes to deliver these products, devices and components that take advantage of these unique properties. Simultaneously, an entirely new manufacturing workforce needs to be educated and trained in nanotechnology to bring to fruition many exciting opportunities opened by nanotechnology. Nanomanufacturing is the focal point of DMII's investment in NSE, as well as knowledge gained within all the fields supported in DMII.

DMII supports the Materials Use: Science, Engineering, and Society (MUSES) program, an emphasis of the Biocomplexity in the Environment (BE) priority area, supporting the design and synthesis of new materials with environmentally benign impact on biocomplex systems. BE's Collaborative Large-scale Engineering Assessment Network for Environmental Research also aligns with DMII's focus on environmentally benign design and manufacture. Opportunities exist to integrate life cycle product design methodologies with manufacturing enterprise systems to realize benefits of reduced energy consumption without adverse environmental impact.

DMII also supports the Mathematical Sciences priority area, which offers multidisciplinary opportunities for advances in distributed sensors systems, scalable manufacturing enterprise systems, managing and modeling uncertainty in complex systems, and new modeling techniques that predict processing behavior and product performance on scales ranging from the molecular to the macro. DMII's engineering design program has established a foundation of knowledge on design decisions under uncertainty, for which the mathematics priority area expands, and addresses issues from product design to manufacturing enterprise system protection to decrease the vulnerability of this part of the national infrastructure.

Major components of DMII activity include the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs that provide support to small businesses for research in advanced materials and manufacturing, biotechnology, electronics and information technology. With a goal of converting scientific discoveries to innovations for the benefit of society, these programs play a critical role in complementing NSF investments in discovery and learning. The result: today, more scientists and engineers are employed in high technology small businesses than in large businesses. The Small Business Innovation Research (SBIR) Program and the Small Business Technology Transfer (STTR) Program increase by $500,000 in FY 2005, to $104.09 million.



A close-up view of the spider, a structural brace that helps the Liberty Bell support its own weight. Also visible is the wireless transmitter that conveys the signals from the sensors on the crack to the computer that is recording the stresses (black box on top in blue tape) and a MicroStrain G-link sensor that detects rocking motion (black box near lip of Bell).

DMII promotes partnerships between industry and university through both the Grant Opportunities for Academic Liaison with Industry (GOALI) program and the STTR program. DMII, in collaboration with the Social, Behavioral and Economic Sciences (SBE) Activity, expects to continue supporting research in understanding of the innovation process through the Innovation and Organizational Change (IOC) program, but at a reduced level.

Retrospective assessments have found that DMII grants have resulted in fundamental contributions either to the creation of new research fields or seminal knowledge in design, manufacturing, and service, the knowledge resource for 21st Century enterprises. These studies have also documented the long-term commercialization and economic impact of many DMII investments. Results include breakthrough advances in solid free-form fabrication technology, pioneering work in nanotechnology for mass storage devices, the establishment of supply chain management as a research field, and integrated solid modeling systems that carry the data and knowledge of today's global enterprises.

By reallocating base funds, investments in FY 2005 will include an increase of $4.19 million for the Nanoscale Science and Engineering priority area. This will enable:

- Research on nanomanufacturing, covering three dimensional nano-feature enhancement in micro/meso products and devices, nano-assembly and connectivity, nano-process control and nano-system integration;
- Support for the National Nanotechnology Infrastructure Network to ensure a full array of interconnected resources to address synthesis and scale-up of nano-sized materials and structures into functional devices, architectures and integrated systems across dimensional scales, leading eventually to useful products and services; and
- Continued support of research on improving human physical and mental abilities through the integration of nanotechnology, biotechnology, information technology and cognitive science, as well as a new generation of tools and processes to achieve this goal.

ELECTRICAL AND COMMUNICATIONS SYSTEMS $72,730,000

The FY 2005 Budget Request for the Electrical and Communications Systems Subactivity is $72.73 million, a decrease of $1.85 million, or 2.5 percent, from the FY 2004 Estimate of $74.58 million.

Electrical and Communications Systems Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Electrical and Communications Systems	73.05	74.58	72.73	-1.85	-2.5%
Total, ECS	$73.05	$74.58	$72.73	-$1.85	-2.5%

The Electrical and Communications Systems Subactivity (ECS) addresses the fundamental research issues underlying both the device technologies and the engineering systems principles of complex systems and applications. It also seeks to ensure the education of a diverse workforce prepared to support the continued rapid development of these technologies as drivers for the global economy. The research and education supported by ECS are key to enabling the synergy between micro/nanotechnology, biotechnology, and information technology through support of programs that address the technological challenges facing the economy of the 21st Century.

The study of microelectronic, nanoelectronic, micromagnetic, photonic, and micro-electromechanical devices (and their integration into circuits and microsystems) is rapidly expanding in technical scope and application. New generations of integrated microsystems incorporate microchip technology with mechanical, biological, chemical and optical sensors, actuators and signal processing devices to achieve new functionality. Modern computing and communications systems are based on these devices. Due to trends toward smaller and faster devices and to address the challenges posed by the physical limitations to Complementary Metal Oxide Semiconductor (CMOS) technologies, ECS is funding programs in new molecular based nanoscale electronic devices and storage technologies and understanding of the quantum principles that dominate their behavior. These programs will play a key role in addressing the challenges identified in the Semiconductor Technology Roadmap.

ECS has provided leadership in initiating new research directions for intelligent sensing systems with wireless, reconfigurable, agile networks of sensor arrays for interpretation, decision and action. These systems, which learn new functions and adapt to changing environments, are of special relevance to the monitoring of the nation's critical infrastructure and security. ECS provides coordination for the foundation wide Sensors solicitation.

The integration of device research and systems principles has broad applications in telecommunications, power and energy, environment, transportation, medicine, agriculture, manufacturing, and other areas.

ECS also provides management support for specialized resources and infrastructure that facilitate research and educational activities, such as the National Nanotechnology Infrastructure Network (NNIN), and NSF oversight for the Science and Technology Center on Nanobiotechnology at Cornell University, Engineering Research Centers at the University of Michigan, Johns Hopkins University and Colorado State University. ECS also actively participates in the development and management of cross-disciplinary programs, industry-related programs and graduate traineeship programs, and provides significant support to the Nanoscale Science and Engineering priority area.

ECS holds a number of grantee workshops to assess the results of research and education grants it funds and to encourage interaction among the Principal Investigators. In addition, ECS holds a number of workshops to evaluate and assess the technologies of current and future importance. This past year, ECS convened a workshop for 42 heads of Electrical and Computer Engineering departments on strategies for recruiting and retaining women and minority faculty.

Recent achievements of ECS grantees include:

- Adaptive CMOS: from biological inspiration to system on a chip - starting from a CAREER PECASE award, this technology has lead to the formation of a new $30.0 million venture company, Impinj, with production rights assigned to National Semiconductor and Asahi Kasei. The ECS grantee's doctoral research was also funded by an NSF ERC grant and the doctoral advisor, a National Medal of Technology recipient, is a cofounder of the new venture.

- An FY 2003 ECS grant has resulted in the development of the first anthropomorphic robot that can walk and run with actuated knees and torso. Potential applications are to rehabilitation and design of prosthetics.

- New sensors based on Electrical Impedance Tomography have been developed for *in situ* imaging of silicon wafer surfaces during manufacturing processes. The technique also has applications for inexpensive approaches to biomedical *in vivo* imaging.

- In January 2004, the Cornell Nanobiotechnology Center's "It's a Nano World" exhibit will be viewed by several hundred thousand visitors at Disney's Epcot Center. NSF is also supporting an external evaluation of the public's reaction to the exhibit in the theme park setting as compared to a more traditional science museum.

- An ECS award for research on Extreme Ultraviolet (EUV) photonics has resulted in the development of compact, table-top, coherent light sources from 80eV to ≈ 1keV. Coherent light sources in this region of the spectrum have exciting applications in EUV imaging, spectroscopy, lithography, and microscopy.

Some of the special research foci funded by ECS are in Organic Electronics and Photonics, co-funded with other ENG divisions and DARPA.

Reallocation within core areas encompasses funding of $36.41 million, an additional $4.74 million over the FY 2004 Estimate of $31.67 million, to support Nanoscale Science and Engineering research on manipulation of nanostructures, and modeling and simulation of new device architectures and systems. ECS has invested an additional $1.0 million towards funding of Nanoscale Exploratory Research (NER) proposals that address challenges to CMOS technology. Increased investments will also support the new NNIN for shared instrumentation facilities for nanoscale research, characterization and nanomanufacturing.

ENGINEERING EDUCATION AND CENTERS $130,710,000

The FY 2005 Budget Request for the Engineering Education and Centers Subactivity is $130.71 million, a decrease of $3.33 million, or 2.5 percent, from the FY 2004 Estimate of $134.04 million.

Engineering Education and Centers Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Engineering Education and Centers	$132.72	$134.04	$130.71	-$3.33	-2.5%
Total, EEC	$132.72	$134.04	$130.71	-$3.33	-2.5%

The Engineering Education and Centers (EEC) Subactivity supports the efforts of U.S. engineering schools, in partnership with government and the private sector, to adapt the engineering education and research enterprise to technological, economic, and social change. This evolution is required to ensure a diverse and highly capable technical workforce, provided by giving students early experience in discovery through research, fabrication and design, and by incorporating new learning theories, teaching methods, and new scientific disciplines into engineering curricula. EEC programs address interdisciplinary research, systemic curriculum and workforce development issues critical to all engineering, benefit from a centralized management focus, and complement the research and education portfolios of the other divisions of ENG. Its programs benefit from a scope encompassing all of engineering and a scale that both facilitates the incorporation of new scientific knowledge into engineering and requires rigorous monitoring and evaluation systems.

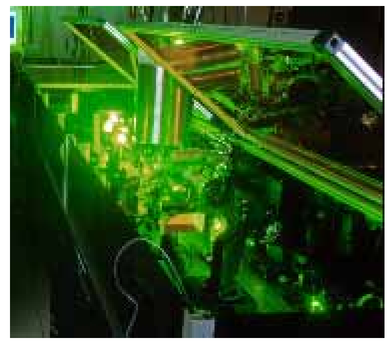
In FY 2005, EEC will provide support for Engineering Research Centers (ERC), Nanoscale Science and Engineering Centers (NSEC), Earthquake Engineering Research Centers (EERC) and Industry/University Cooperative Research Centers (I/UCRC). Industry and universities develop long-term, interdisciplinary partnerships in NSF-supported centers and groups, which spin off a broad range of fundamental knowledge and new invention. The stream of advanced technologies emanating from the centers is carried into industry by new generations of graduating engineers who have learned the skills needed to be effective leaders in technology innovation.

In 2003, 15 ongoing and four newly established Engineering Research Centers conducted research and developed educational materials on key technologies related to the engineering of living tissues, sensory prostheses that interface to the human nervous system, extreme ultraviolet/soft x-ray light sources, systems for detection of severe storms, computer-integrated surgical systems, biotechnology, biofilms, biomaterials for implants, advanced biocatalysts, semiconductor manufacturing, advanced fibers and films, ultrafine particles, reconfigurable manufacturing systems, advanced semiconductor packaging, wireless integrated microsystems, subsurface sensing and imaging, integrated media systems, and power electronics. These centers bring together faculty and students from multiple disciplines and leverage industry expertise and resources to define areas of critical need.

The six Nanoscale Science and Engineering Centers fully or partially supported by EEC perform research to advance the development of the ultra-small technology that will transform electronics, materials, medicine and many other fields. The centers address challenges and opportunities that are too complex and multi-faceted for individual researchers or small teams to tackle. They involve key partnerships with industry, national laboratories and other sectors and support education programs from pre-college to the graduate level designed to develop a highly skilled workforce and advance pre-college training and the public understanding of science and engineering.

In FY 2003, the 50 I/UCRCs worked closely with industry to develop enabling technologies needed to manage the electrical power system, improve manufacturing and biological processes, develop new materials, information and telecommunications technologies, and develop innovative products and services. EEC provides modest seed funds and management expertise to these highly leveraged centers, with States joining in many partnerships to expand the centers' activities in local economic development.

The three Earthquake Engineering Research Centers bring together multi-institutional teams of investigators to provide the knowledge and technology base for industry and public agencies to build and retrofit structures and other infrastructure to prevent damage from earthquakes. These centers take a systems approach, integrating engineering, seismological, and societal response knowledge. The centers integrate research and education and develop partnerships with industry and the public agencies responsible for earthquake hazard mitigation at the regional, state, and local levels. These centers are producing structural design models and earthquake hazard mitigation technology for buildings and transportation and lifeline systems and engaging designers and policy-makers in the development of hazard mitigation strategies for communities with earthquake risks.



The new Extreme Ultraviolet Engineering Research Center brings together researchers from Colorado State University, the University of Colorado, the University of California, Berkeley and industry partners to develop short wavelength laser light sources that can be used to create advanced nanotechnologies, including the smallest, most powerful computer circuits ever developed.

EEC-funded educational innovations and human resource development programs attract students to engineering, implement new educational technologies to give students greater flexibility in how, where and when they learn, and give them the capacity to learn, lead, and innovate throughout their careers. Experiments are being conducted to expose pre-college students and their current and future teachers to the challenges and rewards of engineering at the pre-college level and give undergraduates earlier and more relevant design and research experiences. Successful engineering education innovations are being disseminated to and adopted by a broad range of universities. Efforts are also directed at attracting underrepresented groups to engineering careers and increasing retention and graduation rates.

The FY 2005 Budget Request for EEC is $130.71 million, a decrease of $3.33 million from FY 2004. To accommodate this decrease, some reallocations in the FY 2004 base include:

- Engineering Research Centers, reduced by $2.06 million from the FY 2004 level of $65.55 million, to $63.49 million. $3.10 million have been reallocated to expand nanoscale funding activities;
- Funding for engineering students supported by the IGERT, GRF and GK-12 programs, totaling $19.42 million, an increase of $2.0 million over the FY 2004 level of $17.42 million; and
- A new investment of $1.03 million in the Workforce for the 21st Century priority area, enabling institutions with a proven track record of innovation to encourage U.S. citizens to complete advanced engineering degrees.

GEOSCIENCES

GEOSCIENCES $728,500,000

The FY 2005 Budget Request for the Geosciences Activity (GEO) is $728.50 million, an increase of $15.40 million, or 2.2 percent, over the FY 2004 Estimate of $713.10 million.

Geosciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Atmospheric Sciences	231.29	238.78	243.63	4.85	2.0%
Earth Sciences	147.32	151.58	155.61	4.03	2.7%
Ocean Sciences	313.23	322.74	329.26	6.52	2.0%
Total, GEO	$691.84	$713.10	$728.50	$15.40	2.2%

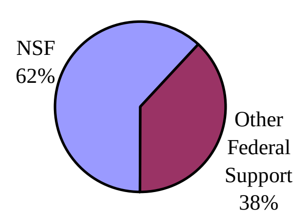
Totals may not add due to rounding.

The mission of the Geosciences Activity (GEO) is to support the research, infrastructure, and education in the atmospheric, earth, and ocean sciences needed to advance our understanding of the integrated Earth system. Breakthroughs in observation techniques, modeling, and understanding complex Earth systems are coming just at the time when society is in critical need of sound scientific advice on how to mitigate or adapt to changes in the habitability of the planet. The geosciences stand poised to make tremendous contributions to improve the quality of life by providing useful information to decision makers about the key planetary processes, their complex interactions, and where possible, their future implications.

RELEVANCE

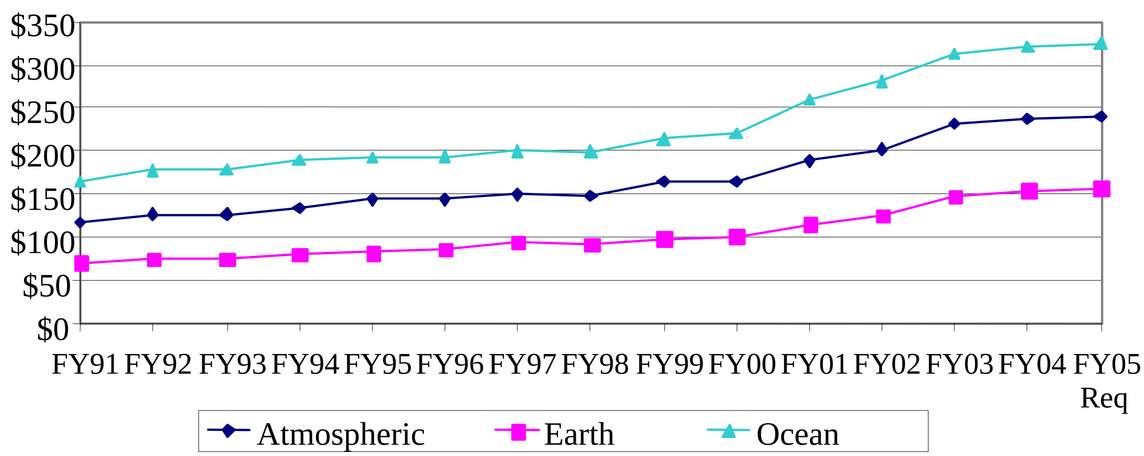
The Geosciences Activity supports basic research that contributes to a better understanding of the many processes that affect global environment such as the role of the atmosphere and oceans in climate, the genesis of earthquakes, and the effects of increased concentrations of greenhouse gasses in the atmosphere. Support is provided for interdisciplinary studies in climate and hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, solid earth processes, and solar influences on the Earth system. Associated with these studies is the need for databases and cyberinfrastructure to provide the scientific community with the resources to assemble and utilize data and information efficiently and effectively.

Federal Support for Basic Research in Geosciences at Academic Institutions



GEO is the principal source of federal funding for university-based basic research in the geosciences, providing about 62 percent of the total federal support in these areas. Within the atmospheric sciences, GEO provides about 47 percent of federal support for university-based basic research; within geological sciences, about 72 percent; and within oceanography, about 67 percent. GEO plays a critical role in addressing the nation's need to understand, predict and respond to environmental events and changes, and helping determine the best use of Earth's resources. Fundamental research in the geosciences advances scientific knowledge of Earth's environment, including resources such as water, energy, minerals, and biological diversity. GEO-supported activities also advance our ability to predict natural phenomena of economic and human significance, such as weather, climate change, earthquakes, fish-stock fluctuations, and disruptive events in the solar-terrestrial environment.

GEO Subactivity Funding
(Dollars in Millions)



STRATEGIC GOALS

GEO invests in four strategic goals:

- People: Improvement of the quality of geoscience education and training and enhancing diversity in all the fields of geoscience. GEO will advance education and training for current geoscientists, increase the diversity of the geoscience community, facilitate education and training for future generations of geoscientists, and enhance public knowledge about the integrated components of the Earth system.

- Ideas: Advancement of knowledge about the Earth system, including both maintaining adequate base support across all geoscience fields and identifying opportunities where more focused support can play a catalytic role in advancing scientific progress.

- Tools: Enhancement of the infrastructure for the conduct of geoscience research. GEO will identify and make investments in instrumentation and facilities, including ships, aircraft, computers, radars, seismometers, and data management systems needed to do world-class research.

- Organizational Excellence: Provision of administrative activities necessary to enable GEO to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	30.76	32.43	33.39	0.96	3.0%
Ideas	412.88	405.21	409.99	4.78	1.2%
Tools	243.38	270.16	279.69	9.53	3.5%
OE	4.82	5.30	5.43	0.13	2.5%
Total, GEO	$691.84	$713.10	$728.50	$15.40	2.2%

PEOPLE (+$960,000 million, for a total of $33.39 million)

GEO People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	20.34	21.31	21.91	0.60	2.8%
Institutions	2.83	3.14	3.50	0.36	11.5%
Collaborations	7.59	7.98	7.98	0.00	0.0%
Total, GEO	$30.76	$32.43	$33.39	$0.96	3.0%

INDIVIDUALS

- $3.42 million, level with the FY 2004 Estimate, to support the Integrative Graduate Education and Research Traineeship (IGERT) program, which reflects an emphasis on multidisciplinary training in all areas of NSF-supported research.
- $6.23 million to support the CAREER program, which supports integrative research and education activities undertaken by early-career scientists.
- $4.60 million, an increase of $600,000 over FY 2004, to support the Opportunities to Enhance Diversity in the Geosciences (OEDG) program, which seeks to increase the participation in geosciences education and research by students from groups historically underrepresented in the geosciences. A secondary goal of the program is to strengthen the understanding of the geosciences and their contribution to modern society by a broad and diverse segment of the population.
- $2.60 million to support the Geoscience Education and the Global Learning and Observations to Benefit the Environment programs.

INSTITUTIONS

- $3.50 million, unchanged from FY 2004, to support the Foundation-wide ADVANCE program to increase the representation and advancement of women in academic science and engineering careers.

COLLABORATIONS

- $2.60 million, unchanged from the FY 2004 Estimate, to maintain the Centers for Ocean Science Education Excellence initiated in FY 2002. These centers foster the integration of ocean research into high quality educational materials, allow ocean researchers to gain a better understanding of educational organizations and pedagogy, provide educators with an enhanced capacity to understand and deliver high-quality educational programs in the ocean sciences, and provide material to the public that will promote a deeper understanding of the ocean and its influence on each person's quality of life and our national prosperity.

IDEAS (+$4.78 million for a total of $409.99 million)

GEO Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	399.66	391.24	396.22	4.98	1.3%
Centers Programs	13.22	13.97	13.77	-0.20	-1.4%
Total, GEO Ideas	$412.88	$405.21	$409.99	$4.78	1.2%

FUNDAMENTAL SCIENCE AND ENGINEERING

Support for ideas, spanning the geosciences and encompassing a wide range of topics, totals $396.22 million in FY 2005, an increase of $4.98 million from the FY 2004 Estimate of $391.24 million. Projects in the Atmospheric Sciences Subactivity improve the understanding and prediction of climate, weather, space weather, and the global environmental system. Earth Sciences Subactivity research advances knowledge of the structure, composition, and history of the solid Earth and of the geological and hydrological processes that modify Earth. Projects in the Ocean Sciences Subactivity improve knowledge of the global climate system, coastal environments, the character of the ocean floor, as well as processes that control the chemical composition, motion, and biological production of ocean waters.

GEO will continue to participate in the Climate Change Research Initiative (CCRI), with an FY 2005 investment of $20.0 million, level with FY 2004. Emphasis in FY 2005 will continue to be placed on understanding the Earth's carbon cycle and advancing our ability to model dynamic multivariate systems. In addition, GEO will continue to support key research activities of the U.S. Climate Change Research Program.

In FY 2005, GEO will emphasize research on the key physical, chemical and geologic cycles within the Earth system, the characteristics and dynamics of which are of paramount importance to science and society. These activities will be complementary to, and well coordinated with, the biologically oriented studies of Earth cycles that will be carried out within the context of the Foundation-wide Biocomplexity in the Environment priority area. Areas of emphasis include:

- Studies of abrupt and rapid climate change through interdisciplinary studies of ocean circulation combined with those of paleoclimate records to document the frequency, temporal resolution, and spatial extent of past rapid climate change;
- Continued examination of biogeochemical cycles including emphasis on understanding the sources, sinks and processes which control the atmospheric abundance and distribution of carbon and water;
- Continuation of the Oceans and Human Health Initiative in partnership with the National Institutes of Health to understand the linkages between oceans and human health, including water-borne diseases, harmful algal blooms and marine pharmaceuticals;

- Multidisciplinary studies of the processes that govern water quantity and quality, the character and dynamics of the Earth's surface, and the interactive processes at the intersection of the geosphere and biosphere;
- Improving understanding of natural hazards such as floods, earthquakes, volcanic eruptions, hurricanes, and solar storms; and
- Research projects and field programs focused on understanding dynamics of the ocean mantle and its effect on the structure and evolution of the lithosphere, and on the dynamics of the atmosphere and atmospheric coupling.

CENTERS PROGRAMS

GEO-supported centers include Science and Technology Centers (STCs) and Long Term Ecological Research (LTER) sites.

GEO Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Science and Technology Centers	11.56	10.77	10.57	-0.20	-1.9%
Long Term Ecological Research Sites	1.66	3.20	3.20	0.00	0.0%
Total, GEO	$13.22	$13.97	$13.77	-0.20	-1.4%

In FY 2005, GEO will support three Science and Technology Centers:

The scientific foci of the Science and Technology Center on the Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA) are: 1) spatial and temporal properties of hydrologic variables; 2) processes controlling water and chemical balances in catchments; 3) functioning of riparian systems; and 4) integrated modeling of catchment-scale processes. Educational initiatives contribute to sustainability by bringing water resources issues to the forefront of K-16 science education and by promoting hydrologic literacy among the public.

The National Center for Earth-surface Dynamics (NCED) is a Science and Technology Center focused on understanding the processes that shape the Earth's surface, and on communicating that understanding to a broad range of stakeholders. NCED's work supports a large, community-based effort to develop a suite of quantitative models of the Earth's surface: a Community Sediment Model (CSM). Results of the NCED-CSM collaboration will help solve pressing societal problems through both short-term prediction of surface response to natural and anthropogenic change and long-term interpretation of how past conditions are recorded in landscapes and sedimentary strata. NCED education and knowledge transfer programs include exhibits and educational programs at the Science Museum of Minnesota, internships and programs for students from tribal colleges and other underrepresented populations, and research opportunities for participants from outside core NCED institutions.

The Center for Integrated Space Weather Modeling (CISM) focuses its activities around building a comprehensive, physics-based, numerical simulation model that describes the space environment from the Sun to the Earth. In the course of developing this model, CISM will achieve three complementary goals: 1) better understanding of the complex, closely coupled Sun-Earth system; 2) transition of the results of space weather research into robust and operationally useful forecasting tools; and 3) improved public awareness of space weather and its effects. Model development activities will lead to new techniques for model coupling, data assimilation, and visualization. Knowledge transfer will be performed through partnerships with operational support personnel at the National Oceanic and Atmospheric Administration

(NOAA) and the Department of Defense. Education and public outreach activities will be integrated with the CISM research program, and will concentrate on creating and preparing a diverse pool of qualified scientists to face space weather challenges of the future.

Long Term Ecological Research sites support projects requiring long periods of study; the sustained nature of studies allows scientifically sound evaluations of major environmental phenomena. The LTERs represent many disciplines that enhance understanding of general ecological phenomena that occur over long temporal and broad spatial scales, provide information for the identification and solution of environmental problems, and enable interdisciplinary collaborative activities.

TOOLS (+ $9.53 million, for a total of $279.69 million)

The GEO Activity supports user facilities necessary for the conduct of research in the geosciences. These include large national user facilities such as the National Center for Atmospheric Research (NCAR) and the U.S. academic research fleet, and smaller facilities in the atmospheric, earth, and ocean sciences.

GEO Investments in Tools
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
FACILITIES:					
Academic Research Fleet/Ship Operations	65.20	76.50	83.20	6.70	8.8%
Advanced Modular Incoherent Scatter Radar	14.00	11.00	12.30	1.30	11.8%
EarthScope Operations	0.40	1.70	3.45	1.75	N/A
Incorporated Research Institutions for Seismology	13.20	13.00	13.00	0.00	0.0%
Integrated Ocean Drilling Program		35.60	31.60	-4.00	-11.2%
Ocean Drilling Program Operations	30.00	1.90	4.00	2.10	110.5%
Other GEO Facilities[1]	22.17	28.00	24.50	-3.50	-12.5%
Subtotal	144.97	167.70	172.05	4.35	2.6%
INFRASTRUCTURE & INSTRUMENTATION:					
Digital Library	4.20	4.91	4.91	0.00	0.0%
Research Resources	13.41	13.75	17.58	3.83	27.9%
Subtotal	17.61	18.66	22.49	3.83	20.5%
FEDERALLY FUNDED RESEARCH & DEVELOPMENT CENTERS:					
NAIC	1.80	1.80	1.90	0.10	5.6%
NCAR	79.00	82.00	83.25	1.25	1.5%
Subtotal	80.80	83.80	85.15	1.35	1.6%
Total, Tools Support	$243.38	$270.16	$279.69	$9.53	3.5%

[1]Other GEO facilities include multi-user accelerator-based mass spectrometers, synchrotron beamlines, radar facilities to study weather and the upper atmosphere (including the National Astronomy and Ionosphere Center), facilities to support the scientific use of the Global Positioning System, and activities related to the Integrated Ocean Drilling program.

FACILITIES

NSF support provides for ongoing operations and maintenance, including upgrades to existing facilities as well as regularly scheduled repairs. FY 2005 plans include:

- $83.20 million, an increase of $6.70 million, or 8.8 percent, over the FY 2004 Estimate of $76.50 million, for the continued operation and renewal of the U.S. Academic Research Fleet. Approximately 325 projects with about 2,500 scientists and students will use the fleet's 27 ships. The projects range from individual investigator studies of coastal waters to integrated multi-investigator studies of global ocean processes. NSF-funded researchers are the primary users of the ships, accounting for about 65 percent of their total use. NSF ship operation funds support the costs associated with the use of the fleet by these researchers. Also included are funds to continue acquisition of a new deep submergence capability to replace the pioneering submersible ALVIN, and anticipated acquisition of a seismic research vessel to replace the aging R/V *Maurice Ewing* which is in need of a significant refit. These new investments will open significant expanses of the deepest ocean to exploration, and bring greatly enhanced capability to map structures under the sea floor to U.S. researchers.
- $12.30 million, an increase of $1.30 million, or 11.8 percent, over the FY 2004 Estimate of $11.0 million, to continue construction of the Advanced Modular Incoherent Scatter Radar (AMISR). Begun in FY 2003, the AMISR represents a significant augmentation of our ability to study phenomena in the upper atmosphere. Using state of the art technology, AMISR sets a new world standard in upper atmospheric research facilities, and its unique design features allow the radar to be disassembled and moved as scientific needs dictate. In FY 2005, the first of three "faces" of AMISR is scheduled to be completed and begin preliminary operation in Alaska.
- $3.45 million, an increase of $1.75 million, will continue preliminary operation of the EarthScope facility. EarthScope, which has received construction funding through the Major Research Equipment and Facilities Construction (MREFC) Account, is a distributed, multi-purpose geophysical instrument array that will make major advances in our knowledge and understanding of the structure and dynamics of the North American continent.
- $13.0 million, unchanged from the FY 2004 Estimate, to continue support for the Incorporated Research Institutions for Seismology (IRIS). IRIS facilities provide rapid analysis of earthquakes, aid in monitoring nuclear proliferation, and permit imaging of the internal physical structure of Earth.
- $31.60 million, a decrease of $4.0 million, or 11.2 percent, below the FY 2004 Estimate of $35.60 million, to continue support of the Integrated Ocean Drilling Program (IODP) initiated in FY 2004 following the conclusion of the successful Ocean Drilling Program. Support in FY 2005 will enable the continued operation of an interim drillship pending the lease and outfitting of a more robust scientific platform utilizing funds from the MREFC Account. Additional information on IODP is contained in the Tools chapter.
- $4.0 million, an increase of $2.10 million over the FY 2004 Estimate, to support core storage and data distribution infrastructure associated with the Ocean Drilling Program (ODP). In 2003, the *JOIDES Resolution* completed its contracted drilling operations for the ODP.
- $24.50 million, a decrease of $3.50 million, or 12.5 percent, below the FY 2004 Estimate of $23.0 million, for Other Geosciences Facilities, which includes facilities to support the use of the Global Positioning System for scientific research, multi-user analytical facilities such as accelerator-based mass spectrometers, synchrotron beamlines, and operation, upgrade, development, and construction of radar facilities to study precipitation and upper atmospheric phenomena.

<u>INFRASTRUCTURE AND INSTRUMENTATION</u>

- $4.91 million, equal to FY 2004, will enable continued operation of the Digital Library for Earth System Education (DLESE). DLESE provides access to high-quality collections of educational resources; data sets and imagery, including the tools and interfaces that enable their effective use in educational settings; support services to help educators and learners effectively create, use, and share educational resources; and communication networks to facilitate interactions and collaborations across all dimensions of Earth system education.

- Included within the $17.58 million for Research Resources is support for significant infrastructure investments and upgrades not associated with specific facilities, as well as investment in some aspects of cyberinfrastructure.

FEDERALLY-FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCs)

- $83.25 million, an increase of $1.25 million, or 1.6 percent, over the FY 2004 Estimate of $82.0 million, for the operation and maintenance of observational and computer facilities at the National Center for Atmospheric Research. NCAR is a world-renowned center for atmospheric research that makes facilities available – including supercomputers, instrumented research aircraft and ground-based portable observing systems – to scientists at universities, NCAR, and elsewhere. FY 2005 sees the initial operation of the new HIAPER facility, constructed utilizing funds from the MREFC Account, at a level of $300,000. In FY 2005 NCAR will focus on: research on Earth's natural cycles, including climate system modeling and the operation of the computation facilities for the Climate Simulation Laboratory; projects within the U.S. Weather Research Program (USWRP) and the National Space Weather Program (NSWP), which aim to achieve a better understanding and improved predictive capability of costly and disruptive storms on Earth and in space; and continued development of observational and computational capabilities.

ORGANIZATIONAL EXCELLENCE (+$130,000, for a total of $5.43 million)

Organizational Excellence provides support for Intergovernmental Personnel Act appointments, IPA's travel and the administrative contracts necessary to conduct the level of program activity at the Request Level. Requested funding for FY 2005 is $5.43 million.

PRIORITY AREAS

In FY 2005, GEO will support research and education efforts related to broad, Foundation-wide priority areas in Biocomplexity in the Environment, Nanoscale Science and Engineering, Mathematical Sciences, and Human and Social Dynamics.

GEO Investments in Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biocomplexity in the Environment	23.00	37.22	37.22	0.00	0.0%
Nanoscale Science and Engineering	7.53	7.94	7.94	0.00	0.0%
Mathematical Sciences	4.57	7.07	7.07	0.00	0.0%
Human and Social Dynamics	N/A	1.35	1.35	0.00	0.0%

Biocomplexity in the Environment: In FY 2005, GEO will provide $37.22 million, level with the FY 2004 Estimate, to support the NSF-wide Biocomplexity competition and a set of coordinated activities in environmental science, engineering and education that advance scientific knowledge about the connection between the living and non-living Earth system. These funds will enable the continuation of four interdisciplinary activities:

- Planetary Ecology focuses on understanding the Earth's marine and terrestrial ecosystems and their evolution, and the interaction of the biosphere with earth system processes. GEO will support research focused on microbial habitats in the terrestrial and submarine deep subsurface to study processes including: biologically controlled mineralization, the production of gas hydrates, microbiological controls on seawater chemistry and productivity, and soil and rhizosphere processes. Included is $4.0 million to study the Ecology of Infectious Diseases;
- Planetary Metabolism aims to understand the links and feedbacks among the Earth's physical, chemical, geological, and biological, as well as social, systems; how they have evolved; and how they affect the planet's biosphere and geosphere;
- Planetary Energetics and Dynamics attempts to understand the links between physical and biochemical processes by focusing on energy exchange. This includes an effort to understand, mitigate and predict natural hazards – for example, hurricane genesis and storm tracking, earthquake nucleation, and energetic processes in the upper atmosphere; and
- Earth Observatories will make sustained time-series observations to understand the temporal evolution of environmental systems that are central to the study of biocomplexity in the environment.

Nanoscale Science and Engineering: In FY 2005, GEO will support Nanoscale Science and Engineering at a level of $7.94 million, unchanged from the FY 2004 Estimate, for activities that focus on:

- Development and application of chemical and biological sensor technology for making rapid, high-precision observations at submicroscopic spatial and volumetric scales;
- Support for crosscutting studies aimed at understanding the distributions and behavior of nanoscale structures throughout the Earth, atmosphere, and oceans; and
- Development of heavily instrumented interdisciplinary Earth System Observatories that facilitate our understanding of nanoscale geoscience processes, including platforms to detect and characterize nanoscale particles and their interactions throughout the atmosphere and oceans.

Mathematical Sciences: In FY 2005, GEO will support multidisciplinary research involving the partnering of mathematicians and geoscientists to investigate topics spanning the earth, atmospheric, and ocean sciences at a level of $7.07 million, unchanged from the FY 2004 Estimate.

Human and Social Dynamics: In FY 2005, GEO will participate in the Human and Social Dynamics priority area at a level of $1.35 million to engage the social science community in understanding and predicting behavior in response to extreme events (earthquakes, hurricanes, tornados, solar disruptions, etc.) and other natural processes affecting society.

QUALITY

GEO maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The share of basic and applied research funds that were allocated to projects that undergo merit review was 77 percent in FY 2003, the last year for which complete data exist. OMB's definition of competitive, merit-based review does not include Federally Funded Research and Development Centers, therefore support for the National Center for Atmospheric Research, although regularly merit-reviewed, is not considered as funding that undergoes competitive, merit-based review for this calculation.

To ensure the highest quality in processing and recommending proposals for awards, GEO convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

The Directorate also receives advice from the Advisory Committee for Geosciences (AC/GEO) on such issues as: the mission, programs, and goals that can best serve the scientific community; how GEO can promote quality graduate and undergraduate education in the geosciences; and priority investment areas in geoscience research. The AC/GEO meets twice a year and members represent a cross section of the geosciences, with representatives from many different sub-disciplines within the field; a cross section of institutions including industry; broad geographic representation; and balanced representation of women and under-represented minorities.

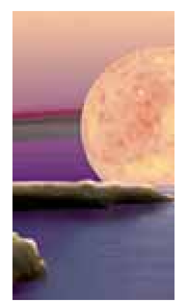
PERFORMANCE

Recent Research Highlights

Understanding Complex Coastlines

Our understanding of shallow water waves and currents, and their effects on beach erosion and the dispersal of pollutants, is based on studies of long, straight coastlines onshore of simple continental-shelf and nearshore bathymetry. However, most of the world's coastlines are complex, having features such as shoals, islands, and submarine canyons, which can have dramatic effects on nearshore waves and currents. To gain a better understanding of the underlying physical processes and to help engineers and planners mitigate the effects of wave and current action, scientists from several institutions are monitoring and modeling waves, currents, and morphological changes to the beach near two steep submarine canyons on the southern California coast during the Nearshore Canyon Experiment. Scientists will test models and investigate coastal processes using observations from an instrument array that includes 6 wave buoys, more than 50 wave gages and current meters, 10 drifters, shore-based video cameras and radars, acoustic sediment sensors, and aircraft overflights.

Geochemical Evidence of the Earliest Conditions on Earth



The refractory mineral zircon forms a robust time capsule from the earliest Earth. Older than the oldest known rocks (4.0 billion years), tiny grains of zircon from Western Australia have been analyzed by ion microprobe/secondary ion mass-spectrometer, revealing new insight into Earth's early history. The discovery of a crystal that formed 4.4 billion years ago, less than 160 million years after the formation of Earth and the Moon, causes researchers to question the conventional view that Earth was covered by oceans of magma at this time. New results suggest the formation of crust, a cool early Earth, and even liquid water oceans much earlier than previously thought. Now researchers are searching for more ancient zircons and hoping to find fragments of rock preserved from this time. Possibly, evidence exists to answer another much-debated question: when did life first exist on Earth? And, if life evolved as early as 4.4 billion years ago, would it have survived late heavy meteorite bombardment?

Upward Lightning

On average, about 100 lightning discharges occur every second in approximately 2000 thunderstorms that are active globally at any given time. While the average person has likely witnessed these "ground-to-cloud" discharges, airline pilots had reported seeing "upward lightning" for some time. It wasn't until the 1990s that these phenomena were finally documented and studied. Scientists have now shown that lightning discharges at cloud altitudes (<10 km) affect the high altitude (>40 km) upper atmosphere either via the release of intense electromagnetic pulses and/or the production of intense quasistatic electric fields. A spectacular manifestation of these intense fields is the so-called "sprites," large, luminous discharges in the altitude range of ~40 km to 90 km, which are produced by the heating of ambient electrons for a few to tens of milliseconds following intense lightning flashes. The so-called "elves" are optical flashes that last for a much shorter (<1 ms) time than sprites, and are typically limited to 80-95 km altitudes with much larger (up to 600 km) lateral extent, being produced by the heating, ionization, and optical emissions due to the electromagnetic pulses radiated by both positive and negative lightning discharges. These newly discovered phenomena indicate strong electrical coupling between upper atmospheric regions, the global significance of which must now be evaluated so that existing models of upper atmospheric dynamics can be properly modified to account for such coupling.

Other Performance Indicators

The tables below show the number of people benefiting from GEO funding, and trends in growth of award size, duration and number of awards.

Number of People Involved in GEO Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	3,816	3,900	3,900
Other Professionals	2,627	2,700	2,700
Postdoctorates	598	600	600
Graduate Students	2,139	2,200	2,200
Undergraduate Students	1,209	1,200	1,200
Total Number of People	10,389	10,600	10,600

GEO Funding Profile

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
Statistics for Competitive Awards:			
Number	1,515	1,500	1,500
Funding Rate	36%	35%	34%
Statistics for Research Grants:			
Number of Research Grants	839	800	800
Funding Rate	33%	32%	31%
Median Annualized Award Size	$82,264	$83,100	$83,100
Average Annualized Award Size	$146,467	$147,900	$147,900
Average Award Duration, in years	2.9	3.0	3.0

ATMOSPHERIC SCIENCES $243,630,000

The FY 2005 Budget Request for the Atmospheric Sciences Subactivity is $243.63 million, an increase of $4.85 million, or 2.0 percent above the FY 2004 Estimate of $238.78 million.

Atmospheric Sciences Funding

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change from FY 2004 Amount	Percent
Atmospheric Sciences Research Support	147.94	156.78	160.13	3.35	2.1%
National Center for Atmospheric Research	83.35	82.00	83.50	1.50	1.8%
Total, ATM	$231.29	$238.78	$243.63	$4.85	2.0%

Totals may not add due to rounding.

Research and education activities in the Atmospheric Sciences Subactivity (ATM) further our understanding of weather, climate, and the solar-terrestrial system by expanding the fundamental knowledge of the composition and dynamics of Earth's atmosphere and geospace environment. About 40 percent of the funds for ATM support the operation and maintenance of large, complex facilities required for research in the atmospheric and solar-terrestrial sciences. These facilities are shared by the atmospheric science community for fundamental research by individuals and groups of investigators participating in national and international scientific field programs and experiments. The year 2005 will see the commissioning and transfer to full operational status of NSF's High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER). The HIAPER project is the modification and instrumentation of a multidisciplinary high altitude research aircraft capable of conducting science from near the Earth's surface to an altitude of 50,000 feet with an extensive scientific payload and a flight range in excess of 6,000 nautical miles that will enable investigators to perform critical atmospheric and earth system science research.

The "Rain in Cumulus over the Ocean" (RICO) experiment, a study of trade wind cumulus clouds, will be conducted from November 2004 through January 2005. It will focus on understanding the formation of rain in warm clouds. The experiment involves investigators from more than 15 universities and other laboratories as well as participants and facilities from France and England. The RICO investigators will attempt to resolve a central and long-standing problem in cloud physics: theoretical and model calculations predict that rain should form in warm clouds more slowly and in smaller amounts than is actually observed. Because precipitation is such an important feature of weather and climate, this weakness in our ability to predict rain formation affects weather and climate models in fundamental ways. The experiment is designed to test a number of hypotheses that address this discrepancy and also to collect a benchmark set of observations that can be used to improve representations of precipitation formation in models. This study also will provide new understanding of the important influences of trade wind cumulus clouds on larger-scale budgets of radiant energy and moisture in the global climate system.

In recent research, the Bow-echo and Mesoscale Convective Vortex Experiment (BAMEX) was conducted over a seven-week period in the spring of 2003 over a large region of the Midwest. The goal of BAMEX is to study the life cycle of mesoscale convective systems (MCS) with an emphasis on the causes of locally damaging straight line winds and a phenomenon known as a mesoscale convective vortex (MCV). The MCV is of special interest since it can persist well after the demise of the parent MCS and often serves as the initiator of a new round of severe storms many hours after all previous storms have dissipated. This implies a degree of predictability of severe weather that is not currently obtainable. The field phase of the BAMEX required an unprecedented coordination of multiple aircraft and ground based observational systems over a very large area of the Midwest including the Great Plains, Mississippi and Ohio Valleys. Additionally, the newly developed Weather Research and Forecast (WRF) model was used for the first time in a forecast mode to aid in planning the daily field operations.

In upper atmospheric and near-Earth space research, there has been increasing body of evidence that indicates that the voltage that is applied across the earth's polar cap by the solar wind is limited by some, as yet unexplained, mechanism. Despite the fact that the solar wind driver can become very large, the polar cap voltage drop never gets much larger than 200 kilovolts. In a recent study, evidence presented shows that the limitation must be related to a limitation on the amount of electric current that can flow along magnetic field lines at very high latitudes. State of the art computer simulations show that during conditions of a strong solar wind driver, a dimple is formed at the magnetopause resulting in a region of stagnation in the flow. This limits the rate of magnetic reconnection and thus limits the amount of field-aligned current that can flow into the polar cap. This new result eliminates several old theories of the cause of the polar cap potential saturation.

The FY 2005 Budget Request includes $160.13 million for Atmospheric Sciences Research Support, which provides funding for individual and group research projects in physical meteorology, large-scale dynamic meteorology, experimental meteorology, climate dynamics, atmospheric chemistry, aeronomy, magnetospheric physics and solar-terrestrial relations. Research studies develop the scientific basis for understanding the dynamic and physical behavior of climate and weather on all scales, the natural global chemical cycles of gases and particles in Earth's atmosphere, the composition, energetics, and particularly the dynamics of the coupled upper atmospheric system, and the sun as it relates to Earth's upper atmosphere and space environment. Support is also provided for lower atmospheric facilities at several universities and for upper atmospheric observatories in Massachusetts, Puerto Rico, Greenland and Peru that are operated by U.S. universities and research institutions. Also included is support for Unidata, a national program to help universities use computing technology and atmospheric data for teaching and research. Highlights for FY 2005 include:

- Development of improved computer systems and numerical models, smart instrumentation, and collaboratories which will allow new discoveries, greater access to atmospheric data, and improved understanding of the atmospheric environment;
- Support for new environmental modeling that employ data assimilation and innovative mathematic and statistical techniques to improve predictions of fundamental atmospheric and Earth system processes;
- Continued construction and initial partial deployment of the Advanced Modular Incoherent Scatter Radar (AMISR), a next-generation upper atmospheric observational system to further our understanding of space weather and, thereby, to help to mitigate society's vulnerability to space storms.

FY 2005 support for the National Center for Atmospheric Research (NCAR) totals $83.50 million. During FY 2005 NCAR will focus on:

- Research in the atmospheric and related sciences, including climate system modeling and the operation of the computation facilities for the Climate Simulation Laboratory;
- The U.S. Weather Research Program and the National Space Weather Program, which aim to achieve a better understanding and improved predictive capability of costly and disruptive storms on Earth and in space; and
- Continued support and development of new and improved observational and computational capabilities.

EARTH SCIENCES $155,610,000

The FY 2005 Budget Request for the Earth Sciences Subactivity is $155.61 million, an increase of $4.03 million, or 2.7 percent, over the FY 2004 Estimate of $151.58 million.

Earth Sciences Funding
(Dollars in Millions)

	FY 2003	FY 2004	FY 2005	Change from FY 2004	
	Actual	Estimate	Request	Amount	Percent
Earth Sciences Project Support	115.38	119.58	122.61	3.03	2.6%
Instrumentation and Facilities	31.94	32.00	33.00	1.00	3.1%
Total, EAR	$147.32	$151.58	$155.61	$4.03	2.7%

Totals may not add due to rounding.

The Earth Sciences Subactivity (EAR) supports research and education activities that improve our understanding of processes that govern the behavior and characteristics of the Earth's surface environment and determine its internal structure, composition and dynamics. EAR funding supports theoretical, computational, laboratory and field studies, and state-of-the-art scientific infrastructure needs. New understanding gained from such studies provides the scientific basis for 1) predicting natural hazards such as earthquakes, volcanic eruptions, floods and droughts, and the mitigation of their impacts; 2) discovery and management of mineral, energy, and water resources; and 3) environmentally sound decision-making. EAR projects are often partnered with and complementary to focused efforts by other federal and state agencies. EAR support is crucial in advancing research and education in the Earth Sciences.

Construction of the new EarthScope facility began with funding from NSF's Major Research Equipment and Facility Construction (MREFC) Account in FY 2003. EarthScope is a distributed, multi-purpose geophysical instrument array for the exploration of fundamental processes that shape the structure and influence the deformation of continents. Research and operation support from Earth Sciences Project Support will enable scientists utilizing EarthScope to enhance understanding of earthquakes and seismic hazards, magmatic systems and volcanic hazards, regional tectonics, continental structure and evolution, and fluids in the crust. Partners in EarthScope include the U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Programme (ICDP). Additional project partners may include state and local governments, Canadian, and Mexican agencies. Geotechnical and engineering firms will use data and models enabled by EarthScope, and instrumentation firms will collaborate on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision Global Positioning Systems (GPS) antenna designs.

EarthScope's broader impacts will be felt through applications in hazard assessment and resource management, and through the EarthScope education and outreach program. While EarthScope is a national program, it will be installed and operated at a local level through interactions with hundreds of U.S. universities, schools and other organizations. EarthScope will be a tool for communicating scientific understanding, and perhaps as importantly, the nature of the scientific method. As EarthScope observatories are installed across the U.S., students and the public will consider scientific questions, and the role their region plays in the North American continent. The broad participation necessary for EarthScope to operate will provide pathways for underrepresented groups, especially in rural areas, to participate directly in a national scientific experiment.

The FY 2005 Budget Request includes $122.61 million for Earth Sciences Project Support to provide funds for three main activities. The first is support for individuals and groups of scientists whose research provides the foundation of excellence and capability across all disciplines of the Earth Sciences. Supported programs include disciplinary studies in geology, paleobiology, geophysics, geochemistry, and the hydrologic sciences. The second is support for interdisciplinary research to help understand the parameters and processes that govern the behavior of complex global systems and gain insight into the character and behavior of the Earth's environment. This funding will enable continued support for U.S. scientists and engineers to participate in coordinated national and international research activities as well as an increased emphasis on natural hazards, the water sciences and collaborative multidisciplinary studies to understand the Earth as a functioning dynamic system. The third is the integration of research, education and public awareness through the support of outreach projects, digital libraries and other human resources activities within the geosciences. Priorities for FY 2005 include support for:

- Multidisciplinary studies of the hydrological and biogeochemical cycles, processes that govern water quantity and quality, the character and dynamics of the Earth's surface, and the interactive processes at the intersection of the geosphere and biosphere;
- Improving understanding of natural hazards such as floods, earthquakes and volcanic eruptions;
- Implementation of the EarthScope geophysical and geodetic observational capabilities in order to better understand the physics of earthquakes and the structure, dynamics and evolution of the North American continent;
- Expanding capabilities for computationally challenging planetary research such as dynamic modeling of Earth system processes, managing very large data sets, and integrating and synthesizing data between disciplines while meeting interagency information technology goals;
- Enabling national and international continental scientific drilling focusing on the mechanics of earthquake initiation, and the detailed mechanisms that control eruptive volcanism.

Support for the Instrumentation and Facilities program and infrastructure activities totals $33.0 million. This supports shared research facilities such as Incorporated Research Institutions for Seismology (IRIS) for seismological research, the University Navstar Consortium (UNAVCO, Inc.) for precision geodetic measurements using Global Positioning Systems (GPS), accelerator-based mass spectrometers, ion-beam microprobes, and synchrotron beam lines. The program also funds the research and educational needs for instrumentation and computational infrastructure at universities and colleges throughout the nation. Priorities for FY 2005 include support for:

- Through the EarthScope facilities, enhancement of seismic, geodetic and other geophysical observational platforms on the North American continent to obtain unprecedented resolution imaging of Earth structures underneath the continent and improved understanding of earthquakes, volcanic eruptions and related active tectonic processes;
- Development and deployment of ultra-high pressure technology enabling laboratory investigations of Earth and other planetary bodies under extreme conditions existing in deep planetary interiors;
- The IRIS facility, for enhancement of operation and deployment of the Global Seismic Network for deep earth research and monitoring associated with nuclear nonproliferation and verification, continue making available portable seismic arrays to facilitate focused geophysical research, and to sustain the Data Management System which makes available data on seismic events to researchers world-wide; and
- Development of a dedicated InSAR (Interferometric Synthetic Aperture Radar) satellite mission, carried out jointly with partner agencies (NASA, USGS), to provide spatially continuous strain measurements over wide geographic areas.

OCEAN SCIENCES $329,260,000

The FY 2005 Budget Request for the Ocean Sciences Subactivity is $329.26 million, an increase of $6.52 million, or 2.0 percent over the FY 2004 Estimate of $322.74 million.

Ocean Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change from FY 2004 Amount	Change from FY 2004 Percent
Oceans Section	117.98	120.45	120.45	0.00	0.0%
Integrative Programs Section	110.26	118.08	120.24	2.16	1.8%
Marine Geosciences Section	84.98	84.21	88.57	4.36	5.2%
Total, OCE	$313.23	$322.74	$329.26	$6.52	2.0%

Totals may not add due to rounding.

The Ocean Sciences Subactivity (OCE) supports research and education to improve understanding of the physical, chemical and biological processes that characterize both coastal seas and deep ocean basins, and the geological and geophysical processes that shape the continental shelves and deep sea floor. Support is also provided for the facilities required to gain access to the ocean, including research vessels, manned deep diving submersibles and a wide range of technologically advanced observational instrumentation. Ocean science is a highly interdisciplinary research endeavor that is fundamental to the understanding of the Earth's climate, to resource and hazard assessment, and to the health of the ocean's complex and diverse ecological systems.

Recent observations from new instruments and techniques employed to study internal tides off Hawaii show that ocean tides do much more than cause the slow rise and fall of sea level. These recent studies show that internal tides flowing over undersea ridges are an important source of deep ocean mixing. The new results show that ocean mixing associated with internal tides flowing over the Hawaiian Ridge was 10 times greater than in normal open ocean areas. Ocean mixing is of fundamental importance to the distribution of heat around the globe and is thus one of the important natural controls of the Earth's climate. The new results could lead to new theories of ocean mixing and thus to better understanding of ocean circulation and its role in affecting global climate.

The FY 2005 Request includes $120.45 million for Oceans Section research support. Studies span a wide range of research topics involving processes occurring within the water column from the air/sea interface to the ocean floor. Research problems increasingly require focused, collaborative, and coordinated programs of observation and interpretation that are often interdisciplinary. Projects range from individual investigator laboratory-based work to multi-investigator collaborations and international programs that require substantial amounts of ship-time and other facility resources. Priorities for FY 2005 include support for:

- A Project Office to coordinate new activities related to ocean observations and the planning for ocean observatories;
- Continuation of the Oceans and Human Health Initiative (with NIEHS) to understand the linkages between oceans and human health, including vector & water-borne diseases, harmful algal blooms and marine pharmaceuticals;

- Studies of marine biocomplexity, particularly marine ecosystems at all levels of organization from functional genomics of marine organisms at the molecular level to open ocean non-linear processes;
- Continued development of capabilities for data assimilation and modeling for ocean circulation and biogeochemical flux studies, resulting from a growing history of sustained time-series observations;
- Interdisciplinary collaborations between mathematicians, statisticians and geoscientists to develop new approaches to solve problems and provide new insights in quantitative oceanography;
- Research to identify, understand, and quantify the processes controlling carbon cycling in the oceans; and
- Enhanced long-term process studies of deep ocean and coastal systems using sustained time-series observations, and development of new technology for ocean and seafloor observation systems.

The Integrative Programs Section totals $120.24 million, an increase of $2.16 over FY 2004, and coordinates critical functions integral to the Ocean Sciences Subactivity. They include education and diversity programs, ship operations, upgrades, construction, instrumentation, technical services, and oceanographic facilities, new technology development, ocean observatories and observation systems, the National Oceanographic Partnership Program (NOPP) and its emerging OCEANS.US coordination office. Priorities for FY 2005 include:

- Replacement and enhancement of deep submergence capabilities using the results of an National Research Council study to guide plans for replacing the 38-year old submersible ALVIN;
- Development of concept designs for new Regional Class vessels as part of the Federal Oceanographic Facilities Committee's (FOFC) plan for renewal of the academic fleet;
- Operation of the academic research fleet to ensure that required ship time and capabilities are provided to satisfy merit reviewed research project requirements for NSF-sponsored studies;
- Enhancement of technical and shared-use instrumentation for projects to sea-going scientists;
- Continued maintenance and ship-improvement programs and increased support for quality improvement activities in operations and technical services programs; and
- Technology development, particularly for smart environmental sensors and the design of infrastructure to support seafloor observatories.

The Marine Geosciences Section totals $88.57 million, an increase of $4.36 million over FY 2004, and supports research to improve fundamental understanding of the composition, structure and evolution of the oceanic crust and continental margins; the record of global environmental and biologic change; and geochemical cycling produced by plate tectonic processes and fluid flow in sedimentary and crustal rock. This includes support for core research in marine geology, geochemistry and geophysics; coordinated community initiatives focused on thematic priorities in planetary dynamics and earth system cycles; and U.S. co-management (with Japan) and participation in the new Integrated Ocean Drilling Program (IODP). Priorities for FY 2005 include support for:

- Research projects and field programs focused on understanding dynamics of the ocean mantle and its effect on the structure and evolution of the lithosphere,
- Increased use of observatory instrumentation and experiments at integrated ridge crest study sites to evaluate biological and hydrothermal dynamics and their roles in planetary metabolism and ecology,
- Integrated observational, laboratory and theoretical studies of continental rifting process in coordination with the Earth Sciences subactivity, and
- Coordinated geologic, geochemical, geophysical and drilling studies of fluid flow in ocean crust and continental margin sediments.

MATHEMATICAL AND PHYSICAL SCIENCES

MATHEMATICAL AND PHYSICAL SCIENCES $1,115,500,000

The FY 2005 Budget Request for the Mathematical and Physical Sciences (MPS) Activity is $1.115 billion, an increase of $23.99 million, or 2.2 percent, over the FY 2004 Estimate of $1.092 billion.

Mathematical and Physical Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Astronomical Sciences	187.07	196.55	204.35	7.80	4.0%
Chemisty	181.61	185.22	188.91	3.69	2.0%
Materials Research	241.39	250.89	253.18	2.29	0.9%
Mathematical Sciences	178.79	200.41	202.25	1.84	0.9%
Physics	224.50	227.67	235.76	8.09	3.6%
Multidisciplinary Activities	27.34	30.77	31.05	0.28	0.9%
Total, MPS	$1,040.70	$1,091.51	$1,115.50	$23.99	2.2%

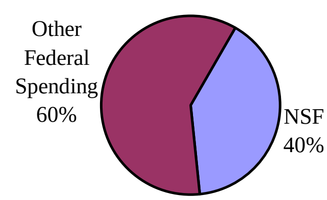
Totals may not add due to rounding.

The Mathematical and Physical Sciences Activity provides funds for research, supporting infrastructure, and development of human resources in the mathematical and physical sciences.

RELEVANCE

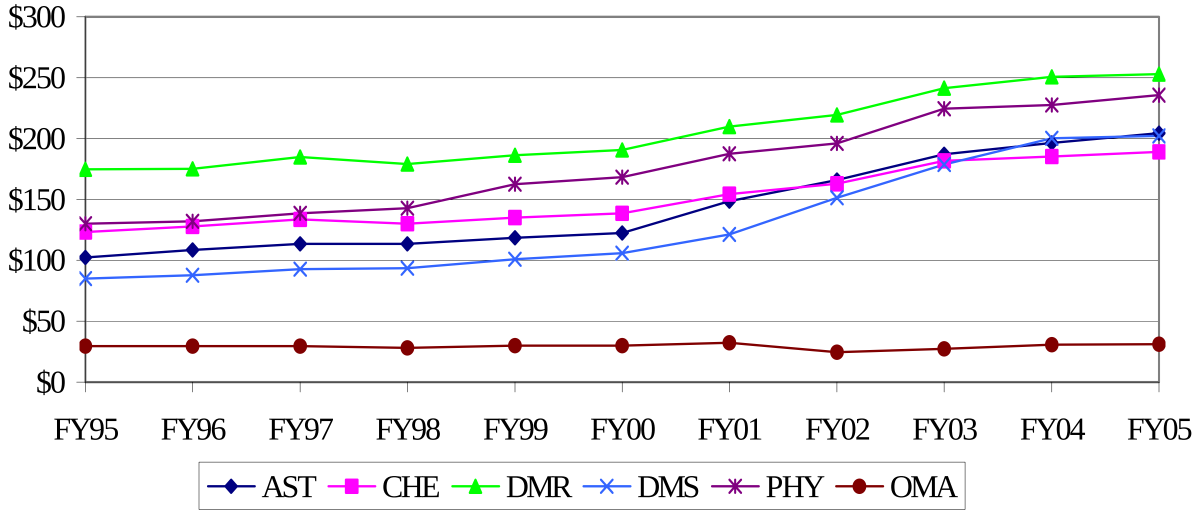
From the structure and evolution of the universe to the fundamental particles and processes of matter, from the behavior and control of molecules at the nanoscale to the complexity of their chemical interactions in materials and life processes, from developing new mathematical structures and theories to transforming them into models of natural systems that connect to computation, experimentation, and observation, the questions of MPS-supported research both stir the imagination and drive technological advances. Most of the research is of an exploratory nature. It requires sustained investment as well as access to the tools of advanced discovery. MPS-supported research provides the backbone for advances in other technical, engineering, and health-related disciplines, and provides a broad basis for industrial and technological development. It has played a fundamental role in the technological leadership of the United States and in maintaining its health, economy, defense, and homeland security. By linking research with education and training, MPS also promotes development of the future U.S. science, engineering, and technology workforce.

Federal Support of Basic Research in Math and Physical Sciences at Academic Institutions



NSF's role as lead agency in MPS research is appropriate, given its basic research mission. MPS provides about 40 percent of the federal funding for basic research at academic institutions in the mathematical and physical sciences. Within the astronomical sciences, MPS provides about 33 percent of the federal support in this area; in chemistry, about 31 percent; in physics, approximately 31 percent; in materials research approximately 50 percent; and in mathematics more than 58 percent. MPS collaborates with other disciplines within NSF and partners with other agencies, the private sector, and other nations in exploring areas such as the physics of the universe, nanoscale science and engineering, molecular processes in the life and environmental sciences, mathematical modeling across scales of time and space, and the evolving scientific capabilities provided by emerging cyberinfrastructure. Such cooperation enhances the synergistic impact of MPS investments.

MPS Subactivity Funding
(Dollars in Millions)



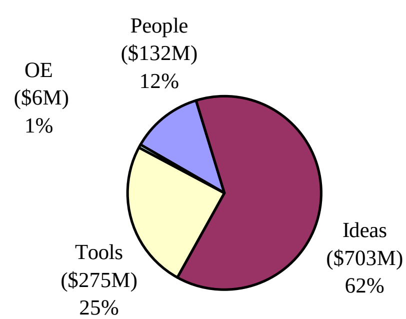
STRATEGIC GOALS

MPS contributes to achieving NSF's strategic goals through its investments in the people, ideas, and tools of mathematical and physical sciences and through its pursuit of organizational excellence.

- People: Investments aim to improve the quality and diversity of the U.S. science and engineering workforce and to enhance the public's knowledge of MPS fields by linking both formal and informal education and training programs to forefront research activities in the U.S. and other countries. This approach invigorates education through the excitement of discovery and contributes to an engagement in the global MPS enterprise.

- Ideas: Investments aim to enable strong, flexible disciplines that generate discoveries across the MPS frontiers, reach out to other disciplines on multidisciplinary frontiers, accept risky undertakings that promise significant advances on fundamental questions, and connect with learning, innovation and national interests. These investments include a mix of broad support across all MPS fields and catalytic support that promotes advances in identified areas of opportunity.

FY 2005 MPS Strategic Goals



- Tools: Investments aim to enhance the infrastructure supporting the conduct of research and education in MPS and related fields and enable broad access to it. The investments range from table-top instruments to international facilities with hundreds of users and include the development of new types of instrumentation. Remote access to facilities through increasingly sophisticated cyberinfrastructure complements on-site capabilities. MPS continually explores the needs and opportunities for investments in infrastructure, including both new capabilities and the operation and upgrade of existing state-of-the-art facilities needed to perform world-class research.

- Organizational Excellence (OE): MPS investments in Organizational Excellence provide for administrative activities necessary to enable NSF to achieve its mission and goals by enhancing the visibility and credibility of MPS programs in the scientific community and enabling state-of-the-art capabilities in award and oversight processes. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	113.84	127.79	131.49	3.70	2.9%
Ideas	667.15	685.72	703.16	17.44	2.5%
Tools	253.57	271.86	274.71	2.85	1.0%
Organizational Excellence	6.14	6.14	6.14	0.00	0.0%
Total, MPS	$1,040.70	$1,091.51	$1,115.50	$23.99	2.2%

PEOPLE (+$3.70 million, for a total of $131.49 million)

MPS is committed to helping NSF ensure a diverse, competitive, and globally-engaged U.S. workforce of scientists, engineers, technologists and well-prepared citizens, the most important goal for ensuring the vitality of science and engineering in the future. All MPS investments focus on enabling people. When enabling people to carry out their ideas for discovery on the frontiers or to develop and use new tools for experimentation and observation, MPS also provides opportunities for learning through discovery. These less direct investments are critical for maintaining a broad focus in developing the next generation of scientists and engineers.

MPS complements this broad approach with targeted investments in people totaling $131.49 million in FY 2005, an increase of $3.70 million or 2.9 percent over FY 2004. This investment, representing a mix of MPS participation in NSF-wide programs, activities aimed at the particular interests of MPS fields, and experiments in collaboration with the Directorate for Education and Human Resources includes education activities at all levels, as well as public outreach and faculty development. Activities may target individuals, institutions, or collaborations depending on their objectives.

MPS regards undergraduate education as a “pressure point” in the system – where investments can influence decisions on future careers being made by a diverse talent pool. Connections to secondary students that draw them into science and engineering as well as to graduate programs that enable students to participate in advanced training complement undergraduate approaches. In all instances, MPS emphasizes the integration of research and education as a mechanism for enhancing undergraduate programs and increasing diversity.

MPS People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	80.74	92.16	95.85	3.69	4.0%
Institutions	7.24	5.44	5.77	0.33	6.1%
Collaborations	25.86	30.19	29.87	-0.32	-1.1%
Total, People	$113.84	$127.79	$131.49	$3.70	2.9%

Totals may not add due to rounding.

<u>INDIVIDUALS</u>

- Funding for Enhancing the Mathematical Sciences Workforce for the 21^{st} Century increases by $2.0 million to $27.78 million through reorientation of $1.50 million from the CAREER program and $500,000 from postdoctoral fellowship activities. This program builds on the Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE) program and includes a component for Research Training Groups in the Mathematical Sciences and a component for Mentoring through Critical Transition Points in the Mathematical Sciences;
- Across MPS, funding for the CAREER program decreases by $500,000 to a total of $40.30 million.
- Support for IGERT will increase by $1.24 million to $10.0 million to support about 25 additional students.
- Support for the post-doctoral and senior fellowship program, Discovery Corps, piloted in FY 2004, will be increased $500,000 to a total of $1.50 million and the MPS Distinguished International Postdoctoral Research Fellowship (MPS-DRF) will increase $250,000 to a total of $2.50 million to support about 10 additional fellows.
- Support for Research Experiences for Teachers (RET) will increase $500,000 to total $4.50 million and the NSF Director’s Award for Distinguished Teaching Scholars (DTS) will increase $200,000 for a total of $500,000 to support about 50 additional K-12 teachers and discipline researchers/educators.
- Support for supplemental undergraduate student research experiences will remain constant at $4.42 million.

<u>INSTITUTIONS</u>

- Support for ADVANCE will increase $230,000 to $5.0 million.

<u>COLLABORATIONS</u>

- Support for Graduate Teaching Fellows in K-12 Education will increase by $100,000 to a total of $2.50 million.
- Support for MPS Internships in Public Science Education (IPSE) program will increase $500,000 to total $3.0 million.
- Investment in research and training activities at the scientifically rich interface between the MPS disciplines and the biological sciences will be increased by $400,000 to total $1.0 million.
- Support for the pilot program proposed to begin in FY 2004 for Undergraduate Research Centers will continue at a level of $3.0 million.

IDEAS (+$17.44 million, for a total of $703.16 million)

Discoveries in the fundamental sciences of astronomy, chemistry, materials research, mathematical sciences, and physics address some of the most fundamental questions about the universe and at the same time provide the basis for technologies that generate new industries. Their potential impact on the future economic health of the nation is profound.

The recent National Research Council report “Connecting Quarks with the Cosmos,” frames an emerging research priority at the interface of physics and astronomy growing out of results that have radically altered our ideas about both the behavior and substance of the universe. The results make a strong case for the existence of new fundamental particles (dark matter) and a new, pervasive brand of energy (dark energy). Compelling questions awaiting answers include: What is the dark matter that dominates the matter content of the universe, and how is it related to as yet undiscovered fundamental particles? What is the dark energy that dominates the entire energy-matter content of the universe, and how does it relate to as yet undiscovered fundamental forces and fields? Can we detect gravitational radiation and use it to explore the most exotic bodies and processes in the universe as well as the relationship of general relativity and quantum mechanics? Working in cooperation with counterparts at NASA and the Department of Energy, MPS will embark on a coherent effort to understand this newly emerging area of the physics of the universe at the very smallest and very largest of spatial scales.

New advances in quantum and nanoscale phenomena will enable MPS researchers to move aggressively toward a more complete molecular-level understanding of life processes by addressing a basic research frontier in molecular science and technology: weak, non-covalent bonding interactions. Individually, each of these bonding interactions is quite weak, but collectively there is cooperative “strength in numbers” that causes proteins to fold, membranes to self-assemble, and enzymes to catalyze remarkable molecular transformations. Key questions involve the ability of collections of weak, non-covalent bonds to produce molecular complexity and emergent behavior. How can a disordered mixture of chemicals spontaneously transform to an organized, self-replicating molecular system? How are molecular reactions coupled to produce periodic behavior like circadian rhythms and heartbeats? MPS aims to produce a far more holistic picture of the chemical bonds that underpin molecular science and technology while yielding new technological opportunities in fields ranging from pharmaceuticals to biomaterials to agrochemicals.

MPS-supported scientists are now exploring physical systems over the entire spectrum of length and time scales. A realistic description of the physical laws governing such systems demands the full integration of theory with experiment and observation. It also requires the generation of sophisticated and mathematically precise models, the development of application-specific software to implement the models computationally, and the ability to manipulate and extract information from large, complex data sets. MPS scientists, along with computer scientists, have developed algorithms and application software to address these problems, creating new approaches in all disciplines (cyberscience) that leverage MPS’s past investments in computational astronomy, chemistry, materials research, mathematics, physics, and statistics to support the development of new algorithms that enable the exploration of previously inaccessible areas of science through computation and simulation.

Research in the MPS disciplines is becoming increasingly multidisciplinary, as the examples above indicate. To facilitate interdisciplinary research MPS supports a variety of research centers and groups. These activities complement the support for individual investigators and small groups. Active participation in research and education activities in undergraduate institutions, as well as connections to Foundation-wide programs such as EPSCoR, CREST, SBIR, and STTR help expand capability in science and engineering. Through their support of students and postdoctoral researchers, MPS investments in

Ideas enhance capability by improving the quality of education and diversity of participation for the next generation of scientists and engineers.

MPS Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	535.09	542.07	553.35	11.28	2.1%
Centers Programs	116.28	130.29	136.45	6.16	4.7%
Capability Enhancement	15.78	13.36	13.36	0.00	0.0%
Total, Ideas	$667.15	$685.72	$703.16	$17.44	2.5%

Totals may not add due to rounding.

FUNDAMENTAL SCIENCE AND ENGINEERING

- Support for disciplinary research will increase $11.28 million to total $551.71 million, increasing average annualized award size by $5,000 to $140,000.
- Initiate focus on the emerging areas of Physics of the Universe with an increase of $9.0 million to support observational and theoretical efforts to understand the nature of dark energy and dark matter; expand support of numerical relativity and theoretical cosmology, neutrino physics, and cosmic microwave background radiation; and support research and development of the Atacama Cosmology Telescope.
- Provide $1.50 million to enhance the understanding of the physical and chemical bases of life processes, with emphasis on the molecular level.
- Support for the NSF priority area in Nanoscale Science and Engineering will increase by $20.66 million through a redirection from other activities of $18.32 million and $2.34 million included within the Centers Program for an investment total of $132.14 million. MPS will place emphasis on structures, phenomena, and quantum control at the nanoscale.
- Increased support of $7.06 million for cyberinfrastructure to a total of $31.99 million. This funding supports the development of new algorithms that enable the exploration of previously inaccessible areas of science through computation and simulation; promotes the development of new methods for extracting information from ever larger and increasingly complex data sets; unifies seemingly disparate practices in scientific computing and data analysis and lays the foundation for the development and application of new concepts and tools that take advantage of the growing computational infrastructure.

CENTERS PROGRAMS

MPS Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Chemistry Centers	13.39	16.85	18.90	2.05	12.2%
Materials Centers[1]	54.65	56.56	58.90	2.34	4.1%
Information Technology Centers	0.30	0.00	0.00	0.00	0.0%
Mathematical Sciences Research Institutes	14.77	15.10	16.60	1.50	9.9%
Nanoscale Science and Engineering Centers	5.98	11.78	11.78	0.00	0.0%
Physics Frontier Centers	12.25	15.20	15.40	0.20	1.3%
Science and Technology Centers	14.94	14.80	14.87	0.07	0.5%
Total, MPS Centers Programs	$116.28	$130.29	$136.45	$6.16	4.7%

Totals may not add due to rounding.

[1]Materials Centers includes support for Materials Research Science and Engineering Centers (MRSECs), International Materials Institutes and Partnerships for Research and Education in Materials.

- Support for Chemistry Centers will increase by $2.05 million to total $18.90 million, increasing the expected number of Chemical Bonding Centers focusing on research related to the MPS emphasis area of the molecular basis of life processes.
- Support for the Materials Centers increases by $2.34 million to $58.90 million to enable establishment of up to three new MRSECs. This increase will support the NSF nanoscale science and engineering priority area. Additional funds may be redirected as needed from existing MRSECs through recompetition.
- Increased support for the Mathematical Sciences Research Institutes of $1.50 million to total $16.60 million to address the growing interface with other disciplines.

CAPABILITY ENHANCEMENT

- MPS investments in Research in Undergraduate Institutions and Research Opportunity Awards remain constant at $13.36 million.

TOOLS (+$2.85 million, for a total of $274.71 million)

The MPS investment in Tools maintains a portfolio of world-class facilities for the science and education communities with a capital investment of well over $1.0 billion, develops instrumentation for cutting-edge research, and provides access to needed research resources. Increased annual support of $2.85 million over the FY 2004 Estimate to a total of $274.71 million significantly enables new science opportunities: allowing for appropriate levels of operations and maintenance at MPS FFRDCs and facilities, support for needed disciplinary instrumentation programs, and, importantly, an expansion of mid-scale instrumentation activities.

Continuing advances in communication, computation, sensing and data technologies are changing the way MPS scientists and engineers perform their work. MPS has been at the forefront in using high-end computing capabilities, linking data with computing through emerging grid technologies, developing embedded sensors that transmit data to researchers, and expanding the capacity for remote observing. MPS will continue to expand its development of cyberinfrastructure, linking these activities with existing, developing, and planned facilities and instrumentation.

The National Science Board Report *Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation* identified significant challenges in obtaining research instrumentation above the size of that provided through regular awards or instrumentation programs (generally below $2.0 million) but below the size of projects eligible for NSF's Major Research Equipment and Facilities Construction (MREFC) Account. MPS is moving to address these challenges, which include, for example, development of adaptive optics systems for telescopes; research and development for new large-scale instruments; and enhanced user support and instrumentation for neutron scattering experiments at the Department of Energy's Spallation Neutron Source (SNS).

MPS Investments in Tools
(Dollars in Millions)

Facilities	**FY 2003 Actual**	**FY 2004 Estimate**	**FY 2005 Request**	**Change over FY 2004 Amount**	**Change over FY 2004 Percent**
Cornell Electron Storage Ring (CESR)	19.49	18.00	19.70	1.70	9.4%
GEMINI	13.48	14.12	14.93	0.81	5.7%
Large Hadron Collider	5.00	7.00	9.00	2.00	28.6%
Laser Interferometer Gravitational Wave Observatory (LIGO)	33.00	33.00	33.00	0.00	0.0%
MSU Cyclotron	15.65	15.65	16.65	1.00	6.4%
Nanofabrication (NNUN/NNIN)	1.75	2.65	2.65	0.00	0.0%
National High Field Mass Spectrometry Center	0.99	0.00	0.00	0.00	N/A
National High Magnetic Field Laboratory (NHMFL)	24.11	24.61	25.61	1.00	4.1%
RSVP		6.00	0.00	-6.00	-100.0%
Other MPS Facilities	12.90	11.41	11.41	0.00	0.0%
Facilities, Subtotal	**126.37**	**132.44**	**132.95**	**0.51**	**0.4%**
Digital Library	1.00	1.00	1.00	0.00	0.0%
Research Resources	26.05	30.28	42.48	12.20	40.3%
Infrastructure and Instrumentation, Subtotal	**27.05**	**31.28**	**43.48**	**12.20**	**39.0%**
NAIC	10.93	10.54	10.60	0.06	0.6%
NCAR	1.27	1.27	1.27	0.00	0.0%
NOAO	42.62	41.35	39.00	-2.35	-5.7%
NRAO	45.33	54.98	47.41	-7.57	-13.8%
FFRDCs, Subtotal	**100.15**	**108.14**	**98.28**	**-9.86**	**-9.1%**
Tools, Total	**$253.57**	**$271.86**	**$274.71**	**$2.85**	**1.0%**

FACILITIES

- An increase of $1.70 million to a total of $19.70 million for the Cornell Electron Storage Ring (CESR) to enable exploration of critical weak and strong elementary particle interaction phenomena and to sustain important accelerator physics research.
- An increase of $810,000 to $14.93 million for the Gemini Observatory will be sufficient to cover the U.S. share of operating costs, and a contribution of $1.0 million for the purchase of the Chilean share of the partnership.
- An increase of $2.0 million for operation of the ATLAS and CMS detectors for the Large Hadron Collider, including computing and software development, to a total of $9.0 million, continuing the ramp-up begun in FY 2003.
- Continued full operation and advanced detector research and development for the Laser Interferometer Gravitational-wave Observatory (LIGO) to run their interferometers at sites in Hanford, WA and Livingston, LA for a total of $33.0 million.

- An increase of $1.0 million, to a total of $16.65 million, for Michigan State University's National Superconducting Cyclotron Laboratory, a unique radioactive ion beam facility for nuclear physics, including nuclear astrophysics and nucleosynthesis. The increase is needed to enhance operations of this recently upgraded facility.
- A decrease of $6.0 million in planning activities for the Rare Symmetry Violating Processes (RSVP) project that was provided at the FY 2004 Estimate. RSVP consists of a pair of elementary particle physics experiments to probe very rare events giving clues to physics beyond the Standard Model. Funding for RSVP is requested through the MREFC Account in FY 2005.
- An increase of $1.0 million to $25.61 million for the National High Magnetic Field Laboratory in order to complete the integration of the Ion Cyclotron Resonance Facility at Florida State University into the NHMFL.

<u>INFRASTRUCTURE AND INSTRUMENTATION</u>
Support for Research Resources will increase by $12.20 million to $42.48 million. These funds will expand support for mid-scale instrumentation. Highlights include:

- Initiate $3.70 million to support the goals of the Physics of the Universe activity through technology development for the Large Synoptic Survey Telescope (LSST).
- Increase of $3.0 million to a total of $13.15 million will support research resources including the synchrotron and neutron beam lines, for example, whose cost and scope exceeds the Major Research Instrumentation program.
- Research and development in adaptive optics amounting to $3.0 million will move from NOAO administration to the instrumentation grants program in FY 2005. An additional $2.50 million will support design studies and technology development for the Giant Segmented Mirror Telescope (GSMT).

<u>FEDERALLY-FUNDED RESEARCH AND DEVELOPMENT CENTERS</u>

- Support for NRAO decreases by $7.57 million to $47.41 million following several one-time funding increments in FY 2004. First funds for early operations of ALMA, estimated at $1.0 million, will be part of NRAO operating expenditures in FY 2005.
- Support for NOAO decreases $2.35 million to $39.0 million. In FY 2003 and FY 2004, NOAO administered a $3.0 million program to support community research in adaptive optics as part of Giant Segmented Mirror Telescope (GSMT) technology development; in FY 2005 this activity is continued but under the mid-scale instrumentation activity mentioned above. A total of $4.0 million will support the Telescope Systems Instrumentation Program (TSIP), which is administered by NOAO on behalf of the community.
- Support for NAIC will increase by $60,000 to $10.60 million.

ORGANIZATIONAL EXCELLENCE ($6.14 million, unchanged from the FY 2004 Estimate)

MPS investments in Organizational Excellence provide funding for Intergovernmental Personnel Act (IPA) appointments, IPA travel and the administrative contracts necessary to conduct the level of program activity. These investments complement the work of the MPS staff, bringing new ideas to the table and enabling a closer connection with the MPS scientific community and a broader range of outreach and oversight activities.

PRIORITY AREAS

In FY 2005, MPS will support research and education efforts related to broad, Foundation-wide priority areas in Biocomplexity in the Environment, Nanoscale Science and Engineering, Mathematical Sciences, Human and Social Dynamics, and Workforce for the 21st Century.

MPS Investments in Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	5.21	4.70	4.70	0.00	0.0%
Nanoscale Science and Engineering	103.92	111.48	132.14	20.66	18.5%
Mathematical Sciences	47.39	70.19	70.19	0.00	0.0%
Human and Social Dynamics	N/A	0.50	0.50	0.00	N/A
Workforce for the 21st Century	N/A	0.00	1.03	1.03	N/A

- Biocomplexity in the Environment support will total $4.70 million. Environmental Molecular Science Institutes will be supported with a particular emphasis on developing a molecular level understanding of processes occurring in aqueous media. In addition, MPS will support research in the modeling of complex environmental phenomena and the development of environmentally benign materials and chemical and materials processing methods.

- Nanoscale Science and Engineering funding increases by $20.66 million to a total of $132.14 million. The increased funding will be used for partial support for up to three new MRSECs and support for individual investigators and interdisciplinary groups with an emphasis on structures, phenomena, and quantum control.

- Mathematical Sciences priority area support totals $70.19 million, unchanged from the FY 2004 Estimate. MPS investments will fall within three categories: (1) fundamental mathematical and statistical sciences, (2) interdisciplinary research connecting the mathematical sciences with science and engineering, and (3) targeted investments in mathematical sciences training activities. Special emphasis will be placed on mentoring advanced high school students through recent doctoral recipients at critical stages of their development in order to encourage them to enter and remain in mathematically related careers.

- MPS plans $1.03 million for the Workforce for the 21st Century priority area, largely through investments in Integrative Institutional Collaborations. The broad thrust of MPS investments in integrating research and education will provide a solid base for connecting the MPS scientific community with the priority area.

- Participation in HSD will be at $500,000, equal to the FY 2004 investment. It will include support for areas such as interdisciplinary research modeling the development and evolution of social and organizational behavior in complex systems.

QUALITY

MPS maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The percent of basic and applied research funds that were allocated to projects that undergo merit review was 87 percent in FY 2003, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, MPS convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

The Directorate also receives advice from the Advisory Committee for Mathematical and Physical Sciences (MPSAC) on such issues as: the mission, programs, and goals that can best serve the scientific community, how MPS can promote quality graduate and undergraduate education in the mathematical and physical sciences, and priority investment areas in MPS-supported research. The MPSAC meets twice a year and members represent a cross section of the mathematical and physical sciences with representatives from many different sub-disciplines within the fields, as well as a cross section of institutions, including industry, broad geographic representation, and balanced representation of women and underrepresented minorities.

PERFORMANCE

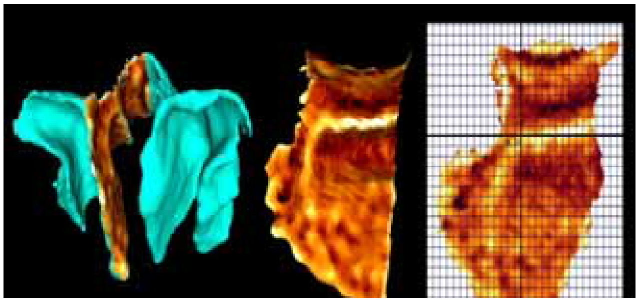
2003 "Breakthrough of the Year."

Researchers supported by MPS were key participants in the work that was named Science Magazine's "Breakthrough of the Year" for 2003. The analysis of the distribution of the first quarter million galaxies mapped by Sloan Digital Sky Survey (SDSS) clearly showed that the galaxies are being affected by the repulsive effect of dark energy. The gravitational clustering patterns in the SDSS map reveal the makeup of the Universe from its gravitational effects and, by combining their measurements with that from NASA's WMAP, the SDSS team measured the cosmic matter to consist of 70 percent dark energy, 25 percent dark matter and five percent ordinary matter.

Understanding Nature's Super Glues.

Dr. Jonathan Wilker and colleagues at Purdue University are studying the adhesives used by marine organisms for sticking to surfaces. This work has shown that mussels concentrate iron from seawater and then use this metal to cure their glue. Efforts are underway to understand the bonding of many biological materials found in the oceans, such as barnacle cements, kelp adhesives, and coral reef structures. These biomaterials are providing inspiration for the development of applications such as new surgical glues to replace stitches and antifouling coatings to keep barnacles off ships. The figure shows a mussel adhering to a Teflon® sheet.

Computational Conformal Mapping and Scientific Visualization.
Computational and mathematical tools are needed to analyze data from human brain scans. A focused research group in the mathematical sciences led by Florida State University is applying tools developed through their award to a region of the brain (the medial prefrontal cortex), which has been implicated in depression and bipolar disease. This highly folded region is ideal for being analyzed with quasi-conformal "flat" maps in order to gain a better understanding of this region of the brain. By examining the folding patterns, curvature and shape of the flat maps of different subjects, diseased and non-diseased regions can be compared and measurements can be developed to quantify the similarities and differences between various regions.

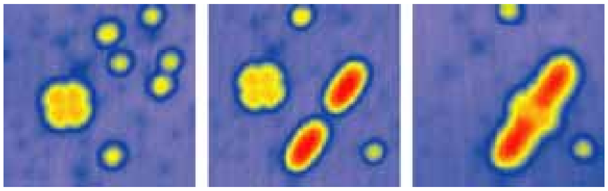


This highly folded medial prefrontal cortex region of the brain (left and center) is well-suited for analysis with quasi-conformal "flat" maps (right).

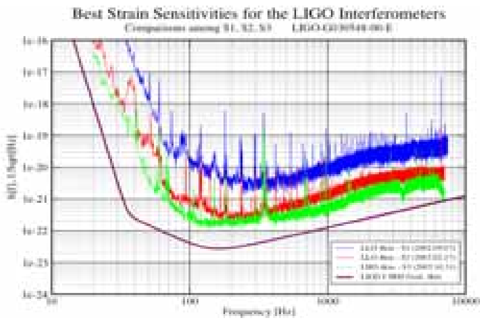
The group's work is leading to improved mathematical techniques for biomedical applications, while providing timely interdisciplinary training in mathematical biology for students and postdoctoral researchers.

Increasing the Participation of Underrepresented Groups in the Mathematical Sciences. The University of Maryland at College Park is working with Morehouse College, Bowie State University, Florida A&M University, North Carolina A&T, Spelman College, Trinity College of DC, and Xavier University to create a well-supported pathway to bring students from underrepresented groups to careers in the mathematical sciences. An annual Affiliates Workshop strengthens ties among these institutions. Sophomores and juniors participate in a Summer Institute that provides both academic classes and research experiences to reinforce the students' training and readiness for graduate study. Graduate fellowships and teaching assistantships enable students to continue to graduate work.

Materials at the Spatial Limit. Wilson Ho's research group at University of California-Irvine has constructed tiny chains consisting of 1 to 20 atoms of gold, silver or manganese. The synthesis of structures atom-by-atom using the scanning tunneling microscope is introducing novel ways to develop and study new materials and nanostructures. These results employ a new experimental approach to shed light on basic problems in molecular electronics, and to obtain new insight into the mechanisms of electrical conductivity through molecules. The image at right is not a simulation – it follows the chemical assembly of an entirely new molecule that Ho and his students synthesized by moving a copper-containing molecule into the gap between two gold atom chains.

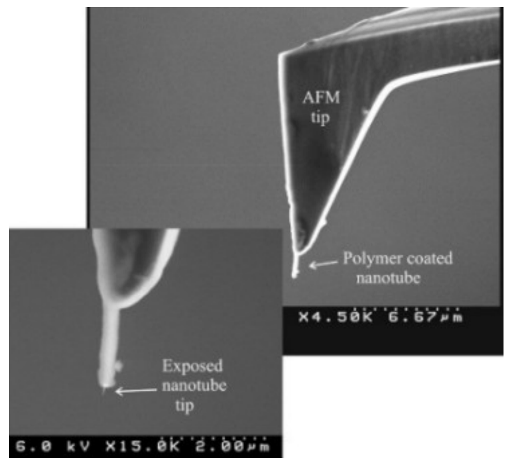


LIGO Completes Third Science Run at Near Design Sensitivity. The Laser Interferometer Gravitational-wave Observatory (LIGO) is an NSF-supported facility consisting of three laser interferometers designed to observe and study the gravitational waves predicted by Einstein's General Theory of Relativity. The goal in the present award, which extends from FY 2002 to 2006, is to accumulate one year's worth of observations at the design sensitivity, an unprecedented capability that would allow sensing the change caused by a gravitational wave in apparent distance between the interferometer mirrors of 4 x 10^{-18} m or one-thousandth of a proton diameter. In August 2002 LIGO began a series of observations with the first science run or "S-1 run" which lasted two weeks at a sensitivity approximately 100 times from the LIGO design goal. S-2, the second in the series, extended



from February 14, 2003 to April 14, 2003 and achieved sensitivities approximately 10 times from the design goal. The third run, S-3, extended from October 31, 2003 to January 8, 2004 and achieved sensitivities only about 3.5 times away from the goal. LIGO is now by far the most sensitive interferometer ever built and the solid progress in the past year and a half gives confidence that the design goals will be reached soon.

A New Probe for Understanding Cell Behavior. A group of researchers from the University of Florida has developed a new way to study cells at the nanoscale. They coat the tiny nanotube probe of an atomic-force microscope with a uniform layer of polymer and then remove the polymer from just the end of the nanotube. This coating dramatically stiffens the nanotube against buckling and makes the attachment of the nanotube to the probe tip extraordinarily robust. This new technique will provide unprecedented electrochemical and structural information about the electro- and neurophysiology of cells. The knowledge gained could impact our understanding in areas ranging from heart arrhythmias to the release of neurotransmitters, with implications for the treatment of nervous system disorders.



Other Performance Indicators

The tables below show the number of people benefiting from MPS funding, and trends in growth of award size, duration and number of awards.

Number of People Involved in MPS Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	6,063	6,000	5,900
Other Professionals	2,403	2,300	2,350
Postdoctorates	2,406	2,440	2,450
Graduate Students	7,124	7,200	7,100
Undergraduate Students	5,614	6,000	5,800
K-12 Students	310	320	320
K-12 Teachers	449	600	650
Total Number of People	24,369	24,860	24,570

MPS Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	2,268	2,120	2,110
Funding Rate	34%	34%	32%
Statistics for Research Grants:			
Number of Research Grants	1,710	1,650	1,610
Funding Rate	31.0%	32.0%	30.0%
Median Annualized Award Size	$100,000	$103,000	$105,000
Average Annualized Award Size	$128,590	$135,000	$140,000
Average Award Duration, in years	3.1	3.1	3.1

ASTRONOMICAL SCIENCES $204,350,000

The FY 2005 Budget Request for the Astronomical Sciences (AST) Subactivity is $204.35 million, an increase of $7.80 million, or 4.0 percent, over the FY 2004 Estimate of $196.55 million.

Astronomical Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Astronomical Sciences	187.07	196.55	204.35	7.80	4.0%
Total, AST	$187.07	$196.55	$204.35	$7.80	4.0%

NSF is the lead federal agency for ground-based astronomy, providing about two-thirds of the federal support for this area of science, including almost all federal support for radio astronomy. NSF works closely with NASA to coordinate ground-based astronomy activities. Astronomy Research and Instrumentation includes support for astronomical and astrophysical studies of the origins and characteristics of planets, the Sun, other stars, our galaxy, extragalactic objects such as clusters of galaxies and quasars, and the structure and origin of the Universe. The development of advanced technologies and instrumentation, at both public and private observatories, and university radio observatories are also supported. Support includes funding for undergraduate and graduate students and postdoctoral fellows. Also supported within this area is NSF's Electromagnetic Spectrum Management (ESM) program.

The FY 2005 Budget Request includes $92.41 million for research and instrumentation support in the Astronomical Sciences that will advance the scientific priorities of studies in cosmology and the origin and evolution of the universe and the formation of stars and planets. The request will support the initiation of several key areas of research and development identified by the Interagency Working Group on Physics of the Universe (POU) as well as continuation of efforts begun in FY 2004 and before. One new area will be the science program definition and technology development leading towards a Large Synoptic Survey Telescope (LSST), an instrument concept aimed at the determination of the nature of dark energy and the distribution of dark matter, two central challenges of the Physics of the Universe program. Construction of the Atacama Cosmology Telescope (ACT), supported jointly by the Divisions of Astronomical Sciences and Physics, and designed to map the cosmic microwave background temperature with resolution and sky coverage complementary to satellite experiments, will continue. Construction of VERITAS, a four element gamma-ray telescope and the operation of CDMS II, an underground experiment to search for dark matter particles, will continue jointly with the Division of Physics and the Department of Energy. A focus on providing support for mid-scale instrumentation needs begun in FY 2004 will continue to address community priorities such as the development of adaptive optics systems for telescopes and the availability of modern, instrumented small aperture telescopes for programs of student training, research, and educational/public outreach. Support will also be provided for research and development that may lead to the highly recommended Giant Segmented Mirror Telescope (GSMT). The Science and Technology Center (STC) for Adaptive Optics will be funded within AST in FY 2005.

Astronomical Sciences includes support for four national facilities: the National Astronomy and Ionosphere Center (NAIC), the National Optical Astronomy Observatories (NOAO), the National Solar Observatory (NSO), and the National Radio Astronomy Observatory (NRAO). Also included is the U.S. share of operations for the International Gemini Observatory, twin 8-meter telescopes located in the northern and southern hemispheres. These facilities together provide world-class observing capabilities throughout the electromagnetic spectrum, from radio to infrared and optical regimes of the electromagnetic spectrum. FY 2005 support for national facilities totals $111.94 million, and includes:

- Support for Gemini Observatory at a level of $14.93 million. Both the northern and southern Gemini telescopes are now in regular science operations. Included in this amount is $1.0 million for partial return of the Chilean construction capital, with which the U.S. assumes a portion of the Chilean share of the Observatory, along with increased observing access for U.S. astronomers.

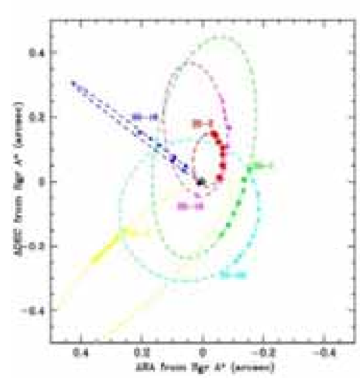
- NAIC will be supported at the level of $10.60 million. This level of support will enable continued operation and maintenance of the Arecibo telescope and the development of instrumentation to take advantage of its greater sensitivity.

- Support for NOAO/NSO at the level of $35.0 million, a decrease of $2.35 million from FY 2004. NOAO is involved in design and technology development for the GSMT and LSST. Levels of support for these activities within the NOAO base operating budget are expected to be approximately $1.20 million for LSST and $1.50 million for GSMT. Additional support for community-based R&D on adaptive optics totaling $3.0 million was managed by NOAO in FY 2004; those funds are being moved to the instrumentation grants program in FY 2005. NSO facilities provide solar telescopes for use by the U.S. astronomical community. Activities in FY 2005 include the final year of design and planning for the Advanced Technology Solar Telescope (ATST) ($2.0 million), an instrument that will use new techniques such as adaptive optics to provide a unique capability for investigating a wide range of questions in solar physics. ATST will be of significant value to studies in atmospheric sciences and space weather in addition to astronomical research.

  Included is $4.0 million for the Telescope System Instrumentation Program (TSIP), which is administered for the community through NOAO. TSIP, which began in FY 2002, is a program of support for instrument development and facility improvement in exchange for public access to private facilities.

- NRAO is supported at the level of $47.41 million, a reduction from the FY 2004 Estimate of $7.57 million, the amount of a one-time funding increment in FY 2004 that enabled repairs to the Robert C. Byrd Green Bank Telescope and accelerated work on the Expanded Very Large Array (EVLA). This level of support will provide for operations, maintenance, and instrumentation for the Byrd Telescope, the Very Large Array, and the Very Long Baseline Array, for continued improvements and enhancements to the EVLA, and for early operations for ALMA.

Black Hole at the Galactic Center.
Recent work by Dr. Andrea Ghez has solidified the case for a massive black hole at the center of our Galaxy. With NSF support, she has used the orbits of stars near the center of the galaxy to infer the density of the dark mass at the Galactic core. Recently, using adaptive optics, and with a 7 year baseline, she has been able to follow the detailed orbits of a larger sample of fainter stars. One of these stars passes a mere 60 astronomical units from the central dark mass. The orbit of this star increases the constraints on the density of the dark mass by four orders of magnitude over her previous estimates, and eliminates several remaining alternatives to a supermassive black hole. Our own galaxy has now become the strongest case for a normal galaxy containing a supermassive black hole.



Orbit analysis for multiple stars orbiting the Galactic Center increases the implied dark mass density by four orders of magnitude over previous estimates.

CHEMISTRY $188,910,000

The FY 2005 Budget Request for the Chemistry (CHE) Subactivity is $188.91 million, an increase of $3.69 million, or 2.0 percent, over the FY 2004 Estimate of $185.22 million.

Chemistry Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Chemistry	181.61	185.22	188.91	3.69	2.0%
Total, CHE	$181.61	$185.22	$188.91	$3.69	2.0%

The single unifying theme in chemistry is the chemical bond, the bond that links atoms together into myriad forms of matter that define our existence. CHE supports research that enables matter to be manipulated, measured, and modeled through management of chemical bonds. The value of investments in molecular science and technology is evident in the ability to image and position individual atoms and molecules; to watch chemical bonds form and break on time scales as short as femtoseconds; to prepare and screen enormous libraries of chemical compounds for desired characteristics; and to calculate physical and chemical properties of matter with great accuracy. An important basic research frontier is the development of an understanding of weak, non-covalent interactions and their cooperativity. These weak bonds are responsible for the structure of proteins, and they control the assembly of nanostructures. Investments in understanding the structure and reactivity of these complex systems will provide the basis for a detailed understanding of the molecular basis of life processes.

Chemistry directly impacts our daily lives through its contributions to production of food, shelter, clothing, energy, medicine, and countless products that enhance our quality of life. Basic research, education, and instrumentation supported by CHE contribute to environmental quality and to industrial strength through advancements in fundamental knowledge and the professional development of our technical workforce. Approximately three-fourths of the CHE investment supports individual investigators and collaborative research centers, with the balance in instrumentation and human resource development.

Noteworthy developments involving CHE-supported scientists this year included the following:

- One of the recipients of the 2002 National Medal of Science is John Brauman of Stanford University. By comparing molecular reactivity in the absence and presence of solvents, Brauman showed how solvents can dramatically influence the course of chemical reactions, particularly those involving ions. His work has provided a basic framework for understanding and controlling the impact of solvents on chemical reactivity.

- Alan Marshall of Florida State University and the National High Magnetic Field Laboratory has pioneered the use of ultra-high resolution Fourier transform ion cyclotron resonance mass spectrometry for characterizing the tens of thousands of chemical constituents of petroleum. He and his coworkers have coined the term “petroleomics” to describe this remarkable analytical tool that permits characterization of petroleum crude oil and its distillates based on their geochemical origin and method of processing.

- Jay Switzer of the University of Missouri at Rolla and co-workers have created a new process that produces so-called chiral films that are related as left- and right-hand mirror images. Such films can selectively bind the left- or right-handed form of chiral molecules. The researchers grew chiral copper oxide films by electrochemical methods on a gold substrate to demonstrate these effects. Roughly one-third of all pharmaceuticals are chiral, and this new process provides a means of synthesizing and separating pharmaceutical molecules of the correct handedness.

The FY 2005 Request of $188.91 million, an increase of $3.69 million, includes:

- Support for CHE core programs devoted to basic chemical research will grow by $380,000 to $141.45 million in FY 2005. Additional funds will be used largely to increase average grant size and to support principal investigators early in their research careers.

- Support for centers will increase by $2.05 million to $18.90 million. Chemical Bonding Centers (CBCs) will complement smaller, focused Environmental Molecular Science Institutes and Collaborative Research in Chemistry centers by providing support for long-term multi-disciplinary, multi-investigator projects that address grand challenges in the chemical sciences, such as the molecular origins of life processes. Approximately ten CBCs will be supported in an initial phase in FY 2005. These centers will collectively contribute to a more holistic understanding of chemical bonding, while providing insight into molecular processes spanning such interdisciplinary fields as the life sciences, environmental sciences, and nanotechnology.

- New support will be provided for cyberinfrastructure and for mid-scale instrumentation that exceeds what is available in cost and scope through the Chemistry Research Instrumentation and Facilities (CRIF) program and the NSF Major Research Instrumentation program. Pilot projects and workshops that identify appropriate investment strategies will be supported. Support for ruggedized, miniaturized instrumentation that can make workhorse instruments like mass spectrometers and nuclear magnetic resonance spectrometers more accessible will be provided through the CRIF program.

- CHE will support at the level of $2.10 million undergraduate, postdoctoral, and senior scientist programs that draw on the nation's rich geographic, institutional, and demographic diversity. Undergraduate Research Centers (URCs) will support faculty teams working with teams of first- and second-year college students to attract a larger and more diverse group of students to the technical workforce. Additional international Research Experiences for Undergraduates (REU) sites will be supported. Discovery Corps Postdoctoral and Senior Fellowships will enable chemical scientists to combine their research expertise with professional service to address national needs, such as developing the workforce, creating jobs, and building research capacity. These activities will be supported by phasing out existing programs such as Research Sites for Educators in Chemistry.

- The Chemistry Subactivity will continue to support new demonstration projects of special interest to the field of chemistry, especially with respect to better preparing graduate students for competition in the diverse, global workforce. Of particular emphasis will be support of innovative programs that have the potential to increase the participation of underrepresented groups in the chemistry profession. The Subactivity will continue its efforts to develop programs to increase the scope of international collaborations in chemistry research.

MATERIALS RESEARCH $253,180,000

The FY 2005 Request for the Materials Research (DMR) Subactivity is $253.18 million, an increase of $2.29 million, or 0.9 percent, from the FY 2004 Estimate of $250.89 million.

Materials Research Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Materials Research	241.39	250.89	253.18	2.29	0.9%
Total, DMR	$241.39	$250.89	$253.18	$2.29	0.9%

DMR supports research and education to advance the fundamental understanding of materials, to enable the development of materials with superior properties, and to enhance the understanding of the interconnections among synthesis, processing, composition, structure and properties of materials and how these factors affect their performance. Materials research integrates a wide range of activities spanning both science and engineering. It extends from investigations of fundamental phenomena in condensed matter physics and solid-state chemistry to research on functional materials including metals, ceramics, polymers, biomaterials, and electronic, photonic and magnetic materials. Its practitioners include physicists, chemists, materials scientists, and engineers, and, increasingly, it benefits from the participation of researchers from an even wider range of disciplines such as biochemistry, biology, earth sciences, mathematics, computer science, and medicine.

NSF provides about half the total federal support for university-based basic research in materials. The technological and societal significance of the field is far-reaching. DMR supports education, fundamental research and facilities that are critically important to the future advancement of industries and technologies ranging from electronics and communications to information technology, transportation and aerospace, energy, environmental protection, manufacturing, medicine and health care, packaging, and civil infrastructure. More than half of DMR's portfolio consists of support for individual investigators and focused research groups. The balance supports 28 Materials Research Science and Engineering Centers (MRSECs), and experimental facilities for shared use, including the National High Magnetic Field Laboratory (NHMFL), user facilities for x-ray synchrotron radiation and neutron scattering, and a Science and Technology Center in materials and devices for information technology research.

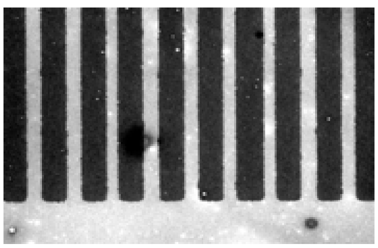
Researchers and educators supported by DMR made exciting progress this year. For example:


WOMEN IN CHEMISTRY
CHEMIST, TEACHER, SCHOLAR, MENTOR

- **Coherent Spin Organization in Nanostructures.** David Awschalom (University of California – Santa Barbara) and Nitin Samarth (Penn State University) have designed new artificial nanostructures that allow electronic spins to be controlled using electric and magnetic fields. The resulting ‘electron spin gate’ is a major step forward towards future ‘spintronic’ devices that may supersede today’s electronic components in computers and communications.

- **Top recognitions to African-American Researchers.** DMR has placed special emphasis on attracting a broad diversity of scientists and educators and helping them develop their scientific careers. This year three African-American grantees are receiving top international recognitions in their fields. Larry Dalton (U. Washington and USC) received the Materials Chemistry Award from the American Chemical Society, the world's largest scientific organization. This is the major research prize in the materials chemistry field worldwide. Joshua Otaigbe (U. Southern Mississippi) has received a major foreign honor, election as a Fellow of the United Kingdom Institute of Materials for contributions of international significance to polymer science and engineering. And Valerie Sheares Ashby, a CAREER grantee at Iowa State University, was featured in the ACS *Chemical & Engineering News* for her superb teaching, mentoring, and scholarly accomplishments.

- **Protein Photoresists.** Although nature provides remarkable examples of the materials properties of proteins (e.g., the strength and elasticity of spider silk), the technological development of protein-based materials has been frustrated by the difficulty of processing proteins and protein-like macromolecules into useful fibers, films and surface coatings. Researchers in the Center for the Science and Engineering of Materials at the California Institute of Technology have recently taken an important step toward solving this problem, by preparing proteins that can be processed by optical lithography techniques. They used amino acids that are sensitive to light to link together individual protein molecules into tough networks that resist dissolution in common solvents.



The FY 2005 Request includes several changes and enhancements:

- DMR will increase support for the NSF Nanoscale Science and Engineering priority area by $14.26 million to $90.95 million in FY 2005. The increment will include support for new individual investigator awards and focused research groups, and for up to three new materials research science and engineering centers (MRSECs).
- DMR support for the Mathematical Sciences priority area and for Biocomplexity in the Environment is unchanged at $1.08 million and $1.0 million, respectively.
- DMR support for cyberinfrastructure will be increased by $600,000 to $7.80 million, enhancing support for computationally-intensive research and education in materials.
- Support for research and education at the interface between materials, the biosciences and bioengineering will be increased by up to $1.0 million.
- Support for the IGERT program will be increased by $300,000 to $2.39 million, and support for the ADVANCE program will be increased by $60,000 to $1.24 million.
- Up to $3.0 million in additional funds will be provided in FY 2005 to support new mid-scale research resources, including synchrotron and neutron beam lines whose cost and scope is beyond that of the NSF Major Research Instrumentation program. This amount includes up to $2.50 million to support beam line instrumentation at the DOE Spallation Neutron Source (SNS).

Funds required for the new and enhanced activities described above total $19.22 million. An increase of $2.29 million is requested for DMR in FY 2005. The additional funds required will be generated by reducing support for Information Technology Research by $4.77 million to $5.23 million in FY 2005, and by reducing support for lower-priority research in individual investigator programs, groups and Centers by up to $12.16 million, equivalent to about 60 fewer awards in these areas. Award size and duration will be maintained at current levels.

MATHEMATICAL SCIENCES $202,250,000

The FY 2005 Request for the Mathematical Sciences (DMS) Subactivity is $202.25 million, an increase of $1.84 million, or 0.9 percent, over the FY 2004 Estimate of $200.41 million.

Mathematical Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Mathematical Sciences	$178.79	$200.41	$202.25	$1.84	0.9%
Total, DMS	$178.79	$200.41	$202.25	$1.84	0.9%

Advances in science and engineering, driven in part by increasingly sophisticated and readily available computing environments, have lifted the mathematical sciences to the forefront of science and engineering, reshaping modern discovery through quantitative predictions, instrumentation development, modeling, visualization, computational algorithms, and optimization methods. Science and engineering are becoming more mathematical and statistical, not only in the physical, engineering and informational sciences, but also the biological, geophysical, environmental, social, behavioral, and economic sciences.

NSF has a crucial role in the support of basic academic research in the mathematical sciences, providing more than 58 percent of all federal university-based support. NSF support involves a broader range of infrastructure and fundamental and multidisciplinary research topics than that sponsored by other federal agencies that support academic mathematical sciences research. Especially important is the critical function of the mathematical sciences in the training of the nation's scientific and engineering workforce.

DMS includes areas such as analysis, geometry, topology, foundations, algebra, number theory, combinatorics, applied mathematics, statistics, probability, biomathematics, and computational mathematics. Awards in these areas support a variety of research projects, multidisciplinary projects, Focused Research Groups, and Research Training Groups with some grants including funding for graduate and postdoctoral students as well as for workshops, computing equipment and other research and education needs. In addition, DMS supports infrastructure efforts across the mathematical sciences, including national research institutes, postdoctoral, graduate, and undergraduate training opportunities, broadened career experiences for researchers, increased participation in the nation's research personnel base, research conferences and workshops, and scientific computing research equipment.

The pervasive nature of the mathematical sciences in underpinning and enabling much of today's scientific, engineering, and commercial activities is illustrated by the following examples:

- Computational and mathematical tools are needed to analyze data from human brain scans. A group involving researchers from Florida State University, the University of Tennessee, and the University of Minnesota is studying a region of the brain that has been implicated in depression and bipolar disease. The group's work is leading to improved mathematical techniques for biomedical applications, while providing timely interdisciplinary training.

- A group based at Duke University and North Carolina State University is studying fundamental problems in the dynamics of thin liquid films and fluid interfaces. These arise in problems ranging from industrial design of paints and microchip fabrication to medical applications including contact lenses and the lining of the lung. Their work has produced and inspired more than sixty papers in connection with the project. The group's work is leading to improved mathematical and computational techniques for many industrial problems, while providing interdisciplinary training experiences for students and postdoctoral researchers.

- Zeta or L-functions are counting devices for the study of the distribution of prime numbers and related issues, and the first and most important example is the subject of the famous Riemann Hypothesis in number theory. An L-function has properties that yield valuable information even though values and roots of the function itself can be difficult to compute. Recent work has exposed ties between prime numbers and some very different objects: (a) statistics of zeros of L-functions seem to agree with statistics of very different objects computed in the physicists' random matrix theory, and (b) recent developments in geometry have established some of the links conjectured thirty years ago between number theoretic L-functions and linear representations of groups.

- Submicron-sized magnetic elements have found a wide range of applications, particularly as information storage, and are being explored as alternative random access memory devices. As the elements get smaller, the effect of thermal noise becomes more significant and the data retention time an increasing concern. It is expected that the limit below which thermal effects simply prevent data retention will affect the magnetic recording industry in the next five to ten years. Researchers from New York University and Princeton University have developed a technique for certain systems with computational advantages in terms of efficiency and flexibility.

- A researcher at the University of California has led a project to accurately predict wildfire hazard, to assess the uncertainty in these estimates and to determine how various meteorological and environmental variables are related. This has resulted in better ways of combining Burning Index (BI) records from different weather stations to obtain more accurate estimates of wildfire risk. Since the BI is used as a predictor, optimally using this information is critical.

The FY 2005 Budget Request of $202.25 million will enhance interdisciplinary research groups and other collaborative mechanisms that integrate the mathematical sciences with chemistry, materials research, physics, astronomy and other sciences and engineering.

Of special importance is the Mathematical Sciences priority area investment of $67.39 million, which is maintained at the FY 2004 Estimate. The Mathematical Sciences priority area reflects the importance of the mathematical and statistical sciences in the kinds of crosscutting science and engineering research areas described above.

The FY 2005 increase in DMS will support:

- Maintaining the investment in focused mathematical sciences research teams, interdisciplinary training groups, and other collaborative mechanisms related to advancing science and engineering.

- Enhancement of the national institutes in the mathematical sciences that address the growing interface with other disciplines and the mathematical and statistical problems whose solutions will contribute to both fundamental knowledge and national needs.

- Enhancement of research training activities in the mathematical sciences and mentoring activities aimed at increasing the number of U.S. students choosing careers in the mathematical sciences. This will be achieved by redistributing funding of other targeted investments in people.

PHYSICS $235,760,000

The FY 2005 Request for the Physics Subactivity is $235.76 million, an increase of $8.09 million, or 3.6 percent, over the FY 2004 Estimate of $227.67 million.

Physics Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Physics	$224.50	227.67	235.76	$8.09	3.6%
Total, PHY	$224.50	$227.67	$235.76	$8.09	3.6%

The Physics Subactivity (PHY) supports fundamental research in a broad range of physical phenomena, including: atomic, molecular, optical, and plasma physics; elementary particle physics; gravitational physics; nuclear physics; particle and nuclear astrophysics; and theoretical physics. Physics also supports interdisciplinary research, including: biological physics, complex systems, turbulence, and other developing interface areas associated with the core disciplines, for example the interface with information technology. The impact of physics research extends far beyond physics as a result of the discovery of new phenomena and the development of new techniques and basic tools that advance other fields, e.g., laser technology, biomedical technology, information technology, nanotechnology, energy science, including nuclear science, and many other techniques used in high technology industries.

Typical awards include funding for faculty salary support, graduate students, postdoctoral associates, instrumentation development, and other research needs. PHY supports an increasingly vigorous effort in the integration of research and education, including support of the Research Experiences for Undergraduates (REU) program, the Faculty Early Career Development Program (CAREER), and important and innovative new outreach efforts aimed at improving links to K-12 teachers and students. The REU program continues to be very successful at reaching underrepresented minorities and women.

PHY provides support for a large portion of university-based research in the physics sub-disciplines, ranging from nearly 100 percent for gravitational physics to 30-50 percent for the other physics programs. The scope of support ranges from individual investigator awards for research based at the investigator’s home institution, to awards to major user groups with responsibility for experiments at national or international user facilities, such as the Large Hadron Collider (LHC) at CERN. PHY also supports centers and institutes in many areas and national user facilities for certain subfields. The user facilities represent important elements of the national infrastructure: in elementary particle physics, the Cornell Electron Storage Ring (CESR); in nuclear physics, the Michigan State University National Superconducting Cyclotron Laboratory; and in gravitational physics, the Laser Interferometer Gravitational-Wave Observatory (LIGO). Center activities include: support for Physics Frontiers Centers, including centers in the areas of biological physics, cosmological physics, gravitational physics, coherent ultrafast optical science, plasma physics, nucleosynthesis, and the structure and origin of matter, the latter at an HBCU (Historically Black College or University); and a Science and Technology Center (STC) in biophotonics.

A newly discovered double neutron star system has boosted predictions of rates for gravitational wave events for possible detection by LIGO. The first-known binary neutron star system, PSR 1913+16, yielded the first indirect detection of gravitational waves. To compensate for gravitational wave energy loss, the two neutron stars fall together and orbit faster. This system is thus a precursor of the coalescing neutron star binaries that form a primary target for LIGO. The estimates of rates of such events within LIGO's range extrapolate from the number of precursors known in our own galaxy to the likelihood of more advanced systems in the galaxies accessible to LIGO. Recently, an international team of radio astronomers has discovered a new, closer, binary neutron star system, PSR J0737-3039, with even stronger gravitational effects. Vicky Kalogera, at Northwestern University, and her collaborators, calculated the implications of the new system for LIGO raising the predicted rates by a factor of 6 to 7 for the most optimistic estimates of events within LIGO's reach.

PHY oversees three major projects whose construction was or is expected to be funded through the Major Research Equipment and Facilities Construction (MREFC) Account. The ATLAS and CMS detectors for the LHC received construction funding from FY 1999 through FY 2003 (see the MREFC chapter for additional information). Partial operation of these LHC detectors is supported through the PHY Subactivity. LIGO, whose construction was also funded through the MREFC Account, is fully operational in FY 2004, with all interferometers operating in coincidence (the 2- and 4-km interferometers at Hanford and the 4-km interferometer at the Livingston site (see the Tools chapter for additional information). Planning activities for the Rare Symmetry Violating Processes (RSVP) project will be undertaken in the PHY Subactivity in FY 2004 at the Likely Enacted level and this project is proposed in the MREFC Account in FY 2005 (see MREFC chapter for more information).

The recent National Research Council (NRC) report "Connecting Quarks with the Cosmos" provided major impetus to expand support of research on Physics of the Universe at the interface between physics and astronomy. Examples of areas to be emphasized in FY 2005 include: numerical relativity and theoretical cosmology, new activities to investigate dark energy, dark matter, neutrino physics, and cosmic microwave background radiation, and awards for additional new projects at the interface of physics and astronomy. Other subfields intended for emphasis include biological physics, computational physics, and nanoscale science. In concert with other MPS Subactivities, especially AST, PHY will continue its emphasis on support for mid-scale instrumentation such as, moderate-scale neutrino, cosmic ray and gamma ray detectors, and the development of resources such as grid computing which serve the data requirements of several information-intensive physics and astrophysics experiments.

The FY 2005 Request for PHY includes:

- An increase of $8.24 million in research projects and centers to a total of $142.38 million. PHY will continue to support forefront areas of physics, with expanded emphasis on projects at the interface between physics and astronomy as recommended in the NRC report "Connecting Quarks with the Cosmos." Additional areas slated for increases include biological physics, computational physics, and fundamental nanoscale studies. Education and outreach activities will receive continued emphasis: enhancing K-12 science teacher training, expanding diversity within the research community, integrating research and education, and broadening the role physics plays in new and emerging areas of research, including the training of young physicists.

- A decrease of $1.30 million for facilities to a total of $78.35 million includes: an increase of $1.70 million for CESR operations to a total of $19.70 million, to enable exploration of critical weak and strong elementary particle interaction phenomena and to sustain important accelerator physics research activity at Cornell; an increase of $2.0 million for early operations of the LHC ATLAS and CMS detectors for a total of $9.0 million; continued support for full operations of LIGO and for advanced detector R&D at a total of $33.0 million; an increase of $1.0 million for operations of Michigan State University's National Superconducting Cyclotron Laboratory radioactive ion beam facility for a total of $16.65 million; and, a decrease of $6.0 million for planning activities for RSVP as funding for this construction project is requested through the MREFC Account in FY 2005.

MULTIDISCIPLINARY ACTIVITIES $31,050,000

The FY 2005 Budget Request for the Multidisciplinary Activities Subactivity is $31.05 million, an increase of $280,000, or 0.9 percent, over the FY 2004 Estimate of $30.77 million.

Multidisciplinary Activities
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Multidisciplinary Activities	27.34	30.77	31.05	0.28	0.9%
Total, OMA	$27.34	$30.77	$31.05	$0.28	0.9%

The Multidisciplinary Activities Subactivity (OMA) enables MPS support of novel, challenging, or complex projects of varying scale in both research and education that are not readily accommodated by traditional organizational structures and procedural processes. This is done primarily in partnership with the five other MPS Subactivities to encourage multidisciplinary proposals from all segments of the MPS community and especially to encourage initiatives by multi-investigator, multidisciplinary teams pursuing problems on a scale that exceeds the capacity of individual investigators. Most often, these cooperative undertakings involve two or more partners – both from MPS and beyond – that join with OMA to push in new directions of scientific understanding and that broaden and enrich education and research training activities in the MPS disciplines. Examples of such multi-investigator, multidisciplinary and often multi-institutional projects facilitated by OMA include the Very Energetic Radiation Imaging Telescope Array System (VERITAS), a multidisciplinary, ten-institution, two international-partner cooperative undertaking to develop an array of four twelve-meter aperture telescopes for the study of high energy gamma rays; the Atacama Cosmology Telescope (ACT), a multidisciplinary five-institution, multi-agency, international partnership to develop the capability to probe more deeply fundamental physics through observations of cosmic structure; and initial awards for the establishment of Physics Frontier Centers and for Undergraduate Research Centers in Chemistry.

OMA facilitates partnerships between MPS and other NSF activities, other agencies, industry, national laboratories, state and local governments, and international organizations. Such partnerships are critically important to the pursuit of the strategic goals of the Foundation and of the MPS community and contribute significantly to the preparation of a diverse workforce for the new century that is broadly trained, flexible, and globally competitive. Facilitation by OMA of both disciplinary partnerships and organizational partnerships is vital to the accelerated discovery of new ideas, the development of new tools, and the broadened training necessary to enable the nation's workforce to meet new and rapidly evolving demands. Examples of the importance of such partnerships are seen in CHEPRO, the Inter-Regional Grid-Enabled Center for High Energy Physics Research and Educational Outreach at Florida International University, a multidisciplinary, multi-directorate cooperative activity that encompasses an integrated program of high energy physics research, network infrastructure development, and education and outreach at one of the largest minority-serving institutions in the U.S.; in the Grant Opportunities for Academic Liaison with Industry (GOALI) program; and in the U.S.-Europe and U.S.-Americas cooperative international research and research training activities in materials research.

The Subactivity supports innovative experiments in physical science and mathematics education that could lead to new paradigms in disciplinary and multidisciplinary graduate and undergraduate education. It also is a focal point within MPS for activities to facilitate the development of a diverse and globally competitive workforce. The MPS research infrastructure serves as a resource to enhance K-12 teaching cohort and broaden the discovery-based learning experiences of K-16 students, and to draw upon MPS-supported research as an effective platform for public science education. Examples of OMA investment in these educational arenas include support for Research Experiences for Teachers (RET), which provides in-service and pre-service K-12 teachers with discovery-based learning experiences in the MPS disciplines and which has benefited more than one thousand K-12 teachers since its inception in FY 1999; support, in partnership with the Education and Human Resources Activity (EHR), of the multidisciplinary Center for the Integration of Research, Teaching, and Learning at the University of Wisconsin which, in collaboration with Michigan State University and Pennsylvania State University, is preparing graduate students, postdoctoral researchers, and current faculty to meet the challenges of STEM higher education; support, in partnership with both the Biological Sciences and the EHR Activities, of multidisciplinary activities to enrich the mathematical sciences content of the undergraduate curriculum in the biological sciences as well as the biological sciences content of the undergraduate curriculum in the mathematical sciences; and support for Internships in Public Science Education (IPSE), a program that brings recent science results from MPS-supported research to the public by promoting partnerships between the MPS research community and specialists in public science education.

In FY 2005, OMA will continue to work with other MPS Subactivities and programs across the Foundation with an emphasis on fundamental research on physics of the universe and on fundamental research on the molecular basis of life processes.

The FY 2005 Budget Request includes:

- Support for the Research Experiences for Teachers (RET) program that will be increased by $500,000 to $2.50 million. In partnership with the EHR Activity, an assessment of the impact of this program will be carried out.

- Increased support for the GK-12 program in the amount of $100,000 to a total of $2.50 million.

- Support for research partnerships with the other MPS Subactivities that attract and retain individuals from traditionally underrepresented groups into doctoral programs in the MPS disciplines will be increased by $250,000 to a total of $1.25 million.

- Support of cooperative international research and training activities will be increased by $350,000 to enhance the global competitiveness of U.S. scientists, engineers, and students. Activities such as the MPS Distinguished International Postdoctoral Research Fellowship program enable graduate students, postdoctorals, and faculty in the MPS disciplines to carry out research at the world's leading facilities and laboratories to develop and to enrich essential international dimensions of their individual research and education programs.

- Support for activities that draw upon the extensive MPS research investment for public science education will be increased by $600,000 to a total of $3.30 million. The MPS Internships in Public Science Education activity supports partnerships between MPS researchers and the public science education communities, with focused emphasis on MPS-supported research centers and facilities.

- Investment in research by multidisciplinary groups of scientists, mathematicians, and engineers leading to the development of next-generation instrumentation, particularly mid-scale instrumentation, will be made at the level of $1.0 million. Such instrumentation integrates modeling, computation and measurement to enable fundamental advances and broad training across a wide spectrum of disciplines.

SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES

SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES $224,710,000

The FY 2005 Budget Request for the Social, Behavioral, and Economic Sciences (SBE) Activity is $224.71 million, an increase of $20.92 million, or 10.3 percent, above the FY 2004 Estimate of $203.79 million.

Social, Behavioral, and Economic Sciences
(Dollars in Millions)

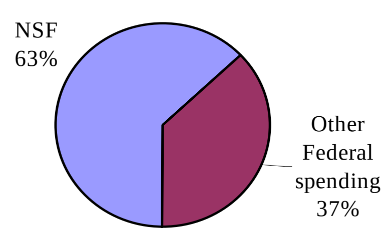
	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Social and Economic Sciences	71.01	81.02	88.52	7.50	9.3%
Behavioral and Cognitive Sciences	62.32	68.50	76.00	7.50	10.9%
Science Resources Statistics	25.31	26.15	26.15	0.00	0.0%
Total, SBE without OISE	**$158.63**	**$175.67**	**$190.67**	**$15.00**	**8.5%**
Office of International Science and Engineering (OISE)[1]	$39.97	$28.12	$34.04	$5.92	21.1%
Total, SBE with OISE	**$198.60**	**$203.79**	**$224.71**	**$20.92**	**10.3%**

Totals may not add due to rounding.
[1]FY 2003 Actual includes a transfer of $12.83 million from the Department of State for an award to the U.S. Civilian Research and Development Foundation.

The Social, Behavioral, and Economics Sciences (SBE) Activity supports research, infrastructure and education in the social, behavioral, cognitive and economic sciences, primarily through grants to investigators at universities and other institutions. The research it supports has resulted in substantial advances in our understanding of human and social development and of how people behave, both as individuals and as parts of groups and other more formal organizations. SBE also supports the collection and dissemination of statistics on the science and engineering enterprise. In addition, NSF's Office of International Science and Engineering is based in the SBE Directorate, and the FY 2005 Request is discussed later in this section.

RELEVANCE

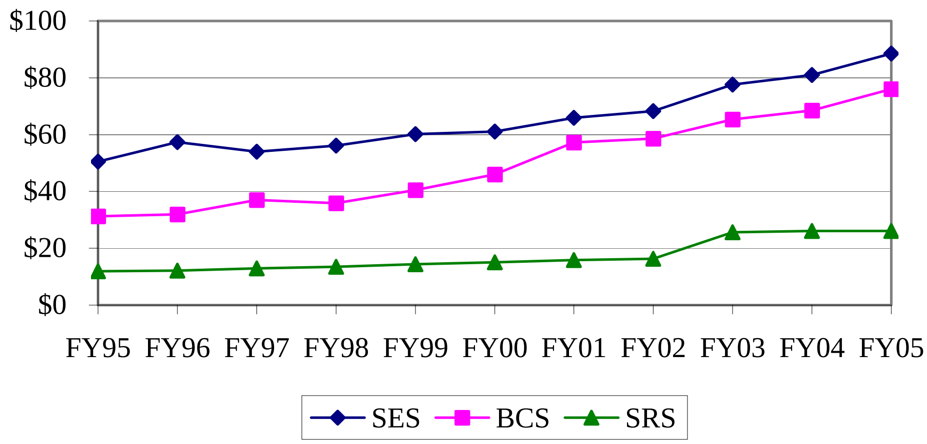
Federal Support for Basic Research in the Social Sciences at Academic Institutions
(excludes the Psychological Sciences)



SBE is a principal source of federal support for fundamental research on human cognition and behavior and social structures and social interaction, as well as for research on the intellectual and social contexts that govern the development and use of science and technology. Overall, SBE accounts for 63 percent of federal support for basic research in the social sciences at U.S. academic institutions. In some fields, including anthropology, archaeology, political science, economics, sociology and the social aspects of psychology, it is the predominant or exclusive source of federal support for basic research and infrastructure development. Critical federal research and development (R&D) investment priorities, including homeland and national security, economic prosperity, integrating research and education, and environmental quality are rooted in the kinds of behavior the SBE sciences seek to understand.

The Science Resources Statistics subactivity within SBE is the Federal statistical agency responsible for the compilation and analysis of data on the science and engineering enterprise. Major components are surveys of the science and engineering workforce and their education and on the nation's research and development portfolio. The results of this work are used to assess the state of the nation's domestic workforce in S&E, its ability to compete globally and the outlook for the nation's research capacity, as well as providing critical benchmarking information on cyberinfrastructure in the research and biomedical communities. Findings from SRS studies have long been important to the development of the nation's educational and science policy agendas.

SBE Subactivity Funding
(Dollars in Millions)

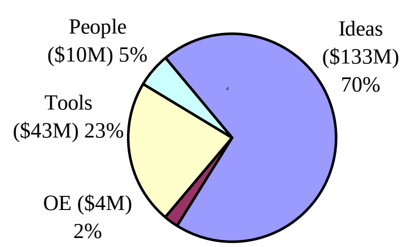


Note: Excludes funding for the Office of International Science and Engineering (OISE).

STRATEGIC GOALS

SBE works to advance the Activity's programs by linking NSF's four strategic outcome goals of People, Ideas, Tools, and Organizational Excellence:

FY 2005 SBE Strategic Goals



PEOPLE: SBE seeks to advance its mission by creating research experiences for undergraduates that engage them in the SBE sciences, by providing graduate students with funds to improve their dissertation research, by helping junior faculty become innovative researchers and teachers, and by funding mid-career training of social scientists in emerging, cutting-edge methodologies. Graduate training also is supported. SBE seeks to enhance diversity through special fellowship competitions; outreach to Historically Black Colleges and Universities (HBCUs), Hispanic, and other minority-serving organizations; and through programs that respond to the need for women in science. SBE's mission supports the overall national goal of maintaining the adequacy, supply and capacity of the R&D enterprise, as well as the broader S&E workforce.

IDEAS: SBE supports fundamental, cutting-edge research in the social, behavioral and economic sciences to better understand individual, collective and organizational behavior. Research in economics, sociology, political science, decision-making, and risk analysis yields theories and information that advance basic science and provide important social benefits in the form of better-informed public policy, more efficient business management, sensible economic and regulatory action, and knowledge that enables wiser individual behavior. Research findings in the psychological, cognitive, anthropological, and geographic sciences yield a sharper picture of human cognition, action, and development, with diverse implications ranging from knowledge regarding how people interact with the environment to groundwork for devices that help disabled individuals overcome their handicaps and become more independent and productive members of society.

TOOLS: SBE seeks to develop knowledge and resource infrastructures that will allow better measurement and analysis of variables that shape and reflect human and organizational decision-making and behavior. SBE also works to meet the statistical demands of a diverse user community interested in the nation's science, engineering, and technology enterprise by providing and disseminating knowledge through survey development, data collection and analysis, information compilation and dissemination, and customer service.

ORGANIZATIONAL EXCELLENCE: Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

SBE's support for ongoing core and new activities contributes to NSF's efforts to achieve its strategic goals and to the administration and management activities necessary to achieve these goals.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	9.49	10.44	10.44	0.00	0.0%
Ideas	107.05	122.27	133.27	11.00	9.0%
Tools	38.96	39.44	43.44	4.00	10.1%
Organizational Excellence	3.13	3.52	3.52	0.00	0.0%
Total, SBE	$158.63	$175.67	$190.67	$15.00	8.5%

PEOPLE (unchanged at $10.44 million)

SBE People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Individuals	8.27	8.49	8.49	0.00	0.0%
Institutions	0.80	1.43	1.43	0.00	0.0%
Collaborations	0.42	0.52	0.52	0.00	0.0%
Total, SBE People	$9.49	$10.44	$10.44	$0.00	0.0%

SBE regards research and education as mutually reinforcing. The people supported represent both the focus of our investments and important products of them. In FY 2005, it is estimated that SBE programs will provide support for about 4,360 people, including students, researchers, postdoctorates, and trainees.

INDIVIDUALS

Major SBE investments in FY 2005 include Integrative Graduate Education and Research Traineeships ($4.30 million), Faculty Early Career Development Program Awards ($2.65 million), and providing Research Experiences for Undergraduates Supplements ($1.54 million).

INSTITUTIONS

In the area of institutional support, SBE continues funding ADVANCE awards at a level of $1.43 million to enable increased representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce.

COLLABORATIONS

In FY 2005, funding for Model Institutions of Excellence continues at $420,000 and SBE also continues support for the GK-12 program at $100,000.

IDEAS (+$11.00 million, for a total of $133.27 million)

SBE Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	100.68	113.37	120.87	7.50	6.6%
Centers Programs	5.93	8.20	11.70	3.50	42.7%
Capability Enhancement	0.44	0.70	0.70	0.00	0.0%
Total, SBE Ideas	$107.05	$122.27	$133.27	$11.00	9.0%

SBE promotes NSF's strategic outcome goal of Ideas through a broad range of research support encompassing the social and behavioral science disciplines. Support for discoveries at and across the frontiers of science and engineering, connected to learning, innovation and service to society extends over SBE's entire portfolio.

FUNDAMENTAL SCIENCE AND ENGINEERING

SBE will provide $59.80 million for fundamental research in the social and economic sciences in FY 2005, an increase of $4.50 million over FY 2004. Research in the social and economic sciences explores the complexities of economic, legal, political, and social behavior, advances risk analysis and the science of decision-making, examines the evolution and social implications of science and technology, and develops and disseminates research methods and data resources across the social and behavioral sciences. During FY 2005, areas of emphasis will include causes, consequences and responses to social system shocks; cognitive aspects of decision-making; innovation in the development of mathematical models;

dynamic aspects of organizations, the economy and other social institutions; and building and maintaining infrastructure, with special attention to longitudinal and repeated cross-section surveys.

In FY 2005, SBE will provide $59.07 million for fundamental research in the behavioral and cognitive sciences, an increase of $3.0 million over FY 2004. Fundamental research supported by SBE in the behavioral and cognitive sciences advances basic scientific knowledge, methods, and capabilities in the behavioral, cognitive, anthropological, and geographic sciences. Special emphases for FY 2005 include research on cognition, the disparate involvement of members of different groups in the scientific workforce of the nation, explorations of what makes people human, and human interactions with the natural environment over space and time.

Funding for the Interagency Education Research Initiative (IERI) will continue at the FY 2004 funding level of $2.0 million. Across SBE activities, there will be an increase in the average award size to $95,829 and average duration to 2.4 years, from $93,248 and 2.4 years in FY 2004.

<u>CENTERS PROGRAMS</u>

In support of the Ideas goal, SBE funds the following centers:

SBE Centers
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Long-Term Ecological Research Sites	0.20	0.20	0.20	0.00	0.0%
Children's Research Initiative Centers	2.50	2.50	2.50	0.00	0.0%
National Consortium for Violence Research	1.00	1.00	1.00	0.00	0.0%
Human Dimensions of Global Change Centers	2.23	0.00	0.00	N/A	N/A
Environmental Social and Behavioral Science Centers	0.00	0.00	3.50	3.50	100.0%
Climate Change Research Initiative Centers	0.00	4.50	4.50	0.00	0.0%
Total, Centers Support	$5.93	$8.20	$11.70	$3.50	42.7%

Totals may not add due to rounding.

In partnership with the Directorate for Biological Sciences, SBE will maintain combined support in FY 2005 at a level of $200,000 for the two Urban Long-Term Ecological Research (LTER) sites. These Urban LTER sites examine the complex interactions of human activity and the natural environment in the Baltimore and Phoenix metropolitan areas.

The Children’s Research Initiative (CRI) supports a variety of research activities, including small research centers, individual investigator awards, collaborative proposals, and workshops. Five CRI research centers, each of which receives approximately $500,000 per year for five years, represent a new thrust in the field of integrative developmental science; supporting cutting-edge research about children and media, developmental science, and the integration and dissemination of developmental science to inform both research and policy.

The National Consortium on Violence Research (NCOVR), based at Carnegie Mellon University, is engaged in a program that focuses on training the next generation of researchers in interdisciplinary approaches to understanding interpersonal violence and on increasing the participation of underrepresented groups in research on violence. NCOVR also seeks to facilitate collaborative methodological and cross-disciplinary research.

Following a new competition, NSF will provide support for two or three centers that advance fundamental knowledge about Environmental Social and Behavioral Science; promote education and training at levels ranging from undergraduate to postdoctoral; and foster interdisciplinary and multidisciplinary research collaborations. Activity in these centers will build on groundwork laid by the Human Dimensions of Global Change centers and represents a $1.20 million increase from the level that supported these centers in FY 2003, the final year of their core funding.

Social and Economic Sciences will continue support for three to five centers focusing on Decision Making Under Uncertainty related to climate variability and change as part of the government-wide Climate Change Research Initiative. These centers involve interdisciplinary teams that advance understanding of all facets of decision-making processes related to climate change and other problems for which information exists but uncertainty remains. Centers also increase knowledge of the content and form of information needed by decision makers, increase their ability to make sound decisions over multiple time scales, and facilitate interaction among researchers and decision makers, thereby increasing the speed with which new research findings are adopted and used by decision makers.

CAPABILITY ENHANCEMENT

IN FY 2005, SBE will continue funding capability enhancement activities, which include Research in Undergraduate Institutions funding at $600,000 and Research Opportunity Awards funding at $100,000.

TOOLS (+$4.00 million, for a total of $43.44 million)

SBE Tools Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Infrastructure and Instrumentation	38.96	39.44	43.44	4.00	10.1%
Total, SBE Infrastructure & Instrumentation	$38.96	$39.44	$43.44	$4.00	10.1%

SBE promotes the development of Tools as it directs resources to research-enhancing investments such as web-based collaboratories, digital libraries, and databases, including science resources data and analysis. Special attention is paid to enhancements permitted by new information technologies.

INFRASTRUCTURE AND INSTRUMENTATION

SBE provides $23.92 million for the Tools part of the Science Resources Statistics Subactivity, level with FY 2004. This enables NSF to fulfill its statutory mandate to produce data and analysis on the scientific and engineering enterprise. In FY 2005, funds will support ongoing statistical data collections on the S&E enterprise, including implementing quality improvements to surveys on the S&E workforce. Funds will support the development of an ongoing data collection program on research instrumentation, as mandated by Congress. Support will be provided to begin researching means of implementing necessary enhancements to the Industry R&D Survey as well as to continue activities to establish an ongoing data series on postdoctorates.

SBE will provide an additional $4.0 million for a total of $19.52 million for research resources. These funds will support fundamental research infrastructure, including major longitudinal and repeated cross-section surveys and secure data enclaves. These resources are crucial to understanding the causes of such phenomena as changing patterns of employment, attitude formation, and patterns of family formation. These funds will also support investments in cyberinfrastructure, including digital libraries, collaboratories, and other applications of modern information technology that link scholars and students with databases and with each other, across universities and internationally. Such links allow people in predominantly undergraduate institutions, HBCUs, other minority serving institutions and institutions in EPSCoR states to participate in research that was once largely confined to major research universities.

ORGANIZATIONAL EXCELLENCE (unchanged at $3.52 million)

Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions.

PRIORITY AREAS

In FY 2005, the SBE Activity will continue support of research and education efforts related to each of the NSF priority areas.

SBE Investments in Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Biocomplexity in the Environment	0.95	2.00	2.00	0.00	0.0%
Nanoscale Science and Engineering	2.32	1.56	1.50	-0.06	-3.8%
Mathematical Sciences	1.43	1.50	1.50	0.00	0.0%
Human and Social Dynamics	4.46	15.90	15.90	0.00	0.0%

Biocomplexity in the Environment: In FY 2005, SBE will maintain its support for BE at $2.0 million. These funds will contribute to NSF's centralized competition to support research on complex interactions among coupled human and natural systems at diverse spatial, temporal, and organizational scales.

Nanoscale Science and Engineering: Support for this priority area decreases slightly from the FY 2004 level of $1.56 million to $1.50 million. This will continue support for research in the social, behavioral and economic sciences on factors that stimulate nanoscientific discovery, ensure the responsible development of nanotechnology, and enhance human performance.

Mathematical Sciences: In FY 2005, SBE continues funding for Mathematical Sciences at $1.50 million, level with FY 2004. These funds will support development of collaborative teams of social/behavioral and mathematical/statistical scientists to develop new mathematical statistical techniques that will advance research in the social and behavioral sciences. Innovative training activities also will be supported.

Human and Social Dynamics: In FY 2005, SBE maintains support for the Human and Social Dynamics priority area at a level of $15.90 million. With other NSF Directorates, SBE will promote major scientific advances through the use of new research tools and new data and by extending prior research of proven utility using new methods or different perspectives. Support will be provided for research that focuses on one or more of the following thematic areas: agents of change, the dynamics of human behavior, and decision-making and risk. Support will be provided also for methodological capabilities in spatial social science and for instrumentation and data resources infrastructure.

QUALITY

SBE maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. Ninety-seven percent of SBE's basic and applied research funds were allocated to projects that underwent merit review in FY 2003, the last year for which complete data exist.

NSF uses various internal and external mechanisms to review the relevance of proposed and existing programs to help the Directorate identify emerging opportunities and goals for the future. The Advisory Committee for the Social, Behavioral and Economic Sciences provides advice on such issues as: the mission, programs, and goals that can best serve the scientific community; how SBE can promote quality graduate and undergraduate education in the social, behavioral, and economic sciences; and priority investments in these research areas. The committee meets twice a year and members represent a cross-section of social, behavioral, and economic sciences; a cross-section of institutions including industry; broad geographic representation; and balanced representation of women and minorities.

To ensure the highest quality in processing and recommending proposals for awards, SBE convenes Committees of Visitors (COVs), composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments. In FY 2003, SBE had a COV for the programs in the BCS Subactivity and SRS commenced a COV with the Committee on National Statistics of the National Academy of Sciences to review the existing R&D data collection and analysis program. In FY 2004, the Social and Economic Sciences subactivity will have COV reviews for each of its programs. Internal and external review mechanisms also include National Academy of Sciences reports, blue ribbon panels, workshops, long-range planning documents, and other reviews.

PERFORMANCE

Recent Research Highlights

Auctions for Multiple Items. Lawrence Ausubel, Peter Cramton, and Paul Milgrom have analyzed the theoretical properties of existing multiple-item auction formats, proposed new efficient auction formats for multiple items, designed new applications for multiple-item auctions, and empirically evaluated recent applications of auctions for spectrum and electricity. In particular, they have developed the properties of package bidding, a new, efficient ascending auction for heterogeneous commodities; and they have extended the analysis of auctions for homogenous commodities in environments with interdependent values. The project contributes to a new and important area of market design. A theory of multiple items auction can be applied to several industries: sale of radio spectrum, emission trading and greenhouse gases, e-commerce, electricity, and new financial securities. This work enhances our ability to use auctions efficiently to allocate scarce resources and has influenced the Federal Communication Commission's auction design and the design of other high stakes auctions throughout the world.

Research Results Used in FCC Spectrum Auction Design

Eyewitness Identification. In a series of experiments involving staged "crimes," Gary Wells explores the implications of confirming feedback on the certainty with which eyewitnesses identify innocent suspects. Wells found that when given confirming feedback, half of those eyewitnesses who had mistakenly identified someone reported they were very certain of their wrong identifications compared to only 12 percent of those in the no feedback condition. These findings were used to help New Jersey reform its police lineup procedures so that now lineups in New Jersey are conducted by people who do not know which person in the lineup is the suspect, and other police departments are considering similar changes. Earlier NSF-supported work by Wells, which revealed that sequential lineups did as well at identifying true suspects as simultaneous lineups but with fewer wrong identifications, has also improved lineup procedures in New Jersey and in other jurisdictions. Practices derived from this research diminish the chance that innocent persons will be wrongly convicted of crimes and increase the likelihood that the police will keep investigating until they identify true perpetrators.

Advanced Training Institutes in Social Psychology. SBE is supporting Advanced Training Institutes in Social Psychology that provide quality training in new methodologies, statistical procedures, and other tools to support and enhance social psychological research. NSF funding helps to establish training institutes where researchers can spend time acquiring basic skills and knowledge. One institute provides training in the use and development of immersive virtual environment technology. Another institute focuses on the use of Internet technology to conduct social and behavioral science research. A third institute offers instruction in newly developed statistical methods for understanding social relations.

Predicting Avalanches. The SBE geography program is supporting research that examines how spatial variations in snow stability and snowpack properties affect the stability of the snow, thereby increasing basic understanding and increasing capabilities to predict avalanches. NSF-supported researchers at Montana State University are using a new snow stability test and a sensitive instrument to measure temporal changes in snow stability. Through their analyses, the researchers will add to knowledge about how the snowpack evolves and how avalanches release. The research will provide critically relevant insights for avalanche professionals working to protect life and property. The researchers are working with a U.S. Forest Service-related network of snow specialists at ski areas throughout the nation. The results of this research will be transmitted to these snow specialists, thereby improving avalanche mitigation efforts that protect ski areas and highway corridors.

Geographer Karl Birkeland uses a new microsensor to determine spatial patterns of snow stability

Strengthening Protection of the Confidentiality of Data Collected by SRS Surveys. The Division of Science Resources Statistics (SRS) ensures the confidentiality of respondents who provide information to SRS surveys. Historically, SRS data collected from individuals have been covered under the Privacy Act. SRS data collected from establishments have been, to some extent, covered under the National Science Foundation Act. Working with Foundation legal staff, the recently enacted revision to the NSF Act, as well as the newly enacted Confidential Information Protection and Statistical Efficiency Act, has improved confidential protection covering all data collected by SRS. The legislation also provides clearer language to justify providing researchers the opportunity to work with micro data files under a secure and structured agreement. The results of these efforts will include broader and more complete data usability for researchers and stronger penalties for misuse of confidential data.

Other Performance Indicators

The tables below show the growth in the number of people benefiting from SBE funding, and trends in award size, duration and number of awards.

Number of People Involved in SBE Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	1,726	1,847	1,951
Other Professionals	324	347	366
Postdoctorates	114	122	129
Graduate Students	1,136	1,216	1,284
Undergraduate Students	559	598	632
Total Number of People	3,859	4,130	4,362

SBE Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	894	925	951
Funding Rate	25.6%	26.0%	26.0%
Statistics for Research Grants:			
Number of Research Grants	516	534	549
Funding Rate	21.0%	21.0%	21.0%
Median Annualized Award Size	$79,000	$81,700	$84,000
Average Annualized Award Size	$90,131	$93,248	$95,829
Average Award Duration, in years	2.3	2.4	2.4

SOCIAL AND ECONOMIC SCIENCES $88,520,000

The FY 2005 Budget request for the Social and Economic Sciences (SES) Subactivity is $88.52 million, an increase of $7.50 million, or 9.3 percent, over the FY 2004 Estimate of $81.02 million.

Social and Economic Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Social and Economic Sciences	71.01	81.02	88.52	7.50	9.3%
Total, SES	$71.01	$81.02	$88.52	$7.50	9.3%

The SES Subactivity supports the scientific study of economic, legal, political, and social systems and the institutions that comprise them, including business, governmental and voluntary organizations, job and product markets, and social networks that range from family relationships to terrorist cells. It also supports research on risk analysis and decision-making, on the social and ethical aspects of scientific and technological production and on methods and models that apply across the social and behavioral sciences. SES also fosters education and builds and maintains core social science infrastructure.

The issues SES researchers investigate are complex, challenging and important because the aim is to unravel the causes of collective behavior and understand the ways that social forces impinge on, shape and are shaped by individual and organizational action. Working toward these aims increasingly requires the use of cutting edge quantitative and qualitative methods, meticulously gathered large data sets and interdisciplinary approaches that cross not just the social sciences but behavioral and other science boundaries as well. The payoff is high, as important social problems can be informed by the research of SES scientists. To give just a few examples:

- Robert Engle of New York University and Clive Granger of the University of California at San Diego, the most recent Nobel Prize winners in Economics, each received SES support at crucial points in their careers. This support led to major breakthroughs in statistical methods for estimating time variant economic relationships, and paved the way for fundamental advances in our understanding of the relations between wealth and consumption, exchange rates and price levels, and short and long-term interest rates. Practical manifestations include providing financial institutions with tools to compute market risks for their securities portfolios and enabling international arrangements that control bank capital requirements to reduce the danger of international financial crises.

- Duncan Watts, a sociologist at Columbia University, is using an NSF CAREER award to advance the science of network analysis. His published work relates network structures to such national concerns as terrorism and disease and suggests ways to counter network-dependent threats. His work also contributes to fields as far removed from the social sciences as biology and physics.

- Jennifer Lerner, a psychologist and decision scientist at Carnegie Mellon University, is engaged in a series of studies aimed at better understanding the role of emotion in how people evaluate and respond to risk. For example, she and several of her colleagues found that action preferences following 9/11 differed dramatically depending on whether one was made mostly angry or mostly fearful by what transpired. Her line of research should lead to a more adequate theory on the role of emotions in risk evaluation and decision-making and promises to substantially enrich our understanding of why individuals decide differently when confronted with similar risks and risk data.

- Robert Axelrod, a political scientist at the University of Michigan, is using agent-based models to explore why in-group preferences and out-group antagonisms arise and endure. His work is likely to open new vistas in understanding ethnic solidarity and cross-ethnic tensions at home and abroad, just as his earlier SES-supported work revolutionized thinking about how cooperation could arise in situations fraught with the potential for conflict.

SES is also deeply concerned with educating future generations of social scientists. SES programs regularly provide support for undergraduate research experiences and graduate fellowships as well as workshops and training institutes. Particularly innovative are the EITM (Empirical Implications of Theoretical Models) summer institutes started by the Political Science Program, which teach students the skills needed to combine formal modeling with empirical testing to better understand the causes of social action. The EITM program sets the stage for a new generation of young faculty who realize that both theoretical and empirical models are deficient without each other.

In FY 2005, the SES Request of $88.52 million will support a range of activities, including:

- Support for the development, integration and utilization of large scale and innovative social, economic, and demographic databases, including the development of more adequate cyberinfrastructure. ($17.0 million, an increase of $3.0 million over FY 2004)

- Research on decision-making under uncertainty in support of the Climate Change Research Initiative. ($5.0 million, level with FY 2004)

- Research on social system shocks and extreme events, including research into their causes and consequences, factors that make for vulnerabilities and resiliency, and modes of analyzing and communicating the risks they entail. ($1.50 million, level with FY 2004)

- Funding to support the development and use of cutting edge social and behavioral science methods, including support for cross-disciplinary work teams, conferences and education. ($8.0 million, level with FY 2004)

- Funding to investigate drivers of social change, such as population shifts, the economy, ethnic conflict, terrorism, technology, scientific discoveries, political upheavals, legislation, the mass media, economic and environmental change. Also funding to examine the value issues raised by nanotechnology and other scientific advances. ($12.0 million, level with FY 2004)

Investments in the above areas will occur both through special competitions and the normal competitions of existing programs. In addition, SES will maintain the health of its core through expanded funding of existing disciplinary and cross-disciplinary programs. Core programs regularly fund a wide variety of peer-reviewed, investigator-initiated research aimed at expanding extant knowledge while pushing disciplinary frontiers. They also support graduate and undergraduate education, workshops that set research priorities and programs to enhance academic careers, often with special attention to women and minorities. Expanded funding for the core is important in order to increase the size and duration of grants ($44.33 million, an increase of $4.50 million over FY 2004).

BEHAVIORAL AND COGNITIVE SCIENCES $76,000,000

The FY 2005 Budget Request for the Behavioral and Cognitive Sciences (BCS) Subactivity is $76.0 million, an increase of $7.50 million, or 10.9 percent, over the FY 2004 Estimate of $68.50 million.

Behavioral and Cognitive Sciences Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Behavioral and Cognitive Sciences	62.32	68.50	76.00	7.50	10.9%
Total, BCS	$62.32	$68.50	$76.00	$7.50	10.9%

The BCS Subactivity supports research and related activities that advance fundamental understanding in the behavioral, cognitive, anthropological, and geographic sciences. The Subactivity seeks to develop and advance scientific knowledge and methods focusing on human cognition, perception, behavior, and development, including neural mechanisms, social behavior, language, and learning. The Subactivity also supports research and related activities that focus on social, cultural, and biological variation in humans and how these patterns developed over time. BCS also supports efforts to increase basic understanding and capabilities to explore geographic distributions and interactions of human, physical, and biotic systems on the Earth's surface as well as the dynamics of human activity as people interact with the natural environment.

Strong core disciplinary programs are complemented by an increased emphasis and support for collaborative and interdisciplinary projects to advance knowledge and build capacity across multiple fields. For example, recent advances in the behavioral and cognitive science have produced new insights into how people learn. Through a convergence of new technologies and theoretical development, behavioral and cognitive scientists are discovering how the human brain acquires, organizes, and retains knowledge and skills; how linguistic, social, cultural, and biological processes relate to children and adolescents' learning in formal and informal settings; and how a deeper understanding of these mechanisms can be used to improve educational outcomes and enhance productivity in the workplace. Rooted in the disciplines of behavioral and cognitive science, this activity provides the foundation for even larger-scale efforts in the science of learning, science education, and development of the scientific workforce of the 21st century. Support for children's research centers already is yielding valuable new insights. Sandra Calvert of Georgetown University and collaborators from Northwestern University, the University of Texas-Austin, and the University of California-Los Angeles are studying how digital interactive entertainment media affects children. At New York University, Catherine Tamis-LeMonda and colleagues are identifying pathways to learning success for all children, with a particular emphasis on African American, Asian, and Caucasian children from diverse backgrounds.

Behavioral and cognitive scientists also address the disparate involvement of members of different groups in the scientific workforce of the nation. Research on social and behavioral processes includes an examination of factors that attract and inhibit members of different groups from pursuing careers in science and engineering. Beth Kurtz-Costes of the University of North Carolina and Stephanie Rowley of the University of Michigan are collaborating in a longitudinal study of the socialization processes that affect racial and ethnic identity development as well as achievement striving in African American adolescents. William Wakefield of California State University-Northridge is leading a multidisciplinary project examining African American and Latina/o adolescents' perceptions of and responses to racial discrimination. Ronald Seifer of Bradley Hospital in Rhode Island is examining links between the processing of emotion and the development of social competence in low-income children who are enrolled in Head Start. Carol Dweck and Catherine Good of Columbia University are investigating ways to close the achievement gap between men and women in mathematics courses. Sarah Elwood of DePaul University is exploring how the use of geographic information systems can be used by community-based organizations to facilitate urban change and neighborhood revitalization.

Researchers supported by the BCS Subactivity are exploring what makes people human. Among the questions being investigated: What are the genes that allow for human cognitive abilities? How have diverse cultures addressed human issues such as family, work, health, and conflict? What does the archaeological record tell us about the pace at which human biological and cultural change occurred? Researchers also have developed synergies across disciplinary boundaries. Morris Goodman of Wayne State University is working with colleagues from molecular biology and neuroscience to discover the genetic changes that shaped humankind's enlarged brain and complex cognitive abilities. Under the supervision of Nicholas Toth at Indiana University, doctoral candidate Dietrich Stout is using positron emission tomography to examine the brain activity associated with the production of simple stone tools to gain insights into the cognitive abilities of early humans.

BCS-supported scientists also are advancing knowledge about complexities associated with human interaction with the natural environment, viewing these over time and space and through the collaborative use of tools and ideas from many disciplines. J. Stephen Lansing of the University of Arizona is collaborating with colleagues from the biological and ocean sciences, showing how stable cooperative networks encompassing tens of thousands of farmers in local Balinese watersheds can be explained through self-organizing ecological models. Jeffrey Johnson of East Carolina University and colleagues from the social and ecological sciences are studying environmental understanding in terms of both scientific and traditional ecological knowledge of indigenous people in Alaska. Robert Walker of Michigan State University and Stephen Perz of the University of Florida are examining the social processes of road extensions and the resulting spatial architecture of expanding road networks in a tropical forest frontier in the Brazilian Amazon, to better understand the complex interactions between road building, human land use, and forest fragmentation.

In FY 2005, the BCS Request of $76.0 million will support a range of activities, including:

- Core disciplinary and interdisciplinary research in the geographic, anthropological, archaeological, cognitive, psychological, and linguistic sciences, totals $42.40 million, an increase of $3.0 million over FY 2004.

- Research on the behavioral and cognitive science of human learning and research and related activities on human diversity at $16.0 million, an increase of $2.20 million over FY 2004, including $6.0 million for the Children's Research Initiative.

- Research on human origins and development over time and space, which will be increased by $1.50 million over FY 2004 to $8.50 million. This funding includes $3.50 million for the Human Origins (HOMINID) special competition.

- Research and related activities on human-environmental interactions, will increase by $800,000 over FY 2004 to a level of $8.50 million. Funding includes an increase of $3.50 million over FY 2004 for the establishment of a new set of centers focusing on environmental social and behavioral science.

SCIENCE RESOURCES STATISTICS $26,150,000

The FY 2005 Budget Request for the Science Resources Statistics (SRS) Subactivity is $26.15 million, unchanged from the FY 2004 Estimate.

Science Resources Statistics
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Science Resources Statistics	25.31	26.15	26.15	0.00	0.0%
Total, SRS	$25.31	$26.15	$26.15	$0.00	0.0%

The legislative mandate for the Division of Science Resources Statistics (SRS), as stated in the National Science Foundation Act of 1950, as amended, is, "…to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources and to provide a source of information for policy formulation by other agencies of the federal Government…." To meet this mandate, SRS provides policymakers, researchers, and other decision makers with high quality data and analysis for making informed decisions about the nation's science, engineering, and technology enterprise. The work of SRS involves survey development, methodological and quality improvement research, data collection, analysis, information compilation, dissemination, and customer service to meet the statistical demands of a diverse user community, as well as preparation of the congressionally mandated *Science and Engineering Indicators* and *Women, Minorities and Persons With Disabilities in Science and Engineering* biennial reports.

SRS continues to make improvements in the relevance and quality of its products. Priorities for FY 2005 are implementing the results of prior methodological and planning activities directed toward improving the quality, relevance, timeliness, and accessibility of SRS products, including implementing redesigns of major components of ongoing SRS data collections, and continuing the development of new data collection efforts initiated in FY 2004.

- Every decade a redesign of the samples and surveys used to collect data on the scientific and engineering workforce is necessary to reflect the results of the Decennial Census. Extensive redesign activities were conducted in FY 2000 through FY 2003. SRS began the 2003 cycle of data collection for the redesigned National Survey of College Graduates, National Survey of Recent College Graduates, and the Survey of Doctorate Recipients in FY 2004. In FY 2005, data processing will occur, including development of preliminary data files as well initial analysis.

- In FY 2004, SRS began a multi-year comprehensive study of the feasibility of developing a new ongoing survey to collect information about individuals in postdoctorate positions, including individuals with foreign doctorates. This developmental activity will continue in FY 2005 and is expected to lead to an ongoing survey and much needed statistical information on individuals in postdoctorate positions.

- In FY 2005, to fill critical data gaps about other countries' highly educated S&E personnel, SRS will continue to participate in efforts to encourage the development of internationally comparable basic data on S&E personnel and postdoctorates through the support of activities with the UNESCO Institute for Statistics and the Organization for Economic Cooperation and Development.

- A major National Academy of Sciences review of the SRS R&D portfolio of surveys is nearing completion and is expected to propose significant revisions to components of the R&D survey portfolio. This multi-year (FY 2003-FY 2005) review is in compliance with the NSF/GPRA requirement for a Committee of Visitors review of NSF programs to be conducted on a rotating basis. The NAS review is also in compliance with Section 25 of Public Law No. 107-368 (NSF Authorization Act of 2002) for a review of discrepancies in the R&D data collection. The results of this review will be received as a Letter Report in FY 2004 and a Final Report in FY 2005. Upon receipt of the Letter Report, SRS will begin to undertake research and methodological activities in response to the recommendations.

- During FY 2004, efforts to improve and redesign the Survey of Research and Development Expenditures at Universities and Colleges and the Survey of Graduate Students and Postdoctorates in Science and Engineering will continue. In FY 2005, additional improvements to both surveys will be implemented on an ongoing basis concurrent with major multi-year redesign efforts underway for both surveys.

- In FY 2005, SRS will continue feasibility and design work leading towards the development of an ongoing data collection program for information on research instrumentation as mandated by the NSF Authorization Act of 2002. This information, in conjunction with the newly redesigned Facilities Survey being implemented in FY 2004, will provide critical benchmarking information on the cyberinfrastructure of the U.S. academic research and biomedical enterprise.

- In FY 2005, SRS will begin implementation of components of proposed new procedures to obtain high quality information on public understanding of science and technology.

- In FY 2005, SRS will begin exploratory research related to the possibility of a state R&D survey to provide more robust data for the new State chapter introduced in the 2004 edition of *Science and Engineering Indicators.*

SRS will continue in FY 2005 to conduct all its other surveys and analytical activities that produce the information for carrying out the NSF statutory mandate, for meeting the Tools strategic outcome goal to, "Provide for the collection and analysis of the scientific and technical resources of the U.S. and other nations to inform policy formulation and resource allocation," and for developing *Science and Engineering Indicators* and *Women, Minorities, and Persons With Disabilities in Science and Engineering.* In FY 2005, SRS will also continue to engage in activities designed to improve the relevance and quality of the data it collects and the information it disseminates. Such activities will lead to further needed quality improvements and additions to current activities in subsequent years.

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING $34,040,000

The FY 2005 Budget Request for the Office of International Science and Engineering (OISE) is $34.04 million, an increase of $5.92 million, or 21.1 percent, over the FY 2004 Estimate of $28.12 million.

Office of International Science and Engineering Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Office of International Science and Engineering	39.97	28.12	34.04	5.92	21.1%
Total, OISE	$39.97	$28.12	$34.04	$5.92	21.1%

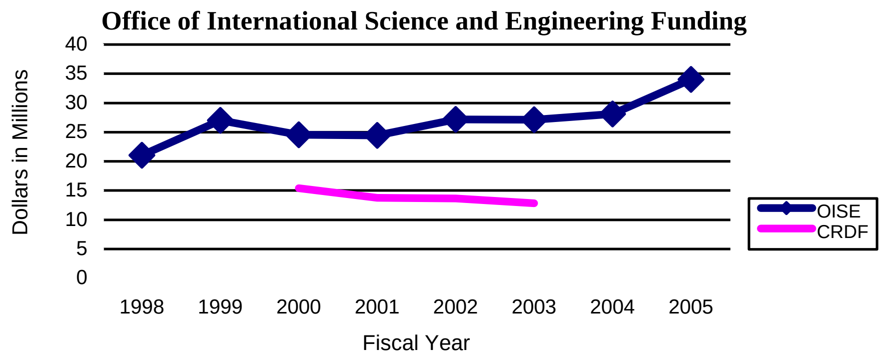
Totals may not add due to rounding.
[1]FY 2003 Actual includes a transfer of $12.83 million from the Department of State for an award to the U.S. Civilian Research and Development Foundation.

The Office of International Science and Engineering (OISE) serves as the focal point, both inside and outside NSF, for international science and engineering activities. OISE promotes the development of an integrated, Foundation-wide international strategy, and manages international programs that are innovative, catalytic, and responsive to a broad range of NSF interests. It is essential that American scientists and engineers have opportunities to engage with the world's top researchers, to lead major international collaborations, and to have access to the best research facilities throughout the globe and across all the frontiers of science and engineering. In November 2001, after an extensive examination of the Foundation's and the U.S. Government's international role, the National Science Board called on the Foundation to make international leadership a high priority for NSF and a much stronger programmatic focus both in core disciplines and in NSF-wide activities. The Office carries out its functions through close partnership with the NSF Directorates and through its own program activities. The Office is housed within the Social, Behavioral and Economic Sciences (SBE) Directorate, but its role is Foundation-wide.

RELEVANCE

Science and engineering are, and will continue to be, international enterprises critical to American competitiveness and security. The NSF – as the nation's core source of academic support for fundamental science, mathematics and engineering research and education – plays a unique role in leading the worldwide efforts of the U.S. science, engineering, and education communities. It is responsible for helping ensure that American scientists and engineers are at the forefront of world research, and equipped to pursue U.S. collaborative and competitive interests directed at solving the country's and the globe's complex array of 21st century challenges.

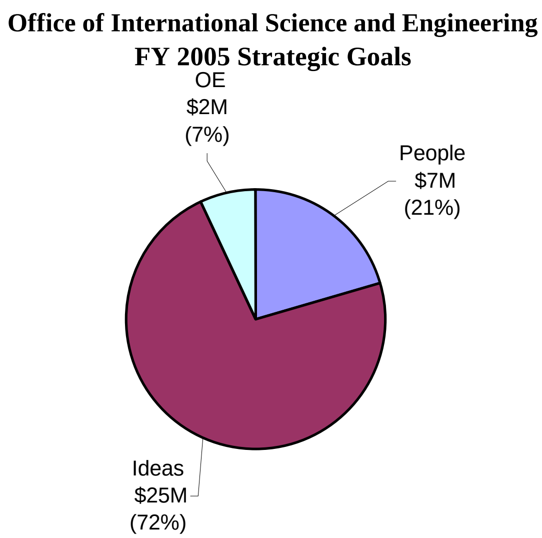
OISE programs support the Foundation's strategic goals of People, Ideas, and Organizational Excellence. America's next generation of scientists and engineers must be able to work effectively in the global research arena and marketplace. The Office maintains a range of activities that enables researchers to experience and engage in international research throughout their training. Bold exploration at the frontiers of science and engineering requires international partnerships. OISE programs are designed to complement and enhance the Foundation's broader research and education portfolio and to overcome the barriers involved in international collaboration.



Note: Additional funding was provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation (CRDF) in FY 2000 ($15.40 million), FY 2001 ($13.75 million), FY 2002 ($13.66 million), and FY 2003 ($12.83 million).

STRATEGIC GOALS

Three strategic outcome goals guide the activities of the Office of International Science and Engineering:



- PEOPLE: For the United States to remain at the forefront of world science and technology, it needs an educated science and engineering workforce capable of operating in an international research environment and a global market. OISE provides U.S. students and junior researchers the opportunity to participate in high quality international collaborative research. It supports activities that seek to broaden the participation of underrepresented groups by providing opportunities to work in foreign settings with the diverse international community of scientists and engineers.

- IDEAS: Discoveries emerge from across the globe and are vital links for the best and the brightest U.S. scientists and engineers to their counterparts. Through investments in collaborative efforts in core disciplines, center efforts, and NSF priority areas, the U.S. research community is able to further its own research goals and objectives. In addition, it is only through international collaborative efforts that the larger scale issues of global concern (e.g., terrorism, infectious disease, biodiversity) can be addressed.

- ORGANIZATIONAL EXCELLENCE: Promoting and supporting the U.S. research community's ability to partner with the best scientists and institutes worldwide requires innovative mechanisms and effectively managed portfolios. OISE's staff and management must be well-equipped to meet the challenge of a dynamic, international scientific and engineering enterprise in order to ensure that the U.S. community is well-served.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People[1]	1.28	4.75	7.00	2.25	47.4%
Ideas	37.65	21.52	24.69	3.17	14.7%
Tools	0.00	0.00	0.00	0.00	N/A
Organizational Excellence	1.04	1.85	2.35	0.50	27.0%
Total, OISE[2]	$39.97	$28.12	$34.04	$5.92	21.1%

[1]/ Note: In FY 2003, the subtotal for "Ideas" includes funding of $3.5 million for postdoctorates. In FY 2004 and 2005, funding support for postdoctorates is included under the category "People."
[2]/Note: In FY 2003, $12.83 million was provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

The FY 2005 Request for the Office of International Science and Engineering Activity is $34.04 million. The OISE seeks to reshape its program by increasing investment in People (including expanding activities with developing countries), developing an innovative institutional approach to international collaboration, and improving management efficiency. Within the Ideas investment, reshaping of the program is proposed to accommodate investments in cyberinfrastructure and to explore new mechanisms for supporting partnerships for international research and education.

PEOPLE (+$2.25 million, for a total of $7.0 million)

OISE People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Individuals	1.28	4.75	7.00	2.25	47.4%
Total, OISE People	$1.28	$4.75	$7.00	$2.25	47.4%

INDIVIDUALS

- Support for postdoctoral fellows will be increased by $600,000 for a total of $3.50 million. Included in the increase are: $100,000 for the existing International Research Fellowship Program, to bring it to a total of $3.0 million, and $500,000 for a fellowship program for junior researchers directed toward developing countries. For the latter, the U.S. scientists and engineers will have the opportunity to participate in unique research opportunities, contribute to capacity building, and establish the foundation for future collaboration.

- Investments in the Foundation's highly successful programs, Research Experiences for Undergraduates (REU) and the Integrative Graduate Education and Research Traineeship (IGERT) program, will be slightly expanded. The investment in IGERT will increase by $850,000 for a total of $1.50 million.

- Support for other individuals, particularly through research experiences for graduate students, will be increased by $800,000 to a total of $1.50 million. This expansion will include an extension of the East Asia graduate research summer institute model to other countries. Currently, this program exists in Japan, Taiwan, Korea, China, and Australia. This program will be increased by $550,000. The second component is a new $250,000 fellowship program for senior researchers pursuing collaborative research with scientists and engineers in developing countries.

IDEAS (+$3.17 million, for a total of $24.69 million)

OISE Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	37.65	21.52	24.69	3.17	14.7%
Total, OISE Ideas	$37.65	$21.52	$24.69	$3.17	14.7%

Note: In FY 2003, additional funding ($12.83 million) was provided to NSF by the U.S. State Department for an award to the U.S. Civilian Research and Development Foundation.

The Office requests $24.69 million to invest in collaborative activities that support the highest quality research and provide U.S. scientists and engineers the opportunity to partner internationally and have access to the best research facilities around the world. Reflecting the overall reshaping of OISE's portfolio as well as the establishment of new programs (e.g., Partnerships for International Research and Education), the Office expects that the average award size and duration of awards will increase in FY 2005. Average award size is expected to almost double from FY 2003 levels – i.e., from $20,566 to $40,000. Likewise, OISE expects the award duration to increase approximately 25 percent from FY 2003 levels – from 2.1 years in FY 2003 to 2.8 years in FY 2005.

FUNDAMENTAL SCIENCE AND ENGINEERING

- *Disciplinary Research*. OISE will continue to support the Foundation's core research investment through highly meritorious research and education activities that present unique risks and offer potentially high payoff because of the critical and integral nature of the foreign collaboration.

  - *Partnerships for International Research and Education*. A significant new ($5.0 million) effort will be mounted to create a leading-edge activity for international science and engineering collaboration. These partnerships will be established in U.S. research institutions and universities working at the most promising frontiers of new knowledge. The awards will invest in U.S. researchers who pursue a well-defined research agenda with top international collaborators and develop a program that involves U.S. researchers at all career levels. It will enhance America's ability to maintain and strengthen international connections, and to provide a context where students and faculty are able to accelerate the achievement of fundamental research objectives through combined international talent, ideas, and tools. In addition, it will provide opportunities for U.S. researchers, at all career levels, to participate in international research.

- *Cyberinfrastructure*. A new $1.0 million cyberinfrastructure investment is proposed for FY 2005. Working in partnership with the CISE Directorate, OISE's objective is to identify and link communities of researchers across international boundaries to facilitate communication and collaboration between the United States and the international scientific community. Efforts in global networking will support the following:
  - Developing and strengthening regional networks that facilitate U.S. collaborative interests;
  - Identifying and strengthening links to communities of researchers not normally served by existing regional networks; and
  - Supporting domain-specific network applications that fundamentally involve international science and engineering.

ORGANIZATIONAL EXCELLENCE (+$500,000, for a total of $2.35 million)

Organizational Excellence supports Intergovernmental Personnel Act appointments (IPAs), IPA travel and the administrative contracts necessary to conduct the level of program activity at the requested level.

Specifically, additional funds are requested to improve management efficiency of the graduate summer research institutes as they expand and increase. Funds also support NSF's overseas offices in Paris, Tokyo, and China. FY 2005 will be the first full year of support to the NSF China office that is planned to open during FY 2004.

PRIORITY AREAS

In FY 2005, OISE will invest in the following priority areas: Biocomplexity in the Environment and Nanoscale Science and Engineering. These investments will be made to support the integration of international collaboration into priority research activities. Many of our international partners are significantly investing in similar priorities and collaborative efforts can contribute to leveraging of funds, to expanding expertise and to enhancing scientific progress. OISE works closely with other NSF directorates engaged in these areas.

OISE Investments in NSF Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	0.35	0.50	0.50	0.00	0.0%
Nanoscale Science and Engineering	0.00	0.00	0.26	0.26	100.0%

QUALITY

The Office of International Science and Engineering maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. Within the existing portfolio, the percent of funds that were allocated to projects that undergo merit review was 44 percent in FY 2003. However, the majority of projects that did not undergo external merit review were supplements that added an international dimension to projects already reviewed and funded in the disciplinary research programs of the Foundation.

The Office of International Science and Engineering employs several internal and external mechanisms to ensure the highest standards of work and quality service as well as to identify potential future opportunities. The three key mechanisms are: the Committee of Visitors (COV), the Advisory Subcommittee for International Science and Engineering, and the Foundation's International Coordinating Committee (ICC). COVs, which are used throughout the Foundation as a method of assessing and processing of proposals, review and provide a retrospective assessment of the quality of results of NSF's investments. The most recent COV for the international portfolio was conducted in March 2002. The report of that group of experts is being used to reshape the portfolio. The next COV is planned for FY 2005.

Given that the role and program of the Office has been elevated within the Foundation, an advisory body was established in FY 2004. As the Office is still organizationally a part of the SBE Directorate, an Advisory Subcommittee for International Science and Engineering has been established. The

Subcommittee is comprised of approximately 12 members from across the science and engineering community. The group meets twice a year and advises the Office on strategic directions, program development, and program performance.

Since its establishment by the NSF Director in FY 2003, the ICC meets regularly to ensure that the various international investments across the Foundation are coordinated and effective. Comprised of representatives from across NSF's directorates and offices and chaired by the Director of the Office of International Science and Engineering, the ICC maintains an inventory of the Foundation's investment in international activities in order to develop a Foundation-wide strategic approach to international investments and to address priority international issues as they arise.

PERFORMANCE

Hydrogeochemistry of Copahue Volcano. Scientists know the basic facts about volcanoes – that they erupt because magna (liquid or molten rock) is buoyant within the Earth's crust and contains dissolved gasses that are rapidly released as magna reaches shallow depth. But many critical questions remain unanswered or unclear: the mechanisms of rock melting, the regions and conditions of melt storage in the crust, the trigger for final rise to the surface, the cause of cessation of that rise, and the controls that lead to explosive or nonexplosive behavior. Copahue is an active volcano on the eastern end of the Southern Andes, located in one of the world's most active volcano zones. Copahue has an extensive acid hydrothermal system with a crater lake, acid springs that draw fluids from deep sources, and a geothermal system on its northeast flank. It showed signs of life during the 1990s with small steam eruptions, which culminated in July 2000 with an eruptive period lasting about 6 months. Explosive eruptions spread ashes more than 100 km from the volcano and fire fountains lit up the skies. This multi-year, NSF-funded research is conducted in Argentina's Neuquen province by scientists and students from Connecticut's Wesleyan University, working alongside their Argentine partners from the National University of Comahue and a national research agency, CONICET. The project focuses on long-term data collection aimed at improving how to predict and monitor volcanic eruptions, especially the nature of eruption triggers. It is assessing the significant environmental and health effects of releases of these toxic "earthy fluids," particularly the severe impact they may have on the local acidified watershed, and it is training young U.S. researchers to explore the frontiers of volcanology and to collaborate internationally.

China: Capitalism Without Democracy? Free enterprise is usually defined as the practice of capitalism under representative government. But for over twenty years, Communist Party-led China has embarked on a process of economic reform that moves toward private or corporate ownership of capital goods and toward investment decisions determined by prices, production and competition in a free market. A Johns Hopkins University social scientist in NSF's International Research Fellowship Program is examining the political orientation of private entrepreneurs in China and testing the hypothesis that private industrialists and merchants make up the basis for a pro-democratic class in contemporary China. In collaboration with a colleague at the Chinese Academy of Social Sciences in Beijing, she has designed and conducted a remarkable, in-depth survey of over 250 interviewees who are leading private entrepreneurs, government and party officials, academics and business experts working in China's major economic centers like Shanghai and Beijing. She has presented her findings at numerous academic and public forums both in China and America including the Senate Foreign Relations Committee.

Temple University and the University of Bremen scientists collaborate to push the frontiers of robot mapping and self-location.

Robotics: U.S.-German Cooperative Research. Robots are computer-controlled machines that can be programmed to move or carry out work. They are especially useful doing repetitive tasks in manufacturing, or in situations dangerous to people like defusing bombs or exploring outer space and the deep ocean floor. Robots can "see" and "hear" for humans. One day, they will be intelligent enough to "know" when to move and stop without any input from people, recognizing objects and shapes, and adjusting their mobility accordingly. Some of the world's top research to develop elaborate, cognitively motivated geometric representation and reasoning formalism for robot localization and mapping is being done at the University of Bremen, Germany. There, in cooperation with Philadelphia's Temple University, American and German scientists use complementary expertise and equipment from both schools to focus on problems of self-location (which allows a robot to determine its position using its internal spatial representation) and to advance robot mapping (which uses mobile robots to acquire spatial models of physical environments). In addition, the project offers U.S. students an existing, cutting-edge research and international training opportunity. Results of this research area could impact virtually every sector of society in the future. But the practical applications will be particularly important for homeland security monitoring and protection where consistent, accurate shape recognition is vital.

International research team member collects data in order to assess the impact of climate change on Lake Tanganyika's plants and fish.

East African Food Supply Threatened by Climate Change. An important new study provides evidence that climatic warming is diminishing Lake Tanganyika's populations of aquatic plants and the fish that feed on them. This deep East African lake holds 18 percent of the world's liquid freshwater. It is a critical food source for the countries that border it, providing approximately 200,000 tons of fish per year. Reporting in the journal *Nature* (August 14, 2003), an international team that included scientists from Tanzania's University of Dar es Salaam as well as NSF-funded researchers from Vassar College, the University of Arizona, University of Washington, and Tulane University, announced that climate change had decreased fish stocks by as much as 30 percent over the last 80 years. The researchers examined recent and historical records of air temperature, wind velocity and water temperature, estimates of aquatic plant growth derived from lake sediment cores, and recent historical fisheries records. They were able to rule out overfishing and conclude that higher surface water temperatures and lower wind velocities have decreased the amount of mixing of lake waters, decreasing the amount of nutrient-laden water to reach the surface and nourish aquatic plants. The reduced plant growth has, in turn, led to reductions in fish numbers.

This ongoing Nyanza Project has long been supported by NSF as a Research Experience for Undergraduates Site through the University of Arizona. This project not only offers valuable training opportunities for a new generation of cross-disciplinary and internationally-skilled young scientists, but the students' contributions have played a major role in developing these new insights into the impact of climate change.

University of California and Taiwanese scientists worked to link SARS-quarantined Taiwanese hospitals with outside health experts.

IT International Partnership Fights Disease. The battle to contain the SARS virus – which emerged in China in November 2002 and spread to 32 countries killing more than 800 people – enlisted the high-powered resources of a unique partnership of computer researchers around the Pacific Rim led by the San Diego Supercomputer Center at the University of California-San Diego (UCSD). This partnership of 14 high-performance computing institutions and the Pacific Rim Applications and Grid Middleware Assembly (PRAGMA), promotes cooperation in grid technology and regional standards development to make grid-enabled computing and resource-sharing a reality. In the case of thethe SARS outbreak, it showed that the NSF's cyberinfrastructure and international linkages – made possible through collaboration between OISE and NSF's Computer Information Science and Engineering Directorate – is not only transforming scientific research and learning on a global scale but also building a powerful tool to safeguard human health. Because quarantine and isolation are the primary means of slowing the spread of SARS, Taiwan's hospitals faced a communications crisis. In May 2003, responding to an urgent request from Taiwan's National Center for High-performance Computing (NCHC), scientists led by UCSD assisted Taiwan in developing a cutting-edge communication access grid among quarantined Taiwanese hospitals. This linked hospitals to each other and to the most up-to-date global sources of health information. It went beyond the standard video- and teleconferencing and allowed physicians to share detailed x-ray images, patient data, and other information in on-line meetings among several sites. According to NCHC's director, this partnership assisted in fighting the disease, relieving the epidemic, and ultimately saved lives.

Other Performance Indicators

The table below shows the number of people for whom OISE provides salary/stipend support. OISE also funds other research-supporting activities for postdoctorates, graduate students and undergraduates. In FY 2003, awards funded solely by OISE supported a total of 410 postdoctorates, 533 graduate students and 194 undergraduates.

Number of People Receiving OISE-funded Salary/Stipend Support

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	92	100	110
Other Professionals	19	25	25
Postdoctorates	10	35	35
Graduate Students	51	100	120
Undergraduate Students	29	40	50
Total Number of People	201	300	340

OISE Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	373	340	325
Funding Rate	56.0%	49.0%	45.0%
Statistics for Research Grants:			
Number of Research Grants	256	220	200
Funding Rate	58.0%	49.0%	45.0%
Median Annualized Award Size	$9,977	$9,100	$15,000
Average Annualized Award Size	$20,556	$30,000	$40,000
Average Award Duration, in years	2.1	2.5	2.8

U.S. POLAR PROGRAMS

OFFICE OF POLAR PROGRAMS $349,730,000

The FY 2005 Budget Request for the Office of Polar Programs Activity (OPP) is $349.73 million, an increase of $7.58 million, or 2.2 percent, over the FY 2004 Estimate of $342.15 million.

Office of Polar Programs Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
U.S. Polar Reseach Programs	255.41	274.08	281.66	7.58	2.8%
U.S. Antarctic Logistical Support	68.55	68.07	68.07	0.00	0.0%
Total, OPP	$323.96	$342.15	$349.73	$7.58	2.2%

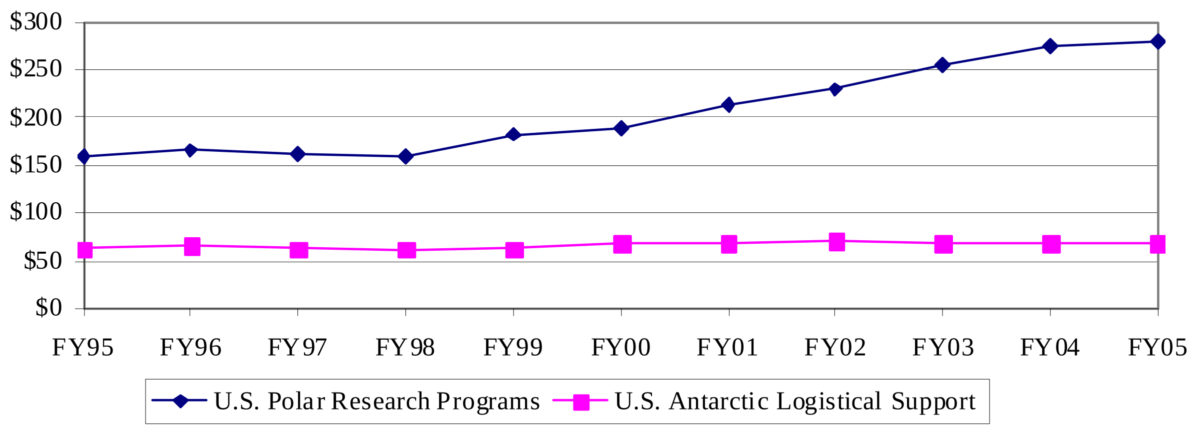
Totals may not add due to rounding.

Polar regions are key elements and possible drivers of the global climate system. They are also premier natural laboratories for a variety of fundamental phenomena that cannot be studied elsewhere. Recognizing the importance of polar regions and the benefits that can accrue from increased multi-national effort in these areas, 2007 has been declared the International Polar Year (IPY) by a number of international research organizations. The FY 2005 Request positions the U.S. to play a leading role in this broad international effort, and OPP funds most of the polar research NSF supports.

RELEVANCE

Polar research addresses the solid earth, glacial and sea ice, terrestrial and marine ecosystems, the oceans, atmosphere and the universe. Key OPP support will broaden and deepen the fundamental observations of Arctic and Antarctic systems, including land, ice, atmosphere, ocean, and social/human systems, as well as natural records of those systems, in order to understand the components, interrelationships, and overall functioning of these systems. Increased observations, analysis and research on polar systems is critical for understanding global climate phenomena and will have ready applicability to Arctic residents, many of whom are currently experiencing a changing natural environment. OPP-sponsored research in polar regions also accesses disciplinary phenomena that cannot be studied as effectively elsewhere. The study of such phenomena in polar regions is changing the forefront of research in many fields of study.

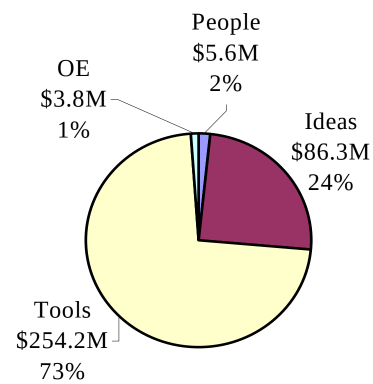
OPP Subactivity Funding
(Dollars in Millions)



STRATEGIC GOALS

Four strategic goals guide OPP activities:

FY 2005 OPP Strategic Goals



- PEOPLE: OPP will place increased emphasis on improving the quality of education for young scientists, with particular focus on multidisciplinary research and on research in emerging areas. OPP-funded activity will provide information important for public policy decisions on a variety of issues. In addition, NSF will build on the interest of young students in Antarctica and the Arctic to provide educational opportunities and increase interest in math and science.

- IDEAS: Advancement of knowledge in all areas of science where the necessary research can best be done in polar regions, including support for work in the physical, life, and social sciences, both on a disciplinary and multi-disciplinary basis.

- TOOLS: Operations, maintenance, and enhancement of the infrastructure required for the conduct of polar research and development or state-of-the art tools that will enable such research in remote or otherwise inaccessible regions of the Arctic and Antarctic.

- ORGANIZATIONAL EXCELLENCE: Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions. A substantial fraction of OPP's science support infrastructure is operated and maintained by private contractors and OPP will continue to evaluate and adopt best practices in its oversight and implementation.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	5.94	5.26	5.56	0.30	5.7%
Ideas	74.42	84.19	86.27	2.08	2.5%
Tools	240.27	248.95	254.15	5.20	2.1%
OE	3.33	3.75	3.75	0.00	0.0%
Total, OPP	$323.96	$342.15	$349.73	$7.58	2.2%

PEOPLE (+$300,000, for a total of $5.56 million)

OPP People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Individuals	4.78	3.94	4.24	0.30	7.6%
Institutions	1.06	1.18	1.18	0.00	0.0%
Collaborations	0.06	0.14	0.14	0.00	0.0%
Total, OPP	$4.78	$3.94	$4.24	$0.30	7.6%

Totals may not add due to rounding.

INDIVIDUALS

- Increase support for Research Experiences for Undergraduates (REU) and dissertation fellowships.
- Redirect support within core programs to emphasize development of scientific expertise in the science workforce. This is part of a modest incremental step toward increasing grant size and duration.

IDEAS (+$2.08 million, for a total of $86.27 million)

OPP Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Fundamental Science & Engineering	72.91	82.77	84.85	2.08	2.5%
Centers Programs	1.51	1.42	1.42	0.00	0.0%
Total, OPP	$74.42	$84.19	$86.27	$2.08	2.5%

Totals may not add due to rounding.

FUNDAMENTAL SCIENCE AND ENGINEERING

- Polar Genomics – Support of Frontier in Polar Biology themes enabling aspects such as functional genomics for overall ecosystem understanding; probably a decade long theme; aligns with NSF Biocomplexity in the Environment interests, and may be done as an OPP-wide partnership with the BIO directorate.
- Support for Study of Environmental Arctic Change (SEARCH) Cyberinfrastructure and Sensors (CIS) to help prepare for U.S. leadership of the International Polar Year (IPY) in 2007. This effort also supports the goals identified at the Administration's Earth Observation Summit of 2003. Polar activities include starting Polar Links to Undersea Telecommunications and Observatories and building a "network of networks," -- the Circumarctic Environmental Observatory Network -- which includes advancing the implementation of the Long Range Plan for the Toolik Alaska Field Station.

- Initial support for the Bering Ecosystem Study (BEST). There is a view among the stakeholder and scientific communities that there is an urgent need to improve our understanding of the linkages between climate variability and the responses of the ecosystems of the Bering Sea. BEST addresses the need to understand how climate change will affect the marine ecosystems of the eastern Bering Sea and their sustainability. Planned as a component of SEARCH, BEST is also viewed by the Interagency Arctic Research Policy Committee (IARPC) as a research priority in its own right. A coordinated research effort will couple academic and fisheries oceanography in an attempt to achieve a level of ecosystem understanding that would enable comprehension of the changes that have occurred. Such basic research will be the foundation of improved models of ecosystem response and can play a key role in helping to ameliorate the impact on society of variability in this important ocean ecosystem.

- ANDRILL - acquisition and exploitation of records of global change in "deep time," - geological drilling to investigate key intervals in Antarctic history as Earth changed from a "greenhouse" world to an "ice-house" world.

- Begin planning and preparation for coordinated studies in the fields of Antarctic meteorological processes and ice sheet dynamics for understanding climate and environmental change.

- Southern Ocean Global Ecosystem Synthesis and Modeling -- a 3-year effort to wrap up recent investments in observing the southern ocean ecosystem.

CENTERS PROGRAMS

- Continue funding Long-Term Ecological Research centers at Palmer Station in the Antarctic peninsula and at McMurdo Station and the Dry Valleys, Antarctica.

TOOLS (+$5.20 million, for a total of $254.15 million)

OPP Tools Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Polar Tools, Facilities & Logistics	240.27	248.95	254.15	5.20	2.1%
Antarctic Facilities & Operations	*141.43*	*149.48*	*153.96*	*4.48*	*3.0%*
Antarctic Logistics	*68.55*	*68.07*	*68.07*	*0.00*	*0.0%*
Arctic Logistics	*30.29*	*31.40*	*32.12*	*0.72*	*2.3%*
Total, OPP	$240.27	$248.95	$254.15	$5.20	2.1%

Totals may not add due to rounding.

POLAR TOOLS, FACILITIES, AND LOGISTICS

- Continued support for a cooperative agreement with the Barrow Arctic Science Consortium to improve support and logistics in the area and make any new facilities useful for basic research programs.

- Support for research projects throughout the Arctic including Alaska, Canada, the Arctic Ocean, Greenland, Scandinavia and Russia.
- Support for Toolik Field Station, the University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope.
- Complete the supporting structure for an 8 meter telescope at the South Pole.
- Support for SHALDRIL (shallow ship-based drilling for paleooceanographic studies related to climate change).
- Support for Deep Ice Drill.
- Complete the McMurdo Power Plant.
- Continue analysis and procurement planning to provide multi-year fuel storage capacity at McMurdo Station.
- Improve maintenance of facilities and infrastructure.
- Continue with communication bandwidth increases.
- Start warehouse and dormitory design.
- Support overland traverse to remain on track for full operational traverse in FY 2007.
- Continue support for two icebreakers to open channel to McMurdo Station.
- Improve the security of USAP IT systems.

ORGANIZATIONAL EXCELLENCE (unchanged at $3.75 million)

Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its strategic goals. Requested funding for FY 2005 is $3.75 million, level with FY 2004. This includes the cost of Intergovernmental Personnel Act appointments and contractors performing administrative functions.

A substantial fraction of OPP's science support infrastructure is operated and maintained by private contractors. OPP will continue to evaluate and adopt best practices in its oversight and implementation.

PRIORITY AREAS

In FY 2005, OPP will support research and education efforts related to broad, Foundation-wide priority areas in Biocomplexity in the Environment and Mathematical Sciences.

Office of Polar Programs Investments in NSF Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Biocomplexity in the Environment	$1.41	$1.55	$1.55	$0.00	0.0%
Mathematical Sciences	0.18	0.18	0.20	0.02	11.1%

QUALITY

OPP assures the quality of the research and development it supports partly through the use of a competitive, merit-based review process, and partly through the oversight of the OPP Office Advisory Committee, and, above all, by its program managers and section heads. Ninety-three percent of basic and applied research funds were allocated to projects that underwent merit review in FY 2003.

To ensure the highest quality in processing and recommending proposals for awards, OPP convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes. These Committees report to the Office Advisory Committee, which then engages OPP management in discussions about the conclusions and actions that should be taken to further assure the quality of future OPP investments.

The Office of Polar Programs also receives advice from its advisory committee concerning science opportunities and support for research, education and human resource activities in polar regions. The advisory committee meets twice a year. Its membership is composed of outstanding scientists and educators representative of the community involved in OPP activities.

PERFORMANCE

Recent Research Highlights

Behavior of Arctic Ocean Ridge Confounds Predictions; May Lead to New Insights into Crust Formation. The discovery that an ocean ridge under the Arctic ice cap is unexpectedly volcanically active and contains multiple hydrothermal vents may cause scientists to modify a decades-long understanding of how ocean ridges work to produce the Earth's crust. The new results, which come from a study of the Gakkel Ridge, one of the slowest spreading ridges on Earth, have broad implications for the understanding of the globe-encircling mid-ocean ridge system where melting of the underlying mantle creates the ocean floor. In the cover story in the June 26, 2003 edition of the journal *Nature*, scientists present striking new results obtained during a nine-week research cruise that lasted from August to October of 2001. In general, fast-spreading ocean ridges, where the Earth's crust is produced, are volcanically very active. So scientists expected the Gakkel, where the spreading rate is one centimeter (.39 inches) per year, to

Investigations of the Gakkel Ridge, the slowest spreading of the mid-ocean ridges located under the central Arctic Ocean, appeared in the 26 June 2003 issue of the journal *Nature*. The cover photo shows the multibeam sonar bathymetry of the ridge mapped using the USCGC *Healy* and the German icebreaker *Polarstern*.

exhibit little, if any, volcanic activity. Because the spreading rate decreases progressively towards Siberia, scientists expected that the amount of melting and magma production would decrease from Greenland eastward. Instead, the very first sampling station brought up fresh volcanic rock, and the new map published in *Nature* shows large young volcanoes dominating the part of the ridge nearest Greenland.

Scientists aboard the *Healy*, a U.S. Coast Guard icebreaker specially equipped for research, and a companion vessel, the German research icebreaker, the PFS *Polarstern*, achieved several scientific "firsts." They obtained high-resolution, well-navigated maps of the entire portion of the ridge, collected thousands of samples by dredging the sea floor, explored for regional anomalies in the water column that would indicate the amount and location of deep hydrothermal vents surrounded by ecosystems that thrive in the absence of sunlight. Based on the picture the Gakkel data painted, factors other than spreading rate must be taken into account when characterizing the likelihood of a given area's volcanic activity. The research team, which included more than 30 scientists from U.S. and German research institutions, based their conclusions on the remarkably detailed map of the sea floor and on 200 samples taken on average every five kilometers (3.1 miles) along the ridge.

New Model of Glacial Erosion Dynamics. Earth scientists have long recognized that glaciers and ice sheets have been responsible for rearranging rock and soil and shaping Earth's surface. Indeed, most visitors to places like Glacier National Park or Yosemite clearly see the magnitude of mass redistribution from ice. Glacial erosion and redistribution of mass has both contributed to the extreme uplift of mountain ranges like the Himalaya and has leveled large areas of continents, like western Canada. Conventional thinking on glacial erosion and transport focused on brute force of ice carrying rock debris along at its base, either as particles in the lowermost ice or as a heterogeneous sediment being carried along by shearing and smearing at the bottom of the ice, or on glacial meltwater moving material along under the ice and away as the water emerged from beneath the ice sheet. A new conceptual model of sediment erosion and transport by Alley and colleagues, featured on the cover article of *Nature* (v.424, 14 August 2003), brings water and ice together in a coupled dynamic system that explains many important observations of glacially formed landscape. This model is important because it ties observations to physical processes that can be rigorously modeled. This in turn will allow development of realistic models of ice sheets and glaciers so that we can better understand their role and predict their fate in a changing global environment.

New Views of Subglacial Lake Vostok. This project undertook a comprehensive aerogeophysical survey to characterize the lake and to understand its geological setting. The survey utilized a unique aerogeophysical system that was specifically designed for work over ice sheets. It consisted of an integrated system that combined a laser surface profiler, an ice-penetrating radar, a magnetometer, and a gravimeter all supported by high precision GPS navigation. Results published provide extraordinary new knowledge about the lake system. Interpretations of ice from the bottom of a deep drill hole completed in the 1990s as a French-Russian-U.S. collaboration showed that the lake water was freezing onto the base of the ice sheet. This process has substantial implications for the nature of the water in the lake. The new aerogeophysical survey provides important new information to help quantify processes and develop a comprehensive model for the lake. This work provides new and unprecedented information about subglacial Lake Vostok, a unique long-lived environment that may represent a new class of ecosystem.

Tidal Modulation of Ice Stream Flow. Research was supported to investigate the new-found, startling sensitivity of two major West Antarctic ice streams (WAIS) to tidal oscillations to learn the extent and character of the effect and its ramifications for future ice-stream behavior. The improved knowledge of ice-stream behavior from this study will contribute to assessment of the potential for rapid ice-sheet change affecting global sea level with societal consequences. Results will be disseminated through scientific publication and talks at professional meetings, as well as contacts with the press, university classes taught by the PIs, visits to schools and community groups, and other activities. Two graduate students will be educated through the project. This work has a good chance of providing a significant improvement to our understanding of ice stream dynamics and by extension, the stability of WAIS in general, which has obvious societal importance.

South Pole Traverse Proof of Concept. Progress was made toward implementation of the proof of concept for an overland traverse capability to the South Pole by the end of 2004 by safely crossing the McMurdo Shear Zone and reaching the "Farthest South" point at S 79 24.213 E 171 09.776. With

Overland traverses from the coast near McMurdo Station to Amundsen-Scott South Pole will be able to deliver up to 2.2 million pounds of materials — the equivalent 85 LC-130 flights.

completion of the proof of concept traverse, the U.S. Antarctic Program will be able to move forward with development of a full-scale traverse capability. The proof of concept fleet will be able to deliver approximately 162,000 pounds of revenue payload to the South Pole per trip, or the equivalent of 6.25 LC-130 flights. Based on current planning, the fully developed traverse capability of three traverse swings, each swing made up of six tractors and 23 trailers or sleds, making three trips per season (twenty days to the South Pole and ten days to return), will deliver approximately 2.2 million pounds of revenue payload – or the equivalent of 85 LC-130 missions – to the South Pole per season at lower cost and with reduced fuel consumption.

Antarctic Health and Safety. The value of the return on investments in telemedical capabilities became apparent during April 2002 when emergency surgical repair of a person's knee was made possible through use of this technology. The South Pole physician, observed in real-time and guided via video link by state-side orthopedic surgeons, was able to perform this first-ever invasive surgery at the South

Pole. In addition, OPP and Raytheon continue to invest in methods to reduce injuries through, for example, safety training and awareness programs. In 2003, a 61 percent reduction in recordable injuries from the prior year was achieved. Delivery of medical services in remote areas is crucial to protecting the health and safety of all USAP participants.

Other Performance Indicators

The tables below show the growth in the number of people benefiting from OPP funding, and trends in growth of award size, duration and number.

Number of People Involved in OPP Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	787	870	880
Other Professionals	616	685	700
Postdoctorates	105	120	120
Graduate Students	439	490	500
Undergraduate Students	236	260	260
Total Number of People	2,183	2,425	2,460

OPP Funding Profile

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Statistics for Competitive Awards:			
Number	241	267	275
Funding Rate	43%	43%	44%
Statistics for Research Grants:			
Number of Research Grants	148	160	181
Funding Rate	43%	43%	44%
Median Annualized Award Size	$126,143	$129,900	$133,700
Average Annualized Award Size	$144,392	$148,700	$153,100
Average Award Duration, in years	2.6	2.7	2.8

U.S. POLAR RESEARCH PROGRAMS $281,660,000

The FY 2005 Budget Request for U.S. Polar Research Programs Activity is $281.66 million, an increase of $7.58 million, or 2.8 percent, over the FY 2004 Estimate of $274.08 million.

Polar Research Programs Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Arctic Research Program	37.56	44.00	44.88	0.88	2.0%
Arctic Research Support and Logistics	30.29	31.40	32.12	0.72	2.3%
Arctic Research Commission	1.08	1.19	1.19	0.00	0.0%
Antarctic Research Grants Program	42.55	45.20	46.70	1.50	3.3%
Antarctic Operations and Science Support	143.93	152.29	156.77	4.48	2.9%
Total, U.S. Polar Research Programs	$255.41	$274.08	$281.66	$7.58	2.8%

Totals may not add due to rounding.

The U.S. Polar Research Programs Activity supports both Arctic and Antarctic research. Arctic support represents part of a larger NSF and federal research effort. Antarctic support includes funding for NSF-supported researchers as well as for meeting NSF responsibilities as manager of the entire federal Antarctic program, including special requirements for operations and science support.

Polar Programs is also responsible for managing several activities funded out of the Major Research Equipment and Facilities Construction (MREFC) Account, including IceCube and South Pole Station Modernization. The new station will provide the infrastructure required for imaginative new science on the drawing board. Taking full advantage of the new station will require new efficiencies in delivering scientists and science supplies to remote locations and the South Pole and fuel to the South Pole. See the MREFC section for further information on these projects.

Polar Activities

The following activities planned for FY 2005 cut across all Polar Research Programs:

- Continuation of a Postdoctoral Fellowship Program targeted at emerging scientific frontiers and underrepresented groups. The evolution of research frontiers in polar areas brings with it the opportunity to engage a new generation of scientists, particularly those from underrepresented groups.

- Activities that address emerging frontiers in polar biology. The National Academy of Sciences/National Research Council study will help set priorities in this area through the report, *Frontiers in Polar Biology in the Genomic Era*.

- Facilitate opportunities for development and deployment of autonomous remote sensors and the cyberinfrastructure to link them together with larger networks and home laboratories.

Arctic Research Program

The FY 2005 Budget Request for the U.S. Arctic Research Program within Polar Programs is $44.88 million, an increase of $880,000, or 2.0 percent, over the FY 2004 Estimate of $44.0 million. This funding, with the Arctic Research Support and Logistics funding, represents over 70 percent of the NSF support for university-based Arctic research.

The U.S. Arctic Research Program supports research on the Arctic Ocean, atmosphere, and land areas – including their people, and marine and terrestrial ecosystems. In addition to research in individual disciplines, an Arctic System Science component focuses on interdisciplinary approaches to understanding the Arctic region, including its role in global climate.

It has become widely recognized that the Arctic is in the midst of a change over the last decade. Changes have been measured in the ice cover, atmosphere, some terrestrial parameters, and northern ecosystems. Residents of the North are seeing these environmental changes affecting their lives. It is important to determine whether these changes are correlated with a short-term shift in regional atmospheric circulation or whether they signal long-term global change. Priorities in FY 2005 include:

- Support for Study of Environmental Arctic Change (SEARCH) Cyberinfrastructure and Sensors (CIS) to help prepare for U.S. leadership of the International Polar Year (IPY) in 2007. This effort also supports the goals identified at the Administration's Earth Observation Summit of 2003. Polar activities include starting Polar Links to Undersea Telecommunications and Observatories and building a "network of networks," -- the Circumarctic Environmental Observatory Network -- which includes advancing the implementation of the Long Range Plan for the Toolik Alaska Field Station.

- Initial support for the Bering Ecosystem Study (BEST). There is a view among the stakeholder and scientific communities that there is an urgent need to improve our understanding of the linkages between climate variability and the responses of the ecosystems of the Bering Sea. BEST addresses the need to understand how climate change will affect the marine ecosystems of the eastern Bering Sea and their sustainability. Planned as a component of SEARCH, BEST is also viewed by the Interagency Arctic Research Policy Committee (IARPC) as a research priority in its own right. A coordinated research effort will couple academic and fisheries oceanography in an attempt to achieve a level of ecosystem understanding that would enable comprehension of the changes that have occurred. Such basic research will be the foundation of improved models of ecosystem response and can play a key role in helping to ameliorate the impact on society of variability in this important ocean ecosystem.

  BEST will be a major effort requiring, as part of integrated field programs, collaborative research among multiple institutions and disciplines, including international collaboration, the deployment of *in situ* long-term instrument arrays, satellite-based remote sensing studies, and the deployment of multiple ships. Mathematical modeling studies will be an integral part of the program from the outset, and will provide frameworks for testing program hypotheses and sampling scenarios. Such an ambitious effort will of necessity require capacity building through targeted internship and training programs, the involvement of social scientists, and strong public awareness and outreach efforts.

- With continued funding, implementation of BEST and most parts of SEARCH will be possible by the time of the International Polar Year (IPY) in FY 2007.

Arctic Research Support and Logistics

The FY 2005 Request for Arctic Research Support and Logistics is $32.12 million, an increase of $720,000, or 2.3% percent, above the FY 2004 Estimate of $31.40 million. Arctic research support and logistics is driven by and responsive to the science supported in U.S. Arctic Research programs. Funding for logistics is provided directly to grantees or to key organizations that provide or manage Arctic research support and logistics. Funding includes:

- Continued support to approximately 150 projects throughout the Arctic including Alaska, Canada, the Arctic Ocean, Greenland, Scandinavia and Russia. Almost half the projects are located in Alaska. There is increasing support available for work in the Arctic Ocean and Bering Sea with full use of the USCGC *Healy* augmented by either *Polar Sea* or *Polar Star,* and the *R/V Alpha Helix.*

- Continued access to fixed and rotary-wing airlift support to researchers conducting regional studies in the difficult and often fragile Arctic terrain in Alaska, Canada, Greenland, Arctic Scandinavia, and Russia.

- Continued access to U.S. Coast Guard and other icebreakers, support for research conducted on the U.S. Coast Guard Cutter *Healy*, and University-National Oceanographic Laboratory vessels and coastal boats.

- Modest upgrades at Toolik Field Station, University of Alaska, Fairbanks' field station for ecological research on Alaska's North Slope.

- Continued safety training for field researchers and funding for field safety experts, global satellite telephones for emergency response, and improved logistics coordination.

- Begin integration under SEARCH of a network of U.S. Long-Term Observatories, linking to similar efforts in Europe and Canada.

- Installation of a modern local area network at the Barrow Environmental Observatory with improved access to the Internet.

Arctic Research Commission

Funding for the Arctic Research Commission (ARC), an independent federal agency, is transferred through the National Science Foundation to ARC. In FY 2005, ARC is requesting $1.19 million, level with the FY 2004 Estimate.

Antarctic Research Grants Program

The FY 2005 Budget Request for the Antarctic Research Grants Program is $46.70 million, an increase of $1.50 million, or 3.3 percent over the FY 2004 Estimate of $45.20 million. The program provides grants to fund scientific research related to Antarctica and to the Southern Ocean. The FY 2005 Request will support research projects in Antarctica and at academic institutions in the U.S. This fundamental research will provide new information on the ozone hole, how extreme environments affect gene expression, the effects of ultraviolet radiation on living organisms, changes in the ice sheet and impacts on global sea level, global weather, climate, and ocean circulation, and on the early evolution of our universe as well as its current composition. Priorities in FY 2005 include:

- Polar Genomics – Support of Frontier in Polar Biology themes enabling aspects such as functional genomics for overall ecosystem understanding; probably a decade long theme; aligns with NSF BE interests, and may be done as an OPP-wide partnership with the BIO directorate.

- ANDRILL - acquisition and exploitation of records of global change in "deep time," - geological drilling to investigate key intervals in Antarctic history as Earth changed from a "greenhouse" world to an "ice-house" world.

- Begin planning and preparation for coordinated studies in the fields of Antarctic meteorological processes and ice sheet dynamics for understanding climate and environmental change.

- Southern Ocean Global Ecosystem Synthesis and Modeling -- a 3-year effort to wrap up recent investments in observing the southern ocean ecosystem.

Antarctic Operations and Science Support

The FY 2005 Budget Request for Antarctic Operations and Science Support is $156.77 million, an increase of $4.48 million, or 2.9 percent, over the FY 2004 Estimate of $152.29 million. Antarctic Operations and Science Support makes research in Antarctica possible by providing the required research and life support facilities, food, fuel, environmental protection, health and safety and all other operational support for all U.S. research conducted on the continent, including research funded through other federal agencies (National Aeronautics and Space Administration, National Oceanographic and Atmospheric Administration, U.S. Geological Survey, Department of Energy, and the Smithsonian Institution).

FY 2005 priorities include:

- Complete the supporting structure for an 8 meter telescope at the South Pole
- Support for SHALDRIL (shallow ship-based drilling for paleooceanographic studies related to climate change)
- Support for Deep Ice Drill
- Provide a modest increase in level of science support
- Complete the McMurdo Power Plant
- Continue analysis and procurement planning to provide multi-year fuel storage capacity at McMurdo Station
- Improve maintenance of facilities and infrastructure
- Continue with communication bandwidth increases
- Continue efforts to streamline inventory management
- Start warehouse and dormitory design
- Support overland traverse to remain on track for full operational traverse in FY 2007
- Continue support for two icebreakers to open channel to McMurdo Station
- Improve the security of USAP IT systems

Longer-term priorities for the program include:

- Complete US commitment to ANDRILL
- Develop a ski-equipped research LC-130
- Replace the current McMurdo trade shops
- Provide for modern warehousing and increase quality of life with new dormitories
- Complete South Pole Traverse
- Increase fuel storage capacity in McMurdo for two years supply
- Complete studies for 24x7 broadband access to South Pole.

Science support and operations are provided primarily through a support contractor, selected through a competitive bidding process. U.S. Coast Guard icebreakers provide access to McMurdo Station for re-supply ships, without which national goals of maintaining three year-round stations would not be possible. Coast Guard costs for icebreaking have increased dramatically in recent years.

The Air Force provides inter-continental air transport to Antarctica and the Air National Guard provides inter- and intra-continental air transport. Both of the above are provided on a reimbursable basis from the Logistical Support Account discussed below. Other agencies and contractors also provide technical support in areas of expertise such as engineering, construction and communications. The estimated costs of these functions are displayed in the following table:

Antarctic Operations and Science Support
(Dollars in Millions)

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Administration	6.10	6.30	6.40
Science Facilities, research ships, field camp operations, science support aircraft	39.30	40.30	41.40
Operations at McMurdo, South Pole and Palmer Stations	35.93	36.80	37.70
Transportation of people and cargo, materials and inventory	21.60	23.10	23.77
Engineering, construction and facilities maintenance	13.00	15.79	16.60
Data handling and communications	18.10	19.60	20.30
Waste management, fire protection, health and safety, quality assurance	3.60	3.70	3.80
U.S. Coast Guard Icebreaker support	6.30	6.70	6.80
Total, Antarctic Operations and Science Support	$143.93	$152.29	$156.77

U.S. ANTARCTIC LOGISTICAL SUPPORT ACTIVITIES $68,070,000

The FY 2005 Budget Request for U.S. Antarctic Logistical Support Activities is $68.07 million, which is unchanged from the FY 2004 Estimate.

Antarctic Logistical Support Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change from FY 2004 Amount	Percent
U.S. Antarctic Logistical Support	68.55	68.07	68.07	0.00	0.0%
Total, U.S. Antarctic Logistical Support Activities	$68.55	$68.07	$68.07	$0.00	0.0%

U.S. Antarctic Logistical Support is provided by U.S. Department of Defense components. The major elements are:

- Military personnel of the 109th Airlift Wing (AW) of the New York Air National Guard.
- 109th AW LC-130 flight activity and aircraft maintenance.
- Transportation and training of personnel in connection with the U.S. Antarctic Program.
- Support of the logistics facilities of the Air Force Detachment 13 in Christchurch, New Zealand and the 109th Airlift Wing in Scotia, New York.
- Support for air traffic control, weather forecasting, and electronic equipment maintenance.
- The charter of Air Mobility Command Airlift and Military Sealift Command ships for the re-supply of McMurdo Station, as well as surface freight charges.
- Fuel purchased from the Defense Logistics Agency.
- Reimbursement for use of Department of Defense satellites for communications.

INTEGRATIVE ACTIVITIES

INTEGRATIVE ACTIVITIES $239,990,000

The FY 2005 Budget Request for Integrative Activities (IA) is $239.99 million, an increase of $95.85 million, or 66.5 percent, above the FY 2004 Estimate of $144.14 million.

Integrative Activities Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Integrative Activities	97.86	144.14	239.99	95.85	66.5%
Integrative Activities	$97.86	$144.14	$239.99	$95.85	66.5%

RELEVANCE

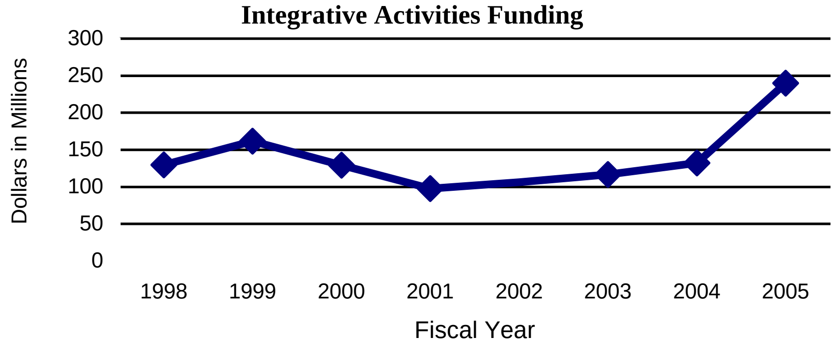
Integrative Activities (IA) supports emerging cross-disciplinary research and education, recognizing the importance of these types of integrative efforts to the future of science and engineering. IA is a source of federal funding for the acquisition and development of research instrumentation at U.S. academic institutions, and funds a number of research centers and programs that support and enhance NSF workforce preparation and investment strategies. In FY 2005, this account also includes funding for the Math and Science Partnership (MSP) program and support for a new Foundation-wide Innovation Fund.

Funds requested and appropriated to IA are managed by a variety of organizations within NSF, which provides the Foundation the flexibility needed to broaden support for emerging cross-disciplinary research programs and activities. For example, the Math and Science Partnership (MSP), previously funded in the Education and Human Resources (EHR) Appropriation, has been transferred to IA in FY 2005 to enable better integration with other NSF disciplines.

Integrative Activities Funding by Program
(Dollars in Millions)

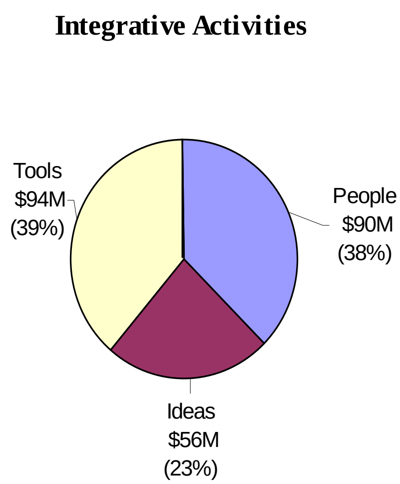
	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Math and Science Partnership[1]	[$144.07]	[$139.17]	80.00	80.00	N/A
Partnerships for Innovation	4.97	9.94	10.00	0.06	0.6%
Disaster Response Teams	0.99	0.00	0.00	N/A	N/A
Innovation Fund	N/A	N/A	5.00	5.00	N/A
Science and Technology Centers	1.69	0.99	30.99	30.00	3030.3%
Science of Learning Centers	2.19	19.88	20.00	0.12	0.6%
Major Research Instrumentation	83.45	109.35	90.00	-19.35	-17.7%
Science and Technology Policy Institute	3.97	2.99	3.00	0.01	0.3%
Research and Development (R&D) Database	N/A	0.99	1.00	0.01	1.0%
NAS Study	0.60	N/A	N/A	N/A	N/A
Total, Integrative Activities	$97.86	$144.14	$239.99	$95.85	66.5%

Totals may not add due to rounding.
[1]Funding for the MSP has been moved from the EHR Account and is reflected in IA in FY 2005.



NSF uses various internal and external mechanisms to review the relevance of proposed and existing programs and to help identify emerging opportunities for agency-wide foci and their associated goals for the future. These include Committees of Visitors, advisory committees, academy and other reports, workshops, and long-range planning documents, among others. Three aims (strategic goals) guide NSF's Integrative Activities efforts:

STRATEGIC GOALS



- PEOPLE: Supports promising partnerships among academe, state/local/federal government and the private sector that will explore new approaches to support and sustain innovation and broaden participation.

- IDEAS: Facilitates the advancement of scientific knowledge and learning research through support of Science and Technology Centers, Science of Learning Centers and other disciplinary research.

- TOOLS: Enables enhancement of the infrastructure for the conduct of research. Investments support acquisition of research instrumentation and the development of laboratories and other facilities needed to do world-class

Summary of Integrative Activities Funding by Strategic Goal
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
People	4.97	9.94	90.00	80.06	805.4%
Ideas	4.87	20.87	55.99	35.12	168.3%
Tools	87.42	113.33	94.00	-19.33	-17.1%
Organizational Excellence	0.60	0.00	0.00	0.00	0.0%
Total, IA	$97.86	$144.14	$239.99	$95.85	66.5%

Budget Highlights

PEOPLE (+$80.06 million, for a total of $90.0 million)

IA People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Collaborations	4.97	9.94	90.00	80.06	N/A
Total, IA People	$4.97	$9.94	$90.00	$80.06	N/A

COLLABORATIONS

- *Math and Science Partnership (MSP).* The budget includes $80.0 million for the Math and Science Partnership program. FY 2005 marks the fourth year for the MSP program at NSF. In FY 2005, NSF begins the process of phasing out the program, although it continues support for (a) out-year commitments to *Comprehensive* and *Targeted* awards made in the first and second competitions and (b) data collection and program evaluation.

  In launching its MSP program in FY 2002, NSF assumed important responsibilities for implementing a key facet of the President's No Child Left Behind (NCLB) vision for K-12 education. The MSP responds to a growing national concern – the lackluster performance of U.S. children in mathematics and science. NCLB articulates this concern and identifies key underlying factors for the poor performance of U.S. students: too many teachers teaching out of field, too few students taking advanced coursework, and too few schools offering challenging curricula and textbooks.

  Integrating the expertise of higher education with that of K-12 to strengthen and reform science and mathematics education, the MSP seeks to improve student outcomes in mathematics and science for *all* students, at all K-12 levels. The MSP program therefore supports the development, implementation and sustainability of promising partnerships among institutions of higher education, K-12 school systems and other important stakeholders to:

  - Ensure that all K-12 students have access to, are prepared for and are encouraged to participate and succeed in challenging curricula and advanced mathematics and science courses;
  - Enhance the quality, quantity and diversity of the K-12 mathematics and science teacher workforce; and
  - Develop evidence-based outcomes that contribute to our understanding of how students effectively learn mathematics and science.

  The MSP program is distinguished from other efforts with a focus on K-12 mathematics and science education by its emphasis on (a) partnerships between institutions of higher education – especially their disciplinary faculty in mathematics, science and/or engineering – and local school districts; and (b) institutional/organizational change in all core partners that ensures the sustainability of promising policies and practices derived from evidence collected in project work. The following domains constitute the key features of the MSP program: partnerships that effectively engage STEM disciplinary faculty; teacher quality, quantity and diversity; challenging courses and curricula; evidence-based design and outcomes; and institutional change and sustainability.

  Three components comprise the MSP program at NSF: (a) *Comprehensive* and *Targeted Partnerships,* (b) *Research, Evaluation and Technical Assistance* (RETA) projects and (c) *Institute*

Partnerships: Teacher Institutes for the 21st Century. MSP *Comprehensive* projects implement change across the K-12 continuum in mathematics, science or both. *Targeted* projects focus on improved student achievement in a narrower grade range or disciplinary focus in mathematics and/or science.

In the *Comprehensive* Appalachian Mathematics and Science Partnership (AMSP), for example, the University of Kentucky partners with 52 rural districts in Kentucky, Virginia and Tennessee, as well as nine other universities/colleges, to improve student achievement in both mathematics and science. The *Comprehensive Partnership* Promoting Rigorous Outcomes in Mathematics/Science Education (PROM/SE) between Michigan State University and five consortia of school districts in Michigan and Ohio utilizes instruments from the Third International Mathematics and Science Study (TIMSS) to collect detailed data on students and teachers, and uses that data to develop more focused and challenging content standards, align standards with instructional materials and improve mathematics and science teaching.

The Vertically Integrated Partnerships K-16 project, a *Targeted Partnership* housed at the University System of Maryland, joins four university partners with the Montgomery County public schools and others to improve high school science instruction. In the Texas Middle and Secondary Mathematics Project, also a *Targeted Partnership*, Stephen F. Austin State University and twelve independent school districts unite to improve mathematics teaching and learning in grades 4-12. The East Alabama Partnership for the Improvement of Mathematics Education partners Auburn University with Tuskegee University and others to improve mathematics education in twelve school districts.

The *Institute Partnerships*, the newest component of the MSP portfolio, are expected to build on the acknowledged strengths of the original NSF *Teacher Institutes*, while giving attention to the changing needs of today's teachers. The *Institutes* are intended to develop teacher leaders who have deep content expertise in mathematics, science and technology related areas; who are excited about newer developments in these fields; and who have the disciplinary depth and stature to motivate students towards continued study of mathematics and science in advanced courses.

All funded MSP projects participate in and contribute to the *MSP Learning Network*, a network of researchers and practitioners studying and evaluating promising strategies to deepen our understanding of how students effectively learn mathematics and science. MSP-RETA projects provide large-scale research and evaluation capacity for the *MSP Learning Network*, and provide *Partnership* awardees with assistance in the implementation and evaluation of their work. The Design, Validation and Dissemination of Measures of Content Knowledge for Teaching Mathematics project at the University of Michigan, for example, is developing and validating instruments to assess teachers' knowledge of mathematics content and how this content is used in teaching upper elementary and middle school algebra and geometry. The instruments are being designed to be especially useful in measuring growth in teacher learning as a result of professional development.

In FY 2003, 271 proposals for *Comprehensive* or *Targeted Partnerships* and an additional 48 RETA proposals were received and externally merit reviewed. From these, 13 Partnership awards were made, including one prototype project for an *Institute Partnership* in anticipation of a major focus on this new MSP component in the FY 2004 competition. Ten RETA awards were also made in FY 2003, including one to establish MSPnet, the electronic community for MSP projects. For the current FY 2004 competition, over 200 proposals have been received and are under review.

NSF continues to cooperate and coordinate its MSP work with that of the U.S. Department of Education (ED) to manage their respective MSP programs for the greatest effectiveness, communicating through the *MSP Learning Network*; through the regular meetings of a *Tiger Team* of representatives from NSF and ED; and through a host of other collaborative activities. In addition, NSF and ED continue to co-manage one *Comprehensive* project and one *Targeted* project awarded in FY 2002 and jointly funded.

- *Partnerships for Innovation (PFI)*. The FY 2005 Request for the PFI program is $10.0 million. PFI funding will support partnership grants that seek to (1) stimulate the transformation of knowledge created by the national research and education enterprise into innovations that create new wealth, build strong local, regional and national economies and improve the national well-being, (2) broaden the participation of all types of academic institutions and all citizens in NSF activities to more fully meet the broad workforce needs of the national innovation enterprise, and (3) catalyze or enhance enabling infrastructure necessary to foster and sustain innovation in the long-term. These awards average $600,000 for a maximum of three years, and more than 90 percent involve academic institutions that do not normally receive a high amount of funding from NSF. On average, fifteen to twenty awards are made each year through this program.

IDEAS (+$35.12 million, for a total of $55.99 million)

IA Ideas Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Fundamental Science and Engineering	0.99	0.00	5.00	5.00	N/A
Centers Programs	3.88	20.87	50.99	30.12	144.3%
Total, IA Ideas	$4.87	$20.87	$55.99	$35.12	168.3%

FUNDAMENTAL SCIENCE AND ENGINEERING

- *Innovation Fund*. The budget includes $5.0 million for a Foundation-wide Innovation Fund. The Innovation Fund provides the agility needed to invest in frontier activities that transcend intellectual and organizational boundaries and test nascent community-driven ideas difficult to fund otherwise. The Fund will seed explorations of emerging science and engineering questions, test instrumentation and process designs, and introduce novel ways to engage U.S. citizens in science and engineering. Emphasis will be placed on strategic investments where focused attention will benefit all of science and engineering, particularly activities at the interfaces of disciplines, integration of research and education, and initiation of new partnerships with other agencies or international entities.

CENTERS PROGRAMS

- *Science and Technology Centers (STCs)*. NSF created the Science and Technology Centers (STC) program in 1989. STCs are university-based research efforts that foster a new collaborative culture among researchers and educators at all levels in academia, industry, government laboratories, and other public and private organizations. In FY 2005, $30.0 million will fund a new cohort of STCs. An estimated six centers will be funded. An additional $990,000 is included for ongoing administrative support of STCs (e.g., annual site visits, contractor support costs, meetings, workshops).

- *Science of Learning Centers (SLCs)*. The FY 2005 Request for the SLC program is $20.0 million. NSF's investment in SLCs was initiated in FY 2003 to build on the Foundation's support for learning research in multiple disciplines. SLCs are built around a unifying research focus and incorporates a diverse, multidisciplinary environment involving appropriate partnerships with academia, industry, international partners, and other public and private entities at all levels of education.

In FY 2005, NSF will continue the third of five years of support for approximately four to five Centers ($3.0 million to $5.0 million per year) awarded in the program's first competition. In addition, the SLC program will support a second cohort of up to 20 Catalyst awards ($200,000 to $250,000 each). This funding level is designed to support a diverse portfolio of research projects, providing leadership across a broad range of science and engineering approaches to science of learning research.

TOOLS (-$19.33 million, for a total of $94.0 million)

IA Tools Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Infrastructure and Instrumentation	83.45	109.35	90.00	-19.35	-17.7%
Federally-Funded R&D Centers	3.97	3.98	4.00	0.02	0.5%
Total, IA Tools	$87.42	$113.33	$94.00	-$19.33	-17.1%

INFRASTRUCTURE AND INSTRUMENTATION

- *Major Research Instrumentation (MRI).* Funding for the MRI program is reduced by $19.35 million from a FY 2004 Estimate of $109.35 million to $90.0 million. MRI funding will (1) support the acquisition and development of major state-of-the-art instrumentation for research, research training, and integrated research and education activities at U.S. institutions, instrumentation that is too costly to support through regular NSF programs, (2) improve access to and increase use of modern research and research training instrumentation by scientists, engineers, graduate and undergraduate students, (3) enable academic departments or cross-departmental units to create well-equipped learning environments that integrate research with education, (4) promote partnerships between academic researchers and private sector instrument developers, and (5) ensure that at least $25.0 million goes to support teaching-intensive institutions and minority-serving institutions, including Historically Black Colleges and Universities, Tribal Colleges, and community colleges, with a focus on research training for American students.

FEDERALLY-FUNDED RESEARCH AND DEVELOPMENT (R&D) CENTERS

- *Science and Technology Policy Institute*. NSF's FY 2005 budget provides $3.0 million for the Science and Technology Policy Institute (STPI) and $1.0 million for a research and development (R&D) database. STPI is a Federally-Funded Research and Development Center established by Congress in 1992 to support the complex task of devising and implementing science and technology policy. The Institute provides analytical support to the Office of Science and Technology Policy (OSTP), to identify near-term and long-term objectives for research and development and to identify options for achieving those objectives. In addition, the Institute supports the Office of Science and Technology Policy by assembling and analyzing information regarding significant science and technology developments and trends. In FY 2003, the Institute for Defense Analysis (IDA) was competitively selected to operate STPI, displacing the RAND Corporation, which had operated the Institute since its establishment in FY 1992.

EDUCATION AND HUMAN RESOURCES

EDUCATION AND HUMAN RESOURCES $771,360,000

The FY 2005 Request for the Education and Human Resources Activity (EHR) is $771.36 million, a decrease of $167.62 million, or 17.9 percent, from the FY 2004 Estimate of $938.98 million.

Education and Human Resources Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Math and Science Partnership[1]	144.07	139.17	0.00	-139.17	-100.0%
EPSCoR	89.21	94.44	84.00	-10.44	-11.1%
Elementary, Secondary and Informal Education[2]	223.30	212.26	172.75	-39.51	-18.6%
Undergraduate Education	172.55	155.50	158.85	3.35	2.2%
Graduate Education	139.50	155.95	173.88	17.93	11.5%
Human Resource Development	99.48	115.85	107.94	-7.91	-6.8%
Research, Evaluation and Communication	66.77	65.81	73.94	8.13	12.4%
Total, EHR	$934.88	$938.98	$771.36	-$167.62	-17.9%

*Totals may not add due to rounding.

[1] FY 2005 funding for the Math and Science Partnership is in the Integrative Activities line of the Budget.

[2] The FY 2003 Actual and FY 2004 Estimate for ESIE includes $40.31 million and $28.01 million, respectively, from Education System Reform (ESR), which has been phased out. In addition, FY 2003 Actual and FY 2004 Estimate have been restated for the purposes of the FY 2005 Budget Request to reflect all funds for the Teacher Professional Continuum (TPC) on this line, including those previously shown in DUE (FY 2003, $6.71 million; FY 2004 Estimate, $6.48 million).

NSF, in accordance with the NSF Act of 1950, is the principal federal agency charged with promoting science and engineering (S&E) education. In support of this mission, the Education and Human Resources Activity promotes the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry that have access to the ideas and tools of science and engineering. The EHR Activity supports education, research, and infrastructure development in all science, technology, engineering and mathematics (STEM) disciplines. The purpose of these activities is to enhance the quality of life of all citizens and the health, prosperity, welfare and security of the nation.

RELEVANCE

Critical issues face the nation’s STEM educational system. Too few K-12 teachers are knowledgeable in science or mathematics. By high school, unacceptably low numbers of students are motivated to enroll in physics or chemistry, and only 20-25 percent of graduating high school seniors have completed enough mathematics to be ready to study science or engineering. S&E degrees each year as a percentage of the population of 24 year olds have remained virtually constant at 5-6 percent for the last several years. Fewer domestic students are pursuing graduate work in S&E fields, and, within this group, women and minorities are seriously underrepresented.

Furthermore, the U.S. Department of Labor estimates that 60 percent of the new jobs being created in our economy today will require technological literacy while only 22 percent of the young people entering the job market now actually possess those skills.

EHR activities help strengthen U.S. education at all levels and help ensure continued U.S. economic and research preeminence. They respond to the need expressed in the recent National Science Board report, *The Science and Engineering Workforce Realizing America's Potential*, "to ensure our country's capacity in S&E in an increasingly competitive and changing global labor market."

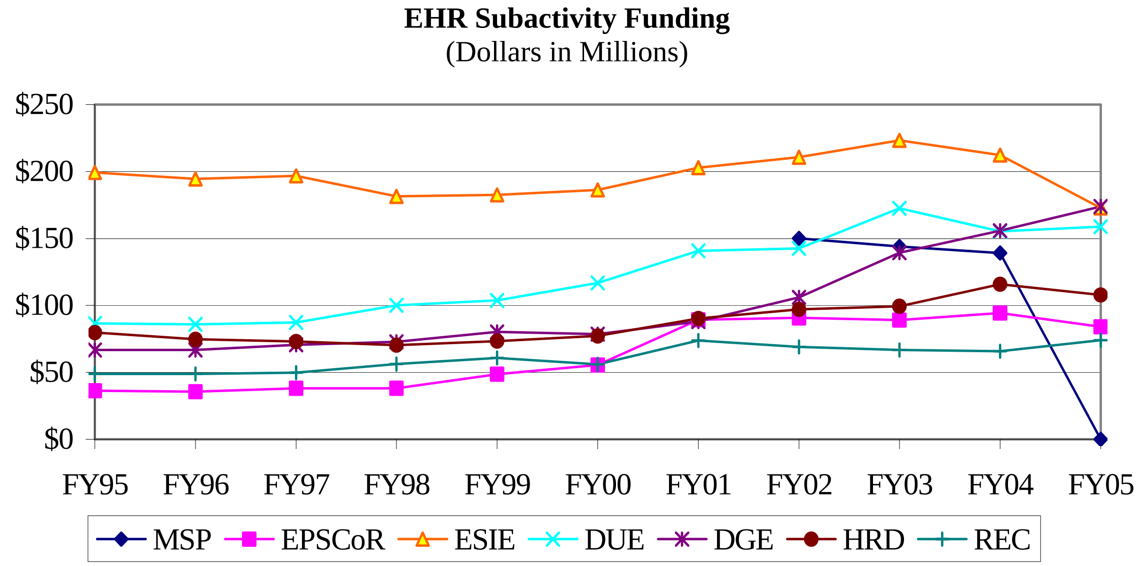
In addressing these issues, the EHR portfolio focuses on three "core" areas:

- Attracting and preparing U.S. citizens for STEM careers
- Developing K-12 teachers and STEM faculty
- Increasing institutional capacity to provide STEM education and prepare STEM professionals

For each of these areas, key programmatic strategies have been developed. The FY 2005 Budget Request provides support for a broad range of educational activities:

- K-12 programs develop effective, research-based instructional materials and provide preparation and professional development for teachers. Development of instructional materials that promote scientific and technological literacy and develop life-long skills for learners of all ages enhance these projects.
- Undergraduate programs focus on developing courses, curricula and laboratory experiences for two- and four-year colleges and universities, expanding the nation's STEM talent, addressing federal workforce needs for cybersecurity specialists, fostering STEM research and education capacity at Historically Black Colleges and Universities (HBCUs) and other minority-serving institutions, and promoting the advancement of women and racial/ethnic minority students to increase their participation in the STEM enterprise.
- Graduate programs provide support to attract and prepare U.S. students for STEM careers. Increasing the number of awards, which in turn will increase the number of supported graduate students, will enhance this support.
- Evaluation and research on education are emphasized throughout the EHR portfolio to inform improvements in educational practice. EHR emphasizes the use of information technology in education and the translation of research results into educational practice.
- EPSCoR's goal is to maximize the potential inherent in a state's science and technology resources and use those resources as a foundation for economic growth.
- Informal science activities across the nation help foster the public understanding of science and promote adult learning in STEM.
- The Workforce for the 21st Century priority area focuses on preparing U.S. domestic students for the STEM workforce, promoting diversity of the workforce, and conducting research to inform the preparation of the next generation of the workforce.

Support for STEM education and related research and human resource development programs for the EHR Subactivities since FY 1995 is shown in the chart below.



STRATEGIC GOALS

The four NSF strategic outcome goals guide EHR activities:

- PEOPLE: EHR contributes approximately 54 percent of all NSF funds intended to achieve NSF's People Strategic Goal. EHR's objectives are to improve the quality of STEM education and training at all levels, increase the diversity of the STEM community and instructional workforce, and broaden the participation of all Americans in the STEM enterprise.

- IDEAS: EHR promotes research on learning, STEM education and the use of learning technologies for students, teachers and adult learners, and fosters the translation of research results into improved educational practice. EPSCoR increases the nation's capacity in S&E research.

- TOOLS: EHR invests in the National STEM Education Digital Library (NSDL), which serves as a national resource to increase the quality, quantity and comprehensiveness of Internet-based STEM educational materials while creating virtual learning communities among students, teachers and faculty.

- ORGANIZATIONAL EXCELLENCE (OE): Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its mission and goals. These investments include support for Intergovernmental Personnel Act appointments and for contractors performing administrative functions as well as for enhancement of the technological capacity required to manage competitions and to monitor the performance of award portfolios.

Faced with difficult choices for competing and meritorious investments, EHR's FY 2005 Budget Request emphasizes the core areas of attracting and preparing U.S. citizens for STEM careers (including increasing support for the Integrative Graduate Education and Research Traineeship, Graduate Research Fellowship and Graduate Fellows in K-12 Education programs), developing K-12 teachers, and increasing institutional capacity to provide STEM education and prepare STEM professionals. The reduction in EHR's budget is primarily due to the phase out of the Math and Science Partnership (MSP). Funding for MSP is discussed in the Integrative Activities chapter. FY 2004 is the last year of the Educational System Reform initiatives ($28.01 million at the FY 2004 Estimate); in FY 2005 these funds are reallocated to support continuing priorities in EHR.

The most significant decrease from the FY 2004 Estimate is $139.17 million for the Math and Science Partnership, which is no longer funded in the EHR Activity.

Other decreases include the following programs:

- Informal Science Education (ISE), decreased by $12.13 million to $50.0 million;
- Experimental Program to Stimulate Competitive Research (EPSCoR), reduced by $10.44 million to $84.0 million;
- STEM Talent Expansion Program (STEP), decreased by $9.85 million to $15.0 million;
- Advanced Technological Education (ATE), reduced by $7.07 million to $38.16 million;
- Robert Noyce Scholarship program, reduced by $3.95 million to $4.0 million; and
- Historically Black Colleges and Universities – Undergraduate Program (HBCU-UP), reduced by $3.88 million to $19.98 million.

Details on the impact of these decreases can be found in the Division narratives following this overview section.

Funding by Strategic Goal: Summary
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
People	748.21	741.53	575.79	-165.74	-22.4%
Ideas	152.15	163.59	161.09	-2.50	-1.5%
Tools	22.43	18.49	21.11	2.62	14.2%
OE	12.09	15.37	13.37	-2.00	-13.0%
Total, EHR	$934.88	$938.98	$771.36	-$167.62	-17.9%

Totals may not add due to rounding.

PEOPLE (-$165.74 million, for a total of $575.79 million)

EHR People Investments
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Individuals	209.21	201.74	209.69	7.95	3.9%
Institutions	137.18	137.05	126.21	-10.84	-7.9%
Collaborations	401.82	402.74	239.89	-162.85	-40.4%
Total, People	$748.21	$741.53	$575.79	-$165.74	-22.4%

Totals may not add due to rounding.

INDIVIDUALS

- Increase support for the Integrative Graduate Education and Research Traineeships (IGERT) by $7.15 million from the FY 2004 Estimate of $24.53 million to $31.68 million in FY 2005, in order to increase the number of participating institutions and awardees.
- Funding for the Graduate Research Fellowships (GRF) program is increased by $5.53 million from the FY 2004 Estimate of $89.21 million to $94.74 million in FY 2005. This will support additional awards and promote increased diversity in the applicant and awardee pools.
- Other EHR activities in support of the Individuals component of the People goal include the development of K-12 teachers with strong disciplinary and pedagogical content knowledge, and undergraduate students well-prepared to enter the scientific and technological workforce or advance to graduate S&E education.

Individuals Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Graduate Research Fellowships	79.76	89.21	94.74	5.53	6.2%
IGERT	23.39	24.53	31.68	7.15	29.1%
Noyce Scholarships	6.93	7.95	4.00	-3.95	-49.7%
Scholarships for Service	30.14	16.08	16.18	0.10	0.6%
Teacher Professional Continuum	66.65	62.16	62.16	0.00	0.0%
Other	2.34	1.81	0.93	-0.88	-48.6%
Total, Individuals	$209.21	$201.74	$209.69	$7.95	3.9%

Totals may not add due to rounding.

INSTITUTIONS

- Support for Course, Curriculum, and Laboratory Improvement (CCLI) for undergraduate students in the nation's two- and four-year colleges and universities is $46.53 million in FY 2005, an increase of $6.12 million over the FY 2004 Estimate of $40.41 million.
- The STEM Talent Expansion Program (STEP) is funded in FY 2005 at $15.0 million, a decrease of $9.85 million from the FY 2004 Estimate, which allows support for approximately ten awards.

- Instructional and Assessment Materials Development (IMD) is funded at $29.45 million, an increase of $630,000 over the FY 2004 Estimate of $28.82 million. IMD projects develop student materials and assessments for improving preK-12 STM education nationally.
- The Advanced Technological Education (ATE) program, which supports improvement in technician education in science- and engineering-related fields that drive the nation's economy, particularly at two-year colleges and secondary schools, is decreased from the FY 2004 Estimate of $45.23 million by $7.07 million to $38.16 million.

<u>COLLABORATIONS</u>

- Support for NSF Graduate Teaching Fellows in K-12 Education (GK-12) totals $47.46 million, an increase of $5.25 million over the FY 2004 Estimate of $42.21 million. The GK-12 Program promotes collaboration between universities and K-12 schools that benefit K-12 students and teachers, as well as the science and engineering graduate students who serve as resources in the K-12 classrooms.
- Support for the Louis Stokes Alliances for Minority Participation (LSAMP) program will be sustained at the FY 2004 Estimate of $34.30 million, and the Alliances for Graduate Education and the Professoriate (AGEP) program will also be level-funded at $14.91 million, to allow for continuing alliances and integration between the programs.
- Other investments in Collaborations foster partnerships with colleges, universities, school districts, and other institutions - public, private, state, local, and federal - to strengthen STEM education at all levels and increase the participation of underrepresented minorities and women in STEM fields.

Collaborations Funding by Program
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Centers for Learning and Teaching	24.60	26.84	26.84	0.00	0.0%
Evaluation	12.50	11.57	11.57	0.00	0.0%
GK-12	36.34	42.21	47.46	5.25	12.4%
HBCU-UP	18.71	23.86	19.98	-3.88	-16.3%
Informal Science Education	60.23	62.13	50.00	-12.13	-19.5%
LSAMP	31.81	34.30	34.30	0.00	0.0%
Math and Science Partnership	144.07	139.17	0.00	-139.17	-100.0%
Alliances for Graduate Education and the Professoriate	11.48	14.91	14.91	0.00	0.0%
Tribal Colleges	9.84	9.92	9.92	0.00	0.0%
Other	52.24	37.83	24.91	-12.92	-34.2%
Total, Collaborations	$401.82	$402.74	$239.89	-$162.85	-40.4%

Totals may not add due to rounding.

IDEAS (-$2.50 million, for a total of $161.09 million)

<u>FUNDAMENTAL SCIENCE AND ENGINEERING</u>

- Support for Research on Learning and Education (ROLE) increases by $8.13 million to $47.46 million in FY 2005. This reflects the need to increase the research base to inform improvements in our nation's educational enterprise.

<u>CAPABILITY ENHANCEMENT</u>

- EPSCoR is funded at $84.0 million, a decrease of $10.44 from the FY 2004 Estimate to support Research Infrastructure Improvement, co-funding and outreach for EPSCoR. An additional $30.0 million is funded in the Research and Related Activities Account, for a total of $114.0 million in FY 2005.

TOOLS (+$2.62 million, for a total of $21.11 million)

<u>INFRASTRUCTURE AND INSTRUMENTATION</u>

EHR's investment in the National STEM Education Digital Library (NSDL) is increased by $2.62 million over the FY 2004 Estimate of $18.49 million to $21.11 million. NSDL will serve as a national resource to increase development and access of high quality educational materials while creating virtual learning communities among students, teachers, and faculty.

ORGANIZATIONAL EXCELLENCE (-$2.0 million for a total of $13.37 million)

Organizational Excellence provides for administrative activities necessary to enable NSF to achieve its strategic goals. Requested funding for FY 2005 is $13.37 million, compared to $15.37 million in FY 2004. This includes the cost of the Intergovernmental Personnel Act (IPA) appointments and contractors performing administrative functions.

PRIORITY AREAS

In FY 2005, EHR will support research and education efforts related to broad, Foundation-wide priority areas in Nanoscale Science and Engineering, Workforce for the 21st Century, and Mathematical Sciences.

EHR Investments in NSF Priority Areas
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Nanoscale Science and Engineering	0.22	2.55	4.16	1.61	63.1%
Workforce for the 21st Century	N/A	0.00	15.38	15.38	N/A
Mathematical Sciences	2.74	2.74	2.74	0.00	0.0%
Human and Social Dynamics	0.00	0.99	0.00	-0.99	-100.0%

Nanoscale Science and Engineering (NSE): The EHR contribution to NSE increases by $1.61 million to $4.16 million in FY 2005 to support undergraduate education and the new emphasis on K-12 nanoscience education.

Workforce for the 21st Century: In FY 2005, $15.38 million is requested for this effort. EHR will focus on preparing scientists, mathematicians, engineers, technologists and educators capable of meeting the challenges of the 21st Century; attracting students, especially those students who have traditionally been underrepresented, to science, technology, engineering and mathematics (STEM) disciplines, thus increasing participation in and diversity of the STEM workforce.

Mathematical Sciences: FY 2005 support totals $2.74 million, equal to the FY 2004 Estimate, providing continuing support for mathematical sciences education activities.

Human and Social Dynamics: Due to the constraints of overall funding, EHR will not make a formal contribution to the Human and Social Dynamics (HSD) priority area in FY 2005. If appropriate, some HSD proposals will be considered for funding within EHR's Division of Research, Evaluation and Communication (REC).

QUALITY

EHR maximizes the quality of the research and education it supports through the use of a competitive, merit-based review process. The percent of basic and applied research funds that were allocated to projects that undergo merit review was 97 percent in FY 2003, the last year for which complete data exist. Project evaluation is required with projects reporting their progress and impact through annual and final reports to NSF. In addition, external program evaluations are conducted for EHR-managed activities.

To ensure the highest quality in processing and recommending proposals for awards, EHR convenes Committees of Visitors, composed of qualified external evaluators, to review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of results of NSF's investments.

The Directorate also receives advice from the Advisory Committee for Education and Human Resources (EHRAC) on such issues as: the mission, programs, and goals that can best serve the scientific community; how EHR can promote quality graduate and undergraduate education in science, technology, engineering and mathematics (STEM); and priority investment areas in STEM education research. The EHRAC meets twice a year and members represent a cross section of STEM disciplines; a cross section of institutions including industry; broad geographic representation; and balanced representation of women and underrepresented minorities.

PERFORMANCE

Recent Research Highlights

The National Center for Accessible Media is developing access specifications for the use of the National STEM Education Digital Library (NSDL) by persons with disabilities, and building the NSDL capacity to ensure interoperability and accessibility of their collections and services. This project is also contributing to the national and international effort to ensure that users with disabilities will have access to online learning resources.

A teacher at an Oklahoma City Community College biotechnology workshop views live cell cultures under a microscope.

Funded by the ***Advanced Technological Education Program***, Oklahoma City Community College is working with the local school districts to infuse high quality biotechnology programs into the high schools. Using nationally developed curriculum as well as engaging parents and mentors, the programs are preparing high school students, especially minority students underrepresented in the sciences, for further study and careers in biotechnology.

In 2002, more than 21,429 underrepresented minority students received science and engineering baccalaureate degrees via the ***Louis Stokes Alliances for Minority Participation Program (LSAMP)***. Collectively, the reach of the LSAMP program extends north to Alaska, Washington, Montana and New York; south to Texas, Florida and Puerto Rico; east to Massachusetts, Rhode Island, Pennsylvania and the Carolinas; through Middle America, including Illinois, Missouri, Oklahoma, Tennessee, Colorado and New Mexico; and west to Arizona, California and Hawaii. The program now includes 30 alliances representing over 400 individual institutions. In 2003, the number of STEM students impacted directly by the LSAMP program reached an all-time high of 206,893.

DragonflyTV features children engaged in their own science investigations, and these investigations are crafted and presented—in collaboration between the show producers and the featured children—to model complete inquiry experiences. *DragonflyTV* young investigators explore every kind of science, from the mysteries of the human body to the power of a tornado. More than 50 percent of young investigators are girls and more than 50 percent are children of color. Program evaluations have demonstrated that children who watch *DragonflyTV* increase their interest in doing science investigations and have a better appreciation of experimental techniques. In 2002, the first season of *DragonflyTV* aired on 250 PBS stations, with the potential for reaching 87 percent of U.S. households. According to Nielsen Research for February 2002, 1,600,000 viewers tuned in each week; total viewers for 2002 exceeded 25,000,000. Nearly 25 percent of the audience was composed of children, ages 6-11; 33 percent were adults, suggesting that many families watch the show together. NSF funding has helped leverage major corporate underwriting from Best Buy, which has recently committed $1.1 million to the continuation of the series.

Victoria and Alejandra from DragonflyTV at the Guadalupe-Nipomo Sand Dunes near San Luis Obispo, California.

Access Science, a project in the NSF Graduate Teaching Fellows in K-12 Education Program, supports graduate students in science and engineering departments at the University of Pennsylvania to work with K-12 students and teachers in the urban public schools in West Philadelphia. With a school population that is 98 percent African American, this project is having a significant impact on populations that are currently underrepresented in the science and engineering fields.

The ***Cancer Detection using 3-D Ultrasonic Imaging*** project at Wayne State University, funded through the Integrative Graduate Education and Research Traineeship Program, is a collaboration between WSU and Karmanos Cancer Research Institute. Engineering, physics, and medicine graduate students as well as medical clinicians are conducting multi-disciplinary research to develop a detection technique with image resolution smaller than 2 mm (typical precursor size of cancer tumors) so that early detection and diagnosis of the tumors could lead to possible therapeutic treatments and higher survival rates.

The Center for Learning and Teaching with a Focus on Research for Developing Instructional Materials in Science represents a collaboration of the American Association for the Advancement of Science, Northwestern University, the University of Michigan, Michigan State University, as well as the Detroit and Chicago Public School Systems. This Center is creating a new generation of leadership for curriculum development, evaluation, and implementation. Efforts focus on (1) developing a national infrastructure at doctoral and postdoctoral levels; (2) providing training to current and prospective science teachers and related professionals; and (3) conducting research on materials development and methods for determining their impact on teacher and student learning.

Members of the West Philadelphia High School Electric Vehicle Team pose with their project.

Number of People Involved in EHR Activities

	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate
Senior Researchers	5,900	5,900	5,500
Other Professionals	3,800	3,800	2,200
Postdoctorates	430	450	290
Graduate Students	4,345	4,800	5,075
Undergraduate Students	21,000	21,000	19,000
K-12 Students	13,000	14,000	10,500
K-12 Teachers	84,500	85,500	82,000
Total Number of People	132,975	135,450	124,565

Change in Teacher Professional Continuum (TPC) Funding by Division

A portion of funds for the Teacher Professional Continuum were expended from the Division of Undergraduate Education in FY 2003 and a portion of funds for this program are reflected in the Congressional report language for FY 2004. In FY 2005, funds have been consolidated in the Elementary, Secondary, and Informal Education (ESIE) Subactivity. In order to compare data across all years in a meaningful manner, FY 2003 Actual and FY 2004 Estimate data have been restated for the purposes of the FY 2005 Budget to reflect all TPC funds in the ESIE Subactivity. Prior to the restatement, funds were distributed as shown below.

TPC Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
Undergraduate Education	6.71	6.48	0.00
Elementary, Secondary and Informal Education	59.94	55.68	62.16
Total, TPC	$66.65	$62.16	$62.16

Totals may not add due to rounding.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH $84,000,000

The FY 2005 Request for the Experimental Program to Stimulate Competitive Research (EPSCoR) is $84.0 million, a decrease of $10.44 million, or 11.1 percent, below the FY 2004 Estimate of $94.44 million.

Experimental Program to Stimulate Competitive Research Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Experimental Program to Stimulate Competitive Research	89.21	94.44	84.00	-10.44	-11.1%
Total, EPSCoR	$89.21	$94.44	$84.00	-$10.44	-11.1%

EPSCoR is a State-NSF partnership designed to stimulate sustainable improvements in R&D competitiveness through the development and utilization of science and technology (S&T) resources that reside in a state's major research universities. EPSCoR emphasizes local direction and administration by broad-based statewide governing committees; program accountability at all levels; and non-federal cost-sharing investments. EPSCoR currently operates in twenty-four states, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands. The states are: Alabama, Alaska, Arkansas, Delaware, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, West Virginia, and Wyoming. EPSCoR attempts to develop nationally competitive R&D infrastructures within participating states by promoting partnerships among state government, universities, and the private sector in strategic research areas with high growth potential.

The FY 2005 Budget Request represents a decrease of $10.44 million from the FY 2004 Estimate, which may require NSF to provide less support for infrastructure awards.

The success of EPSCoR-supported projects is demonstrated in the following examples:

- Researchers at the University of Oklahoma have developed a new method for processing semiconductor laser materials. Use of this procedure will significantly reduce self-heating effects that presently limit the performance of various diode laser technologies. For example, the lifetime of short wavelength lasers designed for next generation high definition DVD players can be increased significantly by using this new packaging technology. Operation temperatures of long wavelength lasers designed for chemical sensing applications can be significantly increased using this new method, helping to reduce the size and cost of sensors used to diagnose diseases such as asthma and monitor air samples for homeland security needs.

- The Montana NSF EPSCoR investment in bio-nanotechnology has resulted in a national effort with both biomedical and electronic applications. The Montana nanotechnology group has successfully synthesized a variety of mono-disperse transition-metal oxide based nanomaterials within various protein cage structures and placed these structures into 2-dimensional arrays. By varying the magnetic alloy content within these cage structures, it is possible to modify the primary (magnetic moment) and secondary magnetic properties of the ion. These monodisperse magnetic particles with controllable magnetic properties and interactions serve as the building blocks for the next generation of electronic memory and logic and have important potential applications in drug delivery and treatments. Several collaborations have been fostered involving Montana scientists and engineers from MIT, Caltech, Scripps, NASA, and UCLA. It motivated the generation of an NSF-supported Nanotechnology Interdisciplinary Research Team (NIRT) proposal, funded by NSF for 5 years.

- On the island of Kauai, a weather-monitoring network is being established using equipment purchased under Hawaii's EPSCoR Research Infrastructure Improvement grant. This network will provide continuous data feeds on regional climate conditions through a wireless network of weather stations/repeaters into an ecoinformatics database program at the Manoa campus. A rich dataset of weather on regional and microclimate scales will be integrated with ecologic and genetic data to allow researchers to develop more accurate models that will assist in the preservation of endangered species and control of invasive species. Integration of research and education is an important part of this project. Partnering with Kamehameha Schools, university graduate and undergraduate students interact with intermediate and secondary level students who are largely of Native Hawaiian ancestry.

- South Dakota Science on the Move consists of two converted semi-trailers, which come equipped with 12 lab stations and a skilled science instructor. These two mobile science classrooms travel to South Dakota's K-12 schools, bringing high-tech learning opportunities and hands-on experiences that are not always available to students in small rural schools. The project is a cooperative effort between South Dakota EPSCoR, state of South Dakota, NSF, the Governor's Math, Science, and Technology Council (MSTC), the South Dakota Rural Development Council, the Governor's Office of Economic Development, South Dakota Future Funds, and the Howard Hughes Medical Institute.

Funding of $84.0 million in EHR is supplemented in the FY 2005 Request by approximately $30.0 million for co-funding activities in the Research and Related Activities Appropriation, bringing total EPSCoR support to approximately $114.0 million. The FY 2005 Request level will require NSF to provide less than level continuing support for the following activities:

Research Infrastructure Improvement (RII) Awards - RII are 36-month awards of up to $9.0 million total for research infrastructure improvements in S&T areas identified as critical to a state's future R&D competitiveness. A fifty percent non-federal state match is required over the term of the award.

Co-funding - Co-funding efforts at NSF involve joint support of research and education proposals submitted by researchers from EPSCoR states to the Foundation's ongoing grant programs as a means of accelerating the movement of EPSCoR researchers and institutions into the mainstream of federal and private sector R&D support. During the period FY 1998-2003, researchers from EPSCoR states received over 1,100 awards totaling $392.0 million through this mechanism. EPSCoR provided $165.40 million and NSF research programs provided $226.60 million of this total.

Outreach - NSF program officers and staff coordinate a comprehensive outreach program to universities, industry, and state government in EPSCoR states to inform researchers and S&T administrators of NSF policies and programs. Since the program's inception in FY 1998, NSF staff have made almost 900 visits to EPSCoR states to foster greater participation by institutions and researchers in other NSF-supported activities.

ELEMENTARY, SECONDARY, AND INFORMAL EDUCATION $172,750,000

The FY 2005 Request for the Elementary, Secondary, and Informal Education (ESIE) Subactivity is $172.75 million, a decrease of $39.51 million, or 18.6 percent, from the FY 2004 Estimate of $212.26 million.

Elementary, Secondary and Informal Education Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Instructional and Assessment Materials Development	28.78	28.82	29.45	0.63	2.2%
Teacher Development[1]	134.08	121.31	93.30	-28.01	-23.1%
Informal Science Education	60.44	62.13	50.00	-12.13	-19.5%
Total, ESIE	$223.30	$212.26	$172.75	-$39.51	-18.6%

Totals may not add due to rounding.
[1] FY 2003 Actual and FY 2004 Estimate for ESIE include $40.31 million and $28.01 million, respectively, from Education System Reform (ESR), which has been phased out. In addition, FY 2003 Actual and FY 2004 Estimate have been restated for the purposes of the FY 2005 Budget Request to reflect all funds for the Teacher Professional Continuum (TPC) on this line, including those previously shown in DUE (FY 2003, $6.71 million; FY 2004 Estimate, $6.48 million).

ESIE's comprehensive programming develops research-based models and high-quality, innovative resources designed to strategically impact learning and teaching in science, technology, and mathematics (STM) education, grades preK-12. Instructional materials and student assessments that promote active investigation, together with new models for teacher education, contribute to STM classroom environments that serve all students well. Moreover, ESIE media, exhibit, and community-based efforts increase scientific and technological literacy and develop life-long skills for learners of all ages. ESIE programs create a solid educational foundation for the future research, instructional, and technological workforce, as well as for students pursuing post-secondary education in other disciplines. All ESIE efforts incorporate innovations that promote high standards in content, pedagogy, and assessment; and through collaborations, capitalize on the strengths of formal and informal education, research and practitioner communities, and major stakeholders (e.g., higher education, school districts, state agencies).

Instructional and Assessment Materials Development (IMD) projects develop student materials and assessments for improving preK-12 STM education nationally. These materials influence traditional textbooks and are gaining wider national acceptance as a growing body of research demonstrates their impact on student performance. For example, *Everyday Mathematics* (a curriculum for grades K-6) has been adopted citywide in New York, Philadelphia, Chicago, Portland, Seattle, and Denver. A recently proposed, innovative, physics-chemistry-biology sequence promotes understanding of biological processes at the molecular level. San Diego is studying the implementation of this sequence using NSF-funded curricula *Active Physics* and *Living by Chemistry*. *Active Physics* is taught to over one million 9th-grade students and is also being implemented in Prince George's County (MD), Boston (MA), and Little Rock (AR). Emphasis in IMD is placed on developing and researching new approaches to teaching secondary science, technology, and mathematics, and testing the limits of emerging educational technologies.

Teacher Development supports creation of models and resources requisite to large-scale STM education reform. A coherent approach to the teacher education continuum consolidates lessons learned from pre-service, in-service, and systemic programs.

Teacher Development activities include:

- **Centers for Learning and Teaching (CLTs)**, which address national priorities for (a) rebuilding and diversifying the human infrastructure for science, technology, engineering and mathematics (STEM) education; (b) increasing the number of highly qualified K-16 educators; and (c) conducting research on learning, teaching, and education policies. Recently funded CLTs focus on creating a national facility for research on science education, mathematics teaching in urban settings, and studying mathematics curriculum development. A recent adaptation of CLT for the nanoscale priority area will accelerate and study the integration of advances in emerging technologies into our nation's classrooms, grades 7-16. Doctoral-student recruitment at the University of California, Berkeley, a partner in the *Diversity in Mathematics Education Center* (University of Wisconsin), represents a notable CLT impact. Four of the six students recruited for 2003-2004 received university fellowships, a number typically awarded to the entire College of Education. In 2003, a significant international dimension was introduced as the German Research Foundation and NSF identified research themes of mutual interest for joint support. FY 2005 funding for this program is $26.84 million, unchanged from the FY 2004 Estimate.

- **Teacher Professional Continuum (TPC)**, which provides a coherent continuum of professional experiences that both prepare teachers and enhance their skills. TPC is a jointly-managed activity with DUE and seeks to expand research on effective STM teaching and teacher learning; to disseminate research findings, strategies and resources to national audiences; and to strengthen the infrastructure that supports the STM teaching professional. NSF has had a major impact on secondary physics teaching nationwide. *QuarkNet* Centers at 43 universities are actively engaging teachers in high energy physics research and translation of these experiences into classrooms. Sustained support for the mature *QuarkNet* effort – jointly supported with NSF's Physics Division – will be provided by the Department of Energy. *Modeling Physics* and *Physics by Inquiry* are both education research projects that now serve teachers across the grades 6-16 and K-20 continuum, respectively. Investigators from both projects have been recognized for their seminal work, one receiving the Oersted Medal, the highest award for physics education given by the American Association of Physics Teachers (AAPT) for original work in physics education; the other received the 2002 Medal of the International Commission on Physics Education at Udine, Italy. FY 2005 funding for this program is $62.16 million, equal to the FY 2004 Estimate.

- **Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST)**, which provide national career recognition for exemplary elementary and secondary teachers of mathematics and science. FY 2005 funding is $4.30 million, unchanged from the FY 2004 Estimate.

Informal Science Education (ISE) promotes public interest, understanding, and engagement in science and technology through voluntary, self-directed, and life-long learning opportunities for millions of children and adults. ISE-supported activities include development of science museum exhibits, radio and television series, large-format films, youth programs, and Web-based projects. One example, *Citizen Science* developed by the Cornell Lab of Ornithology in partnership with the National Audubon Society, integrates informal learning with scientific research and conservation. The Web portal www.eBird.org allows the public to enter and analyze observations used by Cornell researchers to study the distribution and abundance of North American birds; some 15 million records already have been contributed to this national database. ISE projects often receive national recognition. Recent examples include the Emmy for Outstanding Science, Technology, and Nature Programming for the PBS NOVA program, *The Secret Life of the Brain*, and the Giant Screen Theater Association Lifelong Learning Award for Jane Goodall's *Wild Chimpanzees*. Due to the decreased FY 2005 funding level, new initiatives to further develop the informal science education infrastructure and its connections to formal education will be scaled back.

UNDERGRADUATE EDUCATION $158,850,000

The FY 2005 Request for the Undergraduate Education (DUE) Subactivity is $158.85 million, an increase of $3.35 million, or 2.2 percent, over the FY 2004 Estimate of $155.50 million.

Undergraduate Education Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Curriculum, Laboratory, and Instructional Development	99.70	93.20	88.14	-5.06	-5.4%
Workforce Development[1]	72.85	62.30	70.71	8.41	13.5%
Total, DUE	$172.55	$155.50	$158.85	$3.35	2.2%

Totals may not add due to rounding.
[1] FY 2003 Actual and FY 2004 Estimate have been restated for the purposes of the FY 2005 Budget Request to reflect all funds for the Teacher Professional Continuum (TPC) in the ESIE Subactivity, including those previously displayed on this line in DUE (FY 2003, $6.71 million; FY 2004 Estimate, $6.48 million).

The Undergraduate Education Subactivity serves as NSF's focal point for the improvement of undergraduate science, technology, engineering, and mathematics (STEM) education and provides leadership and project support for efforts that promote the opportunity for all undergraduate students including disciplinary majors, prospective preK-12 teachers, undergraduate majors in other fields, and prospective technicians to engage in inquiry-based learning. Objectives are to improve STEM learning across the undergraduate spectrum through the reform of courses, laboratories, curricula, and instructional materials, and to increase the quality and quantity of the science and engineering workforce.

Curriculum, Laboratory, and Instructional Development includes:
The STEM Talent Expansion Program (STEP), initiated in FY 2002, supports efforts at colleges and universities to increase the number of U.S. citizens and permanent residents pursuing and receiving associate or bachelor's degrees in established or emerging STEM fields. The FY 2005 Request is $15.0 million, a decrease of $9.85 million from the FY 2004 Estimate of $24.85 million. This will decrease the already very low success rate in the program. The restricted size of the awards will require that the scope and number of partners able to engage in any given project be limited.

The **Robert Noyce Scholarship Program** offers scholarships for juniors and seniors majoring in mathematics, science or engineering, and stipends for science, mathematics, or engineering professionals seeking to become teachers. Projects help recipients obtain certification and become successful math and science teachers in high-need K-12 schools. FY 2005 funding for this program is $4.0 million, a decrease of $3.95 million from the FY 2004 Estimate of $7.95 million.

National STEM Education Digital Library (NSDL), opened in 2002, establishes a national resource of high quality Internet-based STEM educational content and services to support learners at all levels, in formal and informal settings and forms a critical part of the cyberinfrastructure for teaching and learning. The FY 2005 Request will support continued development of NSDL by strengthening the core integration of previously-funded collections and services projects; continued incorporation of technological advances and targeted research to improve the functionality and usability of NSDL services; initiation of new collections of high quality educational products and digital library services, and expansion of user services across the breadth of the preK-12 enterprise. The FY 2005 Request for this program is $21.11 million, an increase of $2.62 million over the FY 2004 Estimate of $18.49 million.

The NSF Director's Awards for Distinguished Teaching Scholars program seeks to engage faculty who bring the excitement and richness of discovery in STEM fields to all students. The recipients share NSF's "highest honor for excellence in both teaching and research." The FY 2005 Request is held at the FY 2004 Estimate of $1.50 million.

Course, Curriculum, and Laboratory Improvement (CCLI) aims to assure all students access to a high quality STEM education by focusing on the identification, development, adaptation, implementation, dissemination and assessment of exemplary curricular and laboratory educational materials and instructional models. The focus includes introductory and upper level courses, and disciplinary and interdisciplinary efforts in established and emerging fields. This program also supports assessments of undergraduate student performance and provides measures for student academic learning outcomes and the quality of educational environments in support of student learning. The FY 2005 Request for CCLI is $46.53 million, a $6.12 million increase from the FY 2004 Estimate of $40.41 million. This increase will allow an emphasis on assessment and evaluation, modern instrumentation, and educational materials and curricula and program development in emerging areas.

Workforce Development includes:
Federal Cyber Service: Scholarship for Service (SfS) seeks to build a cadre of individuals in the federal sector with the skills needed to protect the nation's critical information infrastructure. Scholarships provide full tuition, academic fees, and student stipends in exchange for service in federal agencies after graduation. Capacity building grants improve the quality and increase the production of information assurance and computer security professionals. FY 2005 funding for SfS is increased by $100,000 over the FY 2004 Estimate of $16.08 million to $16.18 million.

Advanced Technological Education (ATE) supports improvement in technician education in science- and engineering-related fields that drive the nation's economy, particularly at two-year colleges and secondary schools, by supporting the design and implementation of new curricula, courses, laboratories, educational materials, opportunities for faculty and student development, and collaboration among educational institutions and partners from business, industry, and government. In FY 2005, funding is decreased from the FY 2004 Estimate of $45.23 million by $7.07 million to $38.16 million. This will preclude the program from supporting additional activities in core mathematics and science in community colleges and from supporting summer and other research opportunities for community college faculty and students at four-year institutions and research laboratories.

Teacher Professional Continuum (TPC), a joint activity between DUE and ESIE, addresses critical issues regarding the recruitment, preparation, enhancement, and retention of K-12 science, technology, and mathematics teachers. All funds for this activity are shown in ESIE.

The **Higher Education Centers for Learning and Teaching (HE CLTs),** an extension of the CLT program in ESIE, support coordinated efforts to reform teaching and learning at the nation's colleges and universities through a blend of research, faculty professional development, and education practice. The FY 2005 Request of $990,000 is unchanged from the FY 2004 Estimate. Support for these centers is also provided by ENG and MPS.

Workforce for the 21st Century priority area funding of $15.38 million will focus on attracting and preparing U.S. domestic students for the STEM workforce, especially those students who have traditionally been underrepresented in these fields, and conducting research to inform the preparation of the next generation of the workforce.

GRADUATE EDUCATION $173,880,000

The FY 2005 Request for the Graduate Education (DGE) Subactivity is $173.88 million, an increase of $17.93 million, or 11.5 percent, over the FY 2004 Estimate of $155.95 million.

Graduate Education Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Graduate Education Funding	139.50	155.95	173.88	17.93	11.5%
Total, DGE	$139.50	$155.95	$173.88	$17.93	11.5%

The Graduate Education Subactivity aims to recognize and support a diverse pool of outstanding individuals in their pursuit of advanced science, technology, engineering, and mathematics (STEM) education; to reform graduate education; and to build stronger links between higher education and K-12 education. These efforts help strengthen U.S. education at all levels and help ensure continued U.S. economic and research preeminence. Individuals are supported through graduate research and teaching fellowships and traineeships. The increase of $17.93 million reflects the Foundation's commitment to increasing the number of awards and graduate students supported to attract high quality students necessary for the nation's future. In academic year 2004-2005, the annual stipend will be $30,000. An estimated 5,500 GRF, GK-12, and IGERT Fellowships and Traineeships will be supported NSF-wide.

Graduate Research Fellowships (GRF) support the most promising science, mathematics, and engineering students in the U.S. to develop their knowledge and skills so that they perform at the forefront of education and research. In FY 2005, priorities include achieving greater diversity in the applicant and awardee pools and increasing the number of awards. Since 1952, nearly 39,000 U.S. students have received GRF awards. Support from EHR is increased from the FY 2004 Estimate of $89.21 million by $5.53 million to $94.74 million. Total NSF support is $103.30 million.

Although awarded at the early stages of their careers, Fellows have truly remarkable records of accomplishment. Examples of specific activities Fellows have pursued over the past year in addition to their superb academic achievements are:

- Michelle Rich, a student in Archeology at Southern Methodist University, is broadening participation in science through her work with the Waka' (El Peru) Archaeological Project by hiring local Guatemalans to participate in the project. She worked directly with four individuals from different towns to help train them as an archaeological field crew. On a practical level, what they learned can help them not only to secure future gainful employment, but also provides an opportunity for them to understand and teach the public about the history of their region.

- Kathryn DeLaurentis, a Mechanical Engineering Student at Rutgers University (RU), is involved in The Academy at Rutgers for Girls in Engineering and Technology, aimed at encouraging greater involvement of young women (grades 7-10) in engineering and science. She is a mentor for students enrolled in the Ronald E. McNair and the Minority Academic Career (MAC) Programs. In addition, she participated in the RU Graduate Student Advocacy Day on Capitol Hill. She and her fellow graduate students communicated to Congress the importance of and need for federal support for graduate education.

Graduate Teaching Fellowships in K-12 Education (GK-12) supports graduate and advanced undergraduate STEM students working in partnership with K-12 teachers to expand and strengthen the teachers' content knowledge and teaching skills in science and mathematics, and to help the graduate students develop communication and pedagogical skills. Within DGE, support for this program is increased from the FY 2004 Estimate of $42.21 million by $5.25 million to $47.46 million. Total NSF support is $55.70 million.

GK-12 Fellows at North Carolina State are working with students who do not normally participate in science because of language or other limitations. A bilingual Fellow working with limited English proficient Hispanic students at Combs Elementary in Raleigh, North Carolina was instrumental in enabling them to participate in the district science fair. This led to a permanent partnership between Combs and university students in the Spanish for Engineers class. A Fellow who spoke American Sign Language worked with students in the hearing impaired department of Combs and discovered that many science concepts have no unique signs; for example, chemistry and physics have the same sign. As a result the Fellow and teachers at the school produced a handbook for interpreting science to hearing impaired students, including a suggested standardized list of signs to be used county-wide. Interest in science increased dramatically among the hearing impaired students. The hands-on activities brought to their classroom made it possible for them to understand a subject that had previously been inaccessible. Two hearing impaired students entered the annual science fair, and one won in his category.

Research advisors of the current Cornell University GK-12 Fellows were asked for comments on the GK-12 program and its impacts on their advisee and his/her graduate work (either positive or negative), Based on their responses, the program is a success. A typical response was "I have to say that the program has been great for her and has really inspired her to develop interesting interactive projects for the students. She has balanced the teaching with her research extremely well and I think that everyone concerned is benefiting from her efforts - particularly the students who are being turned on to science by her enthusiasm and excellent projects. I think that this is a great program and appreciate the chance to have my graduate student participate in it."

Integrative Graduate Education and Research Traineeships (IGERT), an NSF-wide program initiated in FY 1998, supports U.S. scientists and engineers pursuing careers in research and/or education with interdisciplinary backgrounds and deep knowledge in chosen disciplines. The program is intended to catalyze a cultural change in graduate education for students, faculty, and institutions by establishing innovative new models for graduate education and training in an environment that transcends traditional disciplinary boundaries; to facilitate diversity in student participation and preparation; and to contribute to the development of a globally-engaged science and engineering workforce. Within DGE, support is increased from the FY 2004 Estimate of $24.53 million by $7.15 million to $31.68 million, to make awards to more institutions and reach more trainees. NSF-wide support is $81.74 million.

At the University of Kentucky, the presentation of student posters by John Ball and Phillip Douglass illustrated the integration of the chemistry of molecular recognition with the development of magnetoelastic sensors and surface molecular sensors. Students from chemistry and engineering demonstrated their collaborations effectively. Several journal articles resulted from their work.

At Carnegie-Mellon University, simulations are being used to study the structure and dynamics of social processes. These models of human behavior have numerous applications from the military to computer games. Matthew Dombrowski and Keith Hunter published and presented the results of these studies.

HUMAN RESOURCE DEVELOPMENT $107,940,000

The FY 2005 Request for the Human Resource Development (HRD) Subactivity is $107.94 million, a decrease of $7.91 million, or 6.8 percent, from the FY 2004 Estimate of $115.85 million.

Human Resource Development Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Undergraduate/Graduate Student Support	60.76	68.37	64.49	-3.88	-5.7%
Research and Education Infrastructure	22.74	32.33	28.30	-4.03	-12.5%
Opportunities for Women and Persons with Disabilities	15.98	15.15	15.15	0.00	0.0%
Total, HRD	$99.48	$115.85	$107.94	-$7.91	-6.8%

Totals may not add due to rounding.

The Human Resource Development Subactivity aims to increase the participation and advancement of underrepresented groups and institutions at every level of science, technology, engineering, and mathematics (STEM) education through the promotion of racial and ethnic diversity, gender equity, and access for persons with disabilities. Programs focus on success factors such as increasing interest and academic performance, degree attainment, and workforce participation. These efforts engage the full range of academic institutions and, through the development, assessment and documentation of model efforts to improve teaching, learning, and research participation, serve to benefit all students.

Within this Subactivity, programs address three priorities: (1) increasing substantially the diversity of the STEM professoriate; (2) strengthening the synergy among key minority-focused programs and the interactions among grantees within these programs and with other NSF programs in research and education; and (3) expanding upon a strong educational research base to develop and foster broad implementation of innovative strategies for increasing participation and achievement of girls, women, and persons with disabilities in STEM education and research activities.

Undergraduate/Graduate Student Support includes:
Louis Stokes Alliances for Minority Participation (LSAMP) strengthen and encourage STEM baccalaureate degree production of students from underrepresented populations by utilizing the knowledge, resources, and capabilities of a broad range of organizations from the academic, federal, and commercial sectors. The effectiveness of LSAMP is demonstrated by significant increases in the number of minority students in STEM fields earning baccalaureate degrees. Funding is maintained at the FY 2004 Estimate of $34.30 million to continue coordination with other programs that aim to increase participation of underrepresented minority students. The North Carolina LSAMP is one successful project. Significant highlights of this effort include:

- 841 BS degrees awarded to minority STEM students in 2002.
- Minority STEM enrollment increased 17.8 percent, from 4,744 in Fall 1997 to 5,588 in Fall 2001.
- Faculty and students throughout the Alliance participated in 50 STEM-related local, state, and national conferences and professional meetings. Many students made both oral and poster presentations at several of these events.

Historically Black Colleges and Universities – Undergraduate Program (HBCU-UP) provides awards to enhance the quality of undergraduate STEM programs through curricular reform and enhancement, faculty development, research experiences for undergraduates, upgrade of scientific instrumentation, and improvement of research infrastructure. The FY 2005 Request of $19.98 million is $3.88 million less than the FY 2004 Estimate and provides for continued coordination with LSAMP and the Alliances for Graduate Education and the Professoriate.

Tribal Colleges and Universities Program (TCUP) provides awards to these institutions to enhance the quality of STEM instructional and community outreach programs through curricular reform and enhancement, faculty development, research and other out-of-classroom educational experiences for students, upgrading of scientific instrumentation, and improvement of research infrastructure. In FY 2005, support for the program within HRD remains constant at the FY 2004 Estimate of $9.92 million.

Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM), administered by NSF on behalf of the White House, identify outstanding mentoring efforts/programs designed to enhance the participation of groups underrepresented in science, mathematics, and engineering. In FY 2005, funding is maintained at the FY 2004 Estimate of $290,000.

Research and Education Infrastructure includes:
Alliances for Graduate Education and the Professoriate (AGEP) implement strategies for increasing STEM Ph.D. attainment among students drawn from underrepresented minority populations and encouraging those students to enter the professoriate. AGEP activities are projected to double their STEM doctoral degree production within a five-year period. In FY 2005, program support totals $14.91 million, unchanged from the FY 2004 Estimate.

Centers of Research Excellence in Science and Technology (CREST) serve as hubs for conducting competitive research at minority institutions, including those that produce well-trained doctoral students in STEM fields. A goal of the program is to assist Center faculty to participate more fully in other NSF research programs. Currently, HRD supports 12 Centers. CREST funding for FY 2005 is $10.88 million, a decrease of $4.03 million from the FY 2004 Estimate of $14.91 million. Within CREST, THRUST, strengthens the research capability of doctoral degree granting Historically Black Colleges and Universities in the STEM disciplines by investing in collaborative research, training, equipment and doctoral student support.

Model Institutions for Excellence (MIE) support minority institutions with a strong track record for graduating underrepresented minority students at the baccalaureate level, and encouraging those students to pursue graduate degrees. Jointly funded with the Research and Related Activities Appropriation, EHR funding for this program is sustained at $2.51 million for total NSF support of $9.78 million.

Opportunities for Women and Persons with Disabilities includes:
Program for Gender Equity (PGE) supports education and research activities that foster the increased participation of women and girls in STEM. PGE funding is maintained at the FY 2004 Estimate of $9.90 million.

The Research in Disabilities Education (RiDE) program, formerly the Program for Persons with Disabilities (PPD), will be funded at $5.25 million, equal to the FY 2004 Estimate. RiDE supports efforts to increase the participation and achievement of individuals with disabilities in STEM education and careers. Methods and products of focused research awards are incorporated in program-sponsored regional alliances. The alliances serve to inform educators, government and industry about proven, good practices in the classroom, promote broader awareness and inclusion of disabilities issues, and define specific areas of human learning in need of further attention by the research community.

RESEARCH, EVALUATION AND COMMUNICATION $73,940,000

The FY 2005 Request for the Research, Evaluation and Communication (REC) Subactivity is $73.94 million, an increase of $8.13 million, or 12.4 percent, over the FY 2004 Estimate of $65.81 million.

Research, Evaluation and Communication Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Research	54.27	54.24	62.37	8.13	15.0%
Evaluation	12.50	11.57	11.57	0.00	0.0%
Total, REC	$66.77	$65.81	$73.94	$8.13	12.4%

Totals may not add due to rounding.

Research Funding. The FY 2005 Request of $62.37 million for Research will support:

The **Research on Learning and Education (ROLE)** program seeks to build a stronger interdisciplinary approach to research on learning and education. The FY 2005 funding increase is in line with the increased emphasis across NSF, indeed the nation, on funding evidence-based, rigorous STEM education research. In the past two ROLE competitions, NSF has received 40 percent more proposals than previously, many of them rated "highly competitive" by outside reviewers; however, due to budget constraints, many of these strong projects have not been funded. The FY 2005 increase will allow NSF to increase the size and duration of ROLE grants, allowing more longitudinal studies; fund more ROLE grants; expand the reach of ROLE grants to include more 9-12, undergraduate, graduate and workforce projects; develop capacity-building projects; fund more international efforts; and co-fund more education research projects across EHR and NSF. ROLE and related research funding totals $47.46 million in FY 2005, an increase of $8.13 million over FY 2004 Estimate of $39.33 million.

The **Interagency Education Research Initiative (IERI)** is unique among EHR programs in that its primary purpose is to support research on implementation and scalability of educational methods. IERI is an interagency effort of the NSF, Department of Education and the NICHD of NIH. The goal of IERI is to improve preK-12 student learning in reading, mathematics, and science by supporting interdisciplinary research on large-scale implementations of educational practices and technologies that have already secured significant and credible evidence of success that can generalize to larger and more varied settings. IERI generates knowledge to address directly the challenge of how to bridge the gap between research and practice, to translate knowledge into tangible tools and practical procedures for education, and to improve educational practices and technologies. REC requests $14.91 million in FY 2005 for IERI, unchanged from the FY 2004 Estimate. In addition, the Research and Related Activities Appropriation will provide $9.63 million for this program. The participating agencies will coordinate efforts, but are holding separate IERI competitions for 2004 and 2005.

Research on learning, teaching, and technology generates important discoveries, advancing our understanding of knowledge acquisition and instructional practice and strengthening the research base for all EHR programs. It establishes proofs-of-concept for developing and applying learning technologies to STEM learning and teaching at all education levels. A primary goal is to increase the level of science and mathematics knowledge of all students, as well as to develop mechanisms for ensuring effective implementation of learning strategies and tools in classrooms, schools, and large-scale systems. National and international studies and analyses, such as the Third International Mathematics and Science Study

(TIMSS) and the TIMSS-Repeat (TIMSS-R), provide invaluable descriptions of the status and progress made by U.S. education, as well as insights for meeting its challenges. For example, REC-supported international comparative research highlights the disturbingly low level of content preparation of U.S. middle school teachers compared to other countries, and suggests that high school teacher induction practices of other countries enable more productive and effective instruction in early teaching careers. This blend of results of research on learning, effective learning technology development, and insights from international comparisons can contribute to policy discourse and decision-making in improving U.S. mathematics and science education practice.

The unique span of REC investment, ranging from the cognitive neuroscientific to the scale of large educational systems, is generating insights into the learning process than can only be approached from a multidisciplinary perspective. A portfolio of nearly 200 projects that covers the span from early childhood through adult learning, including preK-16 education, is helping build a productive and forward-moving research community that is characterized by its multidisciplinary expertise in cognition, learning theory, technology, pedagogy, instructional workforce development, policy, and educational system reform.

The research on learning portfolio continues to yield converging results that suggest that different approaches to instruction can produce strong learning gains, especially in disadvantaged settings, such as limited-English urban areas characterized by significant achievement gaps. These studies include a series of separate research projects in different parts of the country. One, for example, has tested an approach based on teaching scientific model-building for fourth and fifth grade students, finding that a sustained program of model-based instruction produced more sophisticated and accurate understanding of scientific concepts and the relationships among them. Another program of instruction, in which presentation of scientific concepts was carefully mediated through the language and cultural symbols of the students, produced significant effect sizes in subsequent standardized science assessments. Projects in REC's educational technology portfolio have continued to build a body of evidence on improving STEM learning. REC-supported tools are designed to amplify, highlight, and reveal mathematical or scientific ideas, principles, and processes, and enable the modeling, representation, manipulation and transformation of scientific or mathematical objects and processes. These tools will support significant pedagogical shifts appropriate for classrooms today and in the future.

REC also pursues an active program of communication to disseminate the results of EHR-sponsored research and evaluations. These efforts broadly inform the STEM research and education community, provide vital information for policy-makers, and advance NSF's efforts to integrate research and practice. The interpretation and dissemination of research results to promote research-based approaches to education practice will be essential as the nation addresses its most critical educational challenges.

Evaluation. Evaluation funding in FY 2005 remains level with the FY 2004 Estimate of $11.57 million. Evaluation efforts that systematically assess the impact and results of all major EHR programs are supported in REC, contributing to improved program performance and accountability. The evaluation program will continue to develop program indicators, produce databases, conduct impact studies, and carry out program evaluations, to document accountability throughout NSF's portfolio of STEM education, training and human resource development programs. The Evaluation Research and Evaluation Capacity Building (EREC) program awarded its first round of grants in FY 2002 and early FY 2003. It was combined in a single program announcement with ROLE to stress the effort within EHR to build a more integrated research and evaluation effort in support of all of EHR's programs. EREC seeks unique approaches to evaluation practice to generate new knowledge for the education community and to support broad policymaking within the research and education enterprise. FY 2005 funding will continue support for evaluations of multiple education programs or projects with similar objectives.

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION

MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION $213,270,000

The FY 2005 Budget Request for Major Research Equipment and Facilities Construction (MREFC) is $213.27 million, an increase of $58.30 million, or 37.6 percent, above the FY 2004 Estimate of $154.97 million.

Major Research Equipment and Facilities Construction Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Over FY 2004 Amount	Change Over FY 2004 Percent
Major Research Equipment and Facilities Construction	$179.03	$154.97	$213.27	$58.30	37.6%

The MREFC Account supports the acquisition, construction and commissioning of major research facilities and equipment that provide unique capabilities at the frontiers of science and engineering. Initial planning and design, and follow on operations and maintenance costs of the facilities are provided through the Research and Related Activities (R&RA) Account.

There can be no doubt that a modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering (S&E). The future success of entire fields of research depends upon their access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.

Among Federal agencies, NSF is a primary supporter of forefront instrumentation and facilities for the academic research and education communities. In recent years, NSF has received an increased number of requests for major research facilities and equipment from the S&E community. Many of these requests have received outstanding ratings from research peers, program staff, management and policy officials, and the National Science Board. NSF's Request for the MREFC Account positions the agency to meet the future needs and opportunities of the research community.

Once a project has been submitted for MREFC funding, it must undergo a multi-phase review and approval process. The process begins with a review by the internal NSF MREFC Panel, which makes recommendations to the NSF Director with attention to criteria such as scientific merit, importance, readiness and cost-benefit. The Director then selects candidates for National Science Board (NSB) consideration. The NSB then approves, or not, projects for inclusion in future budget requests and establishes priorities. The Director selects from the group of NSB-approved projects those appropriate for inclusion in a particular budget request to OMB, and after discussion with OMB, to the Congress.

In order for a project to be considered for MREFC funding, NSF requires that it represent an exceptional opportunity that enables research and education. In addition, the project should be transformative in nature, in that it should have the potential to shift the paradigm in scientific understanding and/or infrastructure technology. NSF believes that all the projects included in this Budget Request meet these criteria.

As a general framework for priority setting, NSF assigned priority to projects based on the following criteria:

> First Priority: Ongoing Projects – Projects that have received funding for implementation and where outyear funding for the full project has already been included in a Budget Request to Congress.
>
> Second Priority: NSB-Approved New Starts – New projects that have received NSB approval for inclusion in a budget request but which have not yet been included in a budget request or received funding.

NSF believes that the highest priority within the MREFC Account must be the current projects. To that end, highest priority in FY 2005 is to continue to request funding for the Atacama Large Millimeter Array ($49.67 million); EarthScope: USArray, Plate Boundary Observatory and San Andreas Fault Observatory at Depth ($47.35 million); and the IceCube Neutrino Observatory ($33.40 million).

In addition, three new starts are requested in FY 2005 and two new starts in FY 2006. In priority order, these are: the National Ecological Observatory Network in FY 2005; the Scientific Ocean Drilling Vessel in FY 2005; Rare Symmetry Violating Processes in FY 2005; Ocean Observatories in FY 2006, and the Alaska Region Research Vessel in FY 2006.

On January 14, 2004, the National Academy of Science released a study it conducted of NSF's processes for prioritization and oversight of activities funded through the MREFC Account. The NSF is now carefully evaluating the findings and recommendations contained in this study as it looks ahead to future activities in this area.

MREFC Account[1]

(Dollars in Millions)

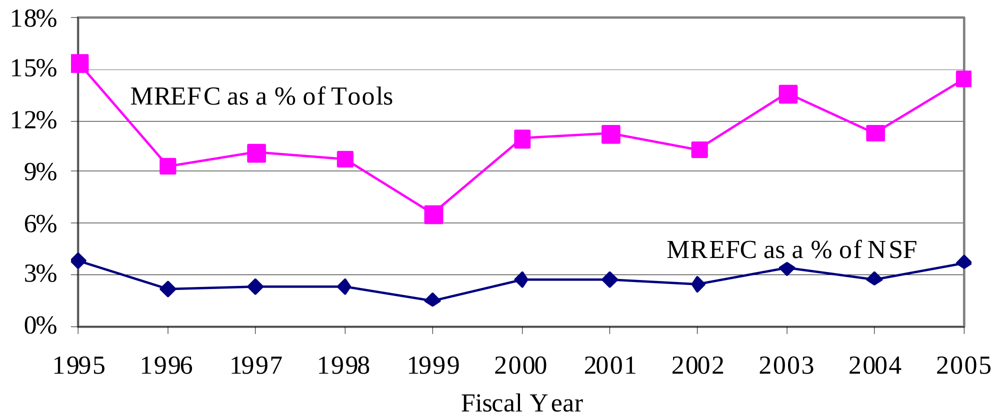
	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	FY 2006 Request	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
ONGOING PROJECTS							
ALMA Construction	29.81	50.70	49.67	48.84	47.89	46.49	37.37
EarthScope: USArray, SAFOD, PBO	29.81	43.24	47.35	50.24	26.80		
High-Performance Instrumented Airborne Platform for Environmental Research	13.00						
IceCube Neutrino Observatory	25.75	41.75	33.40	34.30	35.30	36.30	31.01
Large Hadron Collider	9.69						
Network for Earthquake Engineering Simulation	13.47	8.05					
South Pole Station	12.69	1.29					
Terascale Computing Systems	44.83	9.94					
NEW STARTS							
National Ecological Observatory Network			12.00	16.00	20.00	20.00	20.00
Scientific Ocean Drilling Vessel			40.85	59.94			
Rare Symmetry Violating Processes			30.00	42.66	44.00	20.25	8.00
Ocean Observatories Initiative				24.76	63.44	65.00	47.30
Alaska Region Research Vessel				49.32	32.88		
Totals	**$179.03**	**$154.97**	**$213.27**	**$326.06**	**$270.31**	**$188.04**	**$143.68**

NOTE: Totals may not add due to rounding.

[1]Does not include funding provided for early concept and development or follow-on operations and maintenance. These funds are provided through the R&RA Account and are discussed in the following individual Activity narratives and in the Tools chapter.

[2]FY 2003 Actual include $35.0 million in carryover from prior year appropriations for Terascale Computing Systems due to the NSB meeting schedule. The award was approved in October 2002, and the funds were subsequently obligated. $66.06 million appropriated in FY 2003 is carried over into FY 2004 for HIAPER ($12.53 million), the IceCube Neutrino Observatory ($3.67 million), the Large Hadron Collider ($33,819), the Polar projects ($49.71 million) and Terascale Computing Systems ($107,959). This FY 2003 carryover will be reflected in the Current Plan following an FY 2004 appropriation.

MREFC Funding As A Percent Of Tools And Of The Total NSF Budget



FIRST PRIORITY: ONGOING PROJECTS IN FY 2005

Atacama Large Millimeter Array

Project Description: Originally referred to as the Millimeter Array (MMA) in the United States, this international project will be an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution, millimeter-wavelength telescope, combining sub-arcsecond angular resolution with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The interferometer will be located at 5000m altitude near San Pedro de Atacama in the Second Region of Chile, the ALMA host country.

Principal Scientific Goals: To function as the most capable imaging radio telescope ever built, ALMA will bring to millimeter and submillimeter astronomy the high-resolution aperture synthesis techniques of radio astronomy. ALMA will image at 1mm wavelength with the same 0.1" resolution achieved by the Hubble Space Telescope (HST) at visible wavelengths, and will form a critical complement to the leading-edge optical, infrared, ultraviolet and x-ray astronomical instruments of the twenty first century.


The ALMA array operations site, located at 5,000 meter altitude near San Pedro de Atacama in the Second Region of Chile. *Credit: Division of Astronomical Sciences, NSF.*

Principal Education Goals: ALMA will play a central role in the education and training of U.S. astronomy and engineering students; at least 15 percent of ALMA's ~1000 yearly users are expected to be students. There is already substantial involvement by graduate students in applied physics and engineering at universities participating in the ALMA Design and Development program.

Partnerships and Connections to Industry: North America and Europe are equal partners in ALMA. The North American side of the project, consisting of the U.S. and Canada, is led by Associated Universities, Incorporated/National Radio Astronomy Observatory. Funding and execution of the project in Europe is carried out through the European Southern Observatory (ESO). Japan is likely to join ALMA as a third major partner in 2004. ALMA instrumentation will push gallium arsenide and indium phosphide transistor amplifier technology to high frequencies, will challenge production of high-density, high-speed integrated circuits for computational uses, and can be expected to stimulate commercial device and communication technologies development.

Management and Oversight: Programmatic management is the responsibility of the ALMA Staff Associate in the Astronomical Sciences (AST) Subactivity in the Mathematical and Physical Sciences (MPS) Activity. An NSF advisory group, consisting of representatives from the Office of General Counsel, the Office of Budget, Finance and Award Administration and the Office of Legislative and Public Affairs, serves as a standing ALMA Project Advisory Team. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. AST's external MMA Oversight Committee has been advising NSF on the project since early 1998, and comprises half of the International ALMA Management Advisory Committee. Management of the National Radio Astronomy Observatories effort on ALMA is carried out under Cooperative Agreement with the Associated Universities, Inc.

Project Status and Milestones:

Significant project events in FY 2003 included:

- Signature of the international ALMA agreement between the NSF and ESO, implementing the international construction and operations partnership;
- Start of European construction activities;
- Signature of the NSF-NRC Canada Memorandum of Understanding, implementing the North American ALMA partnership; and
- Finalization of long-term access to the ALMA site, and the start of construction in Chile.

The current baseline schedule for ALMA is specified in version 1 of the ALMA Project Plan. The schedule was developed prior to the start of ALMA construction activities, and was adopted by the ALMA Board in February 2003 following the signature of the ALMA Agreement. The Project Plan is now under configuration control by the Joint ALMA office.

No Level 1 milestones are set for FY 2004. However, the procurement of production antennas for the project will be a major area of effort, with the request for proposals/call for tenders, proposal evaluation, and award of production contracts in the U.S. and Europe, all being major scheduled activities. Level 1 milestones for the project (*i.e.,* milestones specified in the international ALMA Agreement and in the Project Plan) are:

FY 2005 Milestones:
Central back end system ready to install at Array site
Initial Phase of Civil Works in Chile Complete
First Antenna-based Backend Subsystem ready for installation at site Operations Support Facility (OSF)

FY 2006 Milestones:
First Production Antenna available in Chile at OSF
Initial Front End Subsystem available at OSF

FY 2007 – FY 2011 Milestones:
    Start Early Science Observations (FY 2007)
    Continue construction schedule

FY 2012 Milestones
    Completion of Construction Project
    Start Full Science Operations

Funding Profile: U.S.-funded construction activities are scheduled to continue through 2010, with project completion at the end of calendar 2011, and full operation beginning in early 2012. Early science with the array is scheduled to begin at the end of 2007. The estimated cost to construct ALMA is $702.0 million. The U.S. share of the joint array construction is estimated to be $344.18 million.

A $26.0 million, three-year Design and Development Phase was originally planned for the MMA project. However, since the original three-year plan was initiated, the U.S. entered into a partnership with a European consortium to develop ALMA. Because of the expanded managerial and technical complexity of the ALMA concept, an additional year of Design and Development was supported in FY 2001, at a budget level of $5.99 million. U.S. construction was initiated in FY 2002.

The image above is an artist's conception of the ALMA Antennas in a compact array. *Credit: National Radio Astronomy Observatory/Associated Universities Incorporated (NRAO/AUI) and the European Southern Observatory (ESO).*

Appropriated and Requested MREFC Funds for ALMA
(Dollars in Millions)

	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08 Through FY 10	Total
ALMA R&D	9.00	9.00	8.00	5.99								31.99
ALMA Construction					12.50	29.81	50.70	49.67	48.84	47.89	104.77	344.18
Total, ALMA	$9.00	$9.00	$8.00	$5.99	$12.50	$29.81	$50.70	$49.67	$48.84	$47.89	$104.77	376.17

ALMA Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation[1]		Operations & Maintenance[2]		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 1994 & Earlier	0.25						$0.25		**$0.25**
FY 1995	0.35						$0.35		**$0.35**
FY 1996	0.50						$0.50		**$0.50**
FY 1997	0.75						$0.75		**$0.75**
FY 1998		9.00						$9.00	**$9.00**
FY 1999		9.00						$9.00	**$9.00**
FY 2000		8.00						$8.00	**$8.00**
FY 2001		5.99						$5.99	**$5.99**
FY 2002				12.50				$12.50	**$12.50**
FY 2003				29.81				$29.81	**$29.81**
FY 2004 Estimate				50.70				$50.70	**$50.70**
FY 2005 Request				49.67	1.00		$1.00	$49.67	**$50.67**
FY 2006 Estimate				48.84	2.00		$2.00	$48.84	**$50.84**
FY 2007 Estimate				47.89	5.00		$5.00	$47.89	**$52.89**
FY 2008 Estimate				46.49	10.00		$10.00	$46.49	**$56.49**
FY 2009 Estimate				37.37	14.00		$14.00	$37.37	**$51.37**
FY 2010 Estimate				20.91	19.00		$19.00	$20.91	**$39.91**
FY 2011 Estimate					23.00		$23.00		**$23.00**
FY 2012 Estimate					23.00		$23.00		**$23.00**
Subtotal, R&RA	$1.85				$97.00		$98.85		
Subtotal, MREFC		$31.99		$344.18				$376.17	
Total, Each Phase		**$33.84**		**$344.18**		**$97.00**			**$475.02**

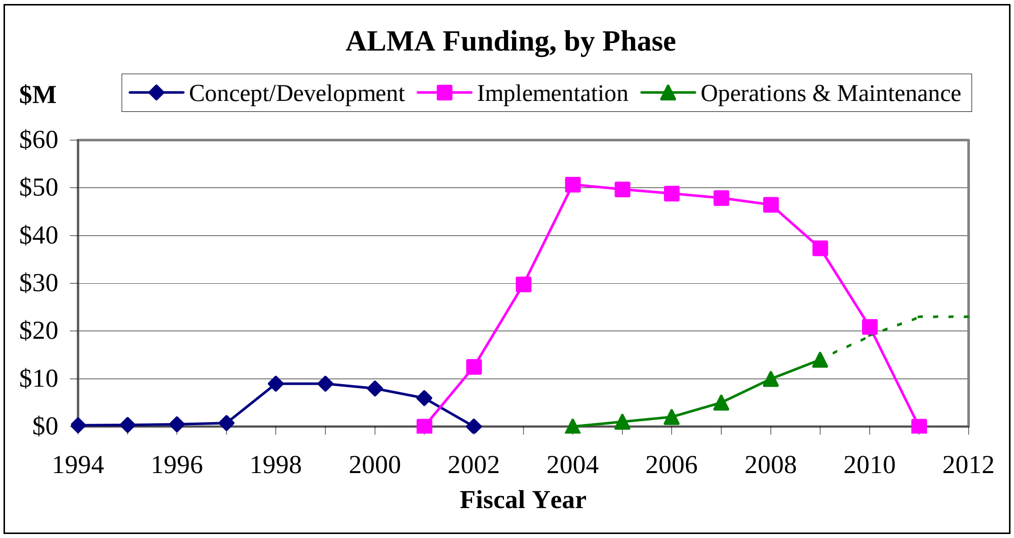
NOTE: The expected operational lifespan of this project is at least 30 years. A steady state of about $23 million annually (FY 2012 dollars) is anticipated for operations support beginning in FY 2012. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.
[1]Based on cost review of original MMA and then projected to ALMA.
[2]Operations funding of $1.0 million in FY 2005 is provided through the National Radio Astronomy Observatory.

Information pertaining to the data in the table is included below.

- Concept/Development: Prior to FY 1998, the National Radio Astronomy Observatory (NRAO) utilized funds provided through the R&RA account to advance the conceptual development of the Millimeter Array, the U.S.-only antecedent to ALMA. Funds were spent on planning workshops, array design and optimization, developing project construction and operations costs, and on site searches and surveys. The planning, design and development supported through the MREFC account achieved the goals set for (i) a refined and audited cost estimate with project milestones, (ii) the selection of a site, (iii) the development of an international partnership with defined shared costs, and (iv) the procurement of prototype antennas.

- Implementation: Implementation funds an array of 64 12-meter antennas having a total collecting area of 7,200 square meters, with 4 receiver bands extending into the submillimeter. The table describes the U.S. contribution to ALMA and does not address the reduction in costs due to Canada's participation.

- Operations and Maintenance: Operations and maintenance funds begin to phase in as initial site construction is completed and antennas begin to be delivered. Funds will be used to manage and support site and instrument maintenance, array operations in Chile, early and eventually full science operations, and in support of ALMA observations by the U.S. science community. The first full year of ALMA science operations is anticipated to be FY 2012.



Future Science Support: Along with direct operations and maintenance support for ALMA, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $10 million once the facility reaches full operations.

EarthScope

Project Description: EarthScope is a distributed, multi-purpose geophysical instrument array that will make major advances in our knowledge and understanding of the structure and dynamics of the North American continent. It is planned as a distributed facility – parts of EarthScope are expected to inhabit nearly every county within the U.S. over the project's life span. NSF, the U.S. Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the International Continental Scientific Drilling Programme will be funding partners, with USGS and NASA expected as operating partners. Project partners may also include state and local governments, geological and engineering firms, and Canadian and Mexican agencies. Over 3000 earth scientists and students are expected to use the facility annually.

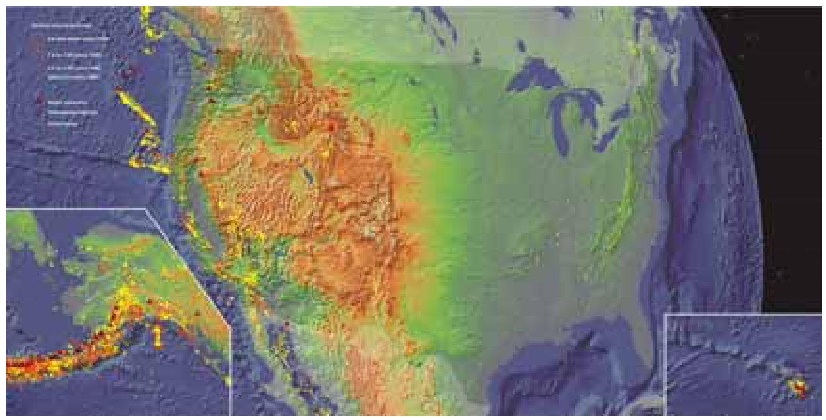
Principal Scientific Goals: Enhanced understanding of earthquakes and seismic hazards, magmatic systems and volcanic hazards, lithospheric dynamics, regional tectonics, continental structure and evolution, fluids in the crust, and associated educational aspects.

Principal Education Goals: To engage science and non-science students in geosciences discovery through the use of technology in real or retrospective time with the aim of integrating research and education.

Partnerships and Connections to Industry: Geotechnical and engineering firms will use data and models enabled by EarthScope. Instrumentation firms will collaborate on development for state-of-the-art seismic systems, down-hole instrumentation, and high-precision GPS antenna designs.

<u>Management and Oversight</u>: NSF oversight is provided by the EarthScope Program Officer and the Section Head for Special Projects, located in the Earth Sciences (EAR) Subactivity in the Geosciences (GEO) Activity. Other internal oversight is provided by a Project Advisory Team including staff from GEO, the Office of the General Counsel and the Office of Budget, Finance and Award Management. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. Following the recommendations of a National Academy of Sciences review of EarthScope, an EarthScope Science and Education Advisory Committee (ESEC) was formed to provide an advisory structure to ensure coordination of facility construction and operation, science, education and outreach, and information technology efforts.

<u>Current Project Status</u>: FY 2003 highlights include dedicated workshops to refine the EarthScope science plan, organize education and outreach, strengthen coordination with EarthScope partners at NASA and the USGS, and refine communications/information technology capabilities. In partnership with the International Continental Scientific Drilling Programme, work was completed on the pilot hole instrumentation package development. In FY 2003, Cooperative Agreements were initiated for construction of the EarthScope facility. Major FY 2004 milestones will include the initiation of airborne imaging of potential study sites, initial equipment acquisition and installation, awarding of the San Andreas Fault Observatory at Depth drilling contract, and construction of the down-hole monitoring string.



EarthScope is a bold undertaking to apply modern observational, analytical and telecommunications technologies to investigate the structure and evolution of the North American continent and the physical processes controlling earthquakes and volcanic eruptions. *Credit: EarthScope.*

EarthScope's Project Execution Plan has been developed and is under review and discussion. The milestones listed below are preliminary and will likely be revised as the project's schedule is finalized.

FY 2003 Milestone:

Award for EarthScope MREFC construction phase (Completed)

FY 2004 Milestones:

Compete and award contracts for broadband and short-period seismic systems (Completed);
Community planning on permanent seismic sites and first array deployment (Completed);
Acquisition begins for GPS and borehole strain systems (2nd quarter);
Airborne imaging of potential study sites (2nd quarter);
Down-hole monitoring equipment constructed (3rd quarter);
San Andreas Fault Observatory at Depth main hole drilling contract competed and awarded (3rd quarter);
Begin drilling (4th quarter);
Delivery of 50 portable GPS systems (4th quarter);
Delivery and installation of 100 GPS and 20 borehole-strain systems (4th quarter); and
NSF conducts first annual review of EarthScope (4th quarter).

FY 2005 Milestones:

Delivery and installation of 50 transportable array sites;
Delivery and installation of 500 flexible pool short period sites;
Delivery and installation of 5 Global Seismic Network (GSN) and 10 National Seismic Network (NSN) permanent stations in cooperation with the Advanced National Seismic System (ANSS);
Main hole completed at San Andreas Fault Observatory;
Down-hole monitoring instrumentation installed;
Airborne imaging of potential study sites;
Delivery and installation of 175 GPS and 30 borehole-strain systems;
Delivery and deployment of 50 portable GPS systems; and
NSF conducts annual review of project status.

FY 2006 Milestones:

Delivery and installation of 200 transportable array sites;
Delivery and installation of flexible pool sites: 200 broadband and 1000 short period seismic systems;
Delivery and installation of 5 GSN and 10 NSN permanent stations (in cooperation with ANSS);
San Andreas Fault site characterization studies carried out;
Delivery and installation of 200 GPS and 50 borehole-strain systems;
Deployment of 50 portable GPS systems; and
NSF conducts annual review of project status;

FY 2007 Milestones:

Delivery of 150 and installation of 200 transportable array sites;
Delivery of flexible pool sites: 200 broadband and 500 short period;
Installation of flexible pool sites: 200 broadband and 1000 short period;
Delivery and installation of 5 NSN permanent stations (in cooperation with ANSS);
Use site characterization and monitoring data to choose four coring intervals at depth in San Andreas Fault Observatory. Commence coring operations;
Delivery and installation of 200 GPS and 50 borehole-strain systems; and
NSF conducts annual review of project status;

FY 2008 Milestones:

Redeployment of USArray;
Install permanent monitoring instrumentation in four core intervals and main hole of San Andreas Fault Observatory at Depth;
Delivery and installation of 200 GPS and 50 borehole-strain systems; and
NSF conducts annual review of project status.

FY 2009 – FY 2013 Milestones:

Redeployment of USArray on a continual basis;
Complete analysis of San Andreas Fault cores, cuttings and logs. Continue monitoring at depth;
Ongoing operation and maintenance of the PBO; and
NSF conducts biennial reviews of project status.

<u>Funding Profile</u>: Conceptual planning for the EarthScope project has developed over the past decade. NSF has funded planning, design and development since FY 1998, and began the implementation of a five-year period of acquisition, construction and commissioning in FY 2003.

Appropriated and Requested MREFC Funds for EarthScope
(Dollars in Millions)

FY 2003	FY 2004	FY 2005 Request	FY 2006	FY 2007	Total
$29.81	$43.24	$47.35	$50.24	$26.80	$197.44

EarthScope Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
FY 1998	1.00						$1.00		**$1.00**
FY 1999	1.00						$1.00		**$1.00**
FY 2000	1.00						$1.00		**$1.00**
FY 2001	2.00						$2.00		**$2.00**
FY 2002	1.00						$1.00		**$1.00**
FY 2003	3.36			29.81	0.40		$3.76	$29.81	**$33.57**
FY 2004 Estimate				43.24	1.70		$1.70	$43.24	**$44.94**
FY 2005 Request				47.35	3.45		$3.45	$47.35	**$50.80**
FY 2006 Estimate				50.24	5.27		$5.27	$50.24	**$55.51**
FY 2007 Estimate				26.80	10.41		$10.41	$26.80	**$37.21**
FY 2008 Estimate					13.00		$13.00		**$13.00**
FY 2009 Estimate					13.33		$13.33		**$13.33**
FY 2010 Estimate					13.66		$13.66		**$13.66**
FY 2011 Estimate					14.00		$14.00		**$14.00**
FY 2012 Estimate					14.35		$14.35		**$14.35**
Subtotal, R&RA	$9.36				$89.56		$98.92		
Subtotal, MREFC				$197.44				$197.44	
Total, each phase		**$9.36**		**$197.44**		**$89.56**			**$296.36**

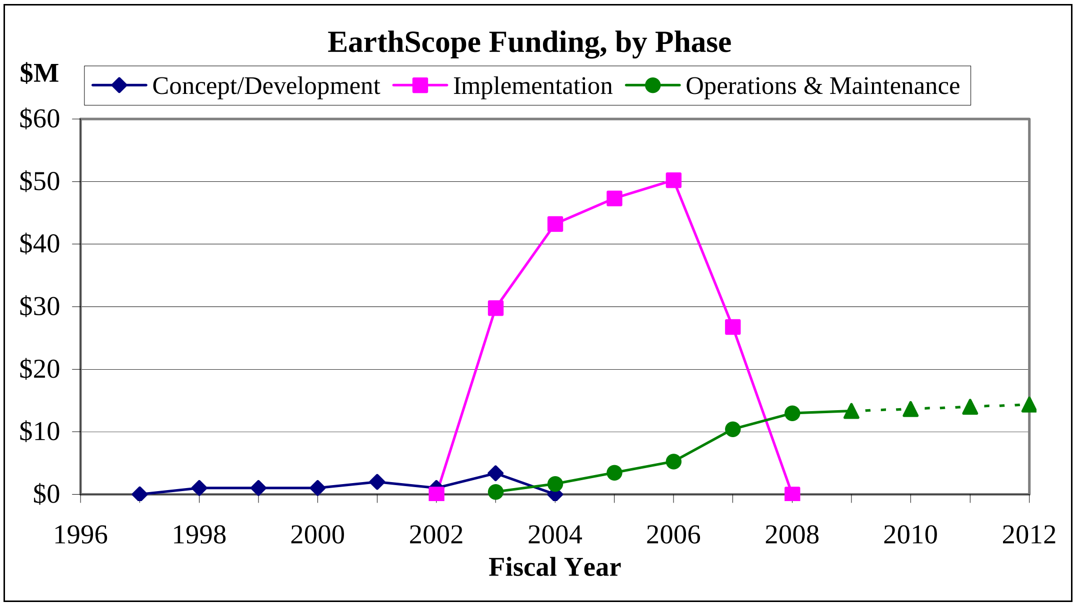
NOTE: The expected operational lifespan of this project is 15 years after construction is complete in FY 2007. A steady state of $13 million in operations support is anticipated by FY 2008. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is provided below.

- Concept/Development: FY 1998-FY 2000 funds were used to support workshops, instrument development, and installation technique development appropriate to EarthScope, from existing programs within the Division of Earth Sciences. Dedicated funding was established for FY 2001-03 supporting pre-EarthScope activities that would facilitate the construction and installation. This funding supports meetings, workshops, instrumentation prototype development, installation technique development, and site selection activities.

- Implementation: During FY 2003-07, the project will put in place three components of the distributed EarthScope system: (1) the USArray - portable seismometers for deployment across North America; (2) the San Andreas Fault Observatory at Depth - to monitor fault conditions; and (3) the Plate Boundary Observatory – an array of GPS monitors and borehole strain systems to monitor crustal deformation.

- Operations and Maintenance: Operations and maintenance will begin to phase-in during the first year of construction. When EarthScope is completed it will be managed, operated and maintained by a consortium including participation from host institutions, affiliate organizations, and the user community.



Future Science Support: Along with direct operations and maintenance support for EarthScope, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $15 million, once the facility reaches full operations.

High Performance Instrumented Airborne Platform for Environmental Research (HIAPER)

Project Description: This project is the acquisition, modification and instrumentation of a high altitude research aircraft capable of conducting science at or near the tropopause (~50,000 ft) with an extensive scientific payload and a flight range in excess of 6,000 nautical miles. The aircraft will fly approximately 400-500 research flight hours each year, with extensive mission specific outfitting preceding each research campaign. The remaining time will be devoted to aircraft maintenance and technology refreshment of the platform infrastructure. HIAPER will be a national facility, available to the university community as well as to NSF's federal partners such as the National Oceanographic and Atmospheric Administration, the National Aeronautics and Space Administration, the Office of Naval Research and the Department of Energy under existing interagency agreements. HIAPER will be based at NCAR's Research Aviation Facility, Jefferson County Airport, Broomfield, Colorado. Deployments of the aircraft will occur worldwide.

HIAPER - Shored aircraft checked weekly (and often daily) using specialized laser instruments. *Credit: National Center for Atmospheric Research (NCAR) and NSF.*

Principal Scientific Goals: HIAPER will be a research platform with altitude, range, and endurance capabilities that will enable investigators to perform critical earth system science research. With a maximum altitude for the aircraft of 51,000 feet, the ability to carry significant payloads to such high altitudes will enable scientists to conduct important atmospheric studies in and near the tropopause. The modified aircraft will be capable of covering a range of 6000 nautical miles in a single flight, which will allow for such varied missions as research flights covering the borders of the continental U.S., the world's large ocean basins, and even studies of the South Pole environment conducted from South America or New Zealand. The platform will serve the entire geosciences community: atmosphere, cryosphere, biosphere, and hydrosphere.

Principal Education Goals: To engage science and non-science students and the broader public in atmospheric and geosciences discovery through the use of technology to create a HIAPER "tele-presence" in real or retrospective time with the aim of integrating research and education.

Partnerships and Connections to Industry: The airframe has been acquired from Gulfstream Corporation, with selected airframe modifications being provided by Lockheed-Martin Corporation. Additional support is being received from Aeromet Corporation. Significant participation from smaller private firms in research instrumentation development is also expected.

Management and Oversight: The project is managed and overseen by a project director in the Atmospheric Sciences (ATM) Subactivity in the Geosciences (GEO) Activity. The project director receives advice and oversight support from a NSF Project Advisory Team, which consists of representatives from GEO, the Office of General Counsel, the Office of Budget, Finance and Award Management (BFA), the Mathematical and Physical Sciences (MPS) Activity, and the Office of Polar Programs. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. A separate HIAPER Advisory Committee, consisting of representatives of the university research community, national laboratories, the University Corporation for Atmospheric Research (UCAR), NCAR and NSF provides advice and recommendations to the Director of NCAR and to the project director at NSF.

Current Project Status: In late December 2001 UCAR and Gulfstream Aircraft Corporation (GAC), a subsidiary of General Dynamics, signed a contract for the acquisition of a Gulfstream V. The green airframe was delivered to Lockheed-Martin in June, 2002 for extensive airframe structural modifications to meet science requirements. Modifications and instrumentation activities are on schedule.

Milestones for the project are outlined below:

FY 2002 Milestones (Completed):
- Negotiation of final contract between UCAR and GAC;
- Approval of contract by NSF;
- Contract between UCAR and GAC for acquisition of green airframe and structural modifications;
- Production of green airframe;
- Staff HIAPER project office at National Center for Atmospheric Research (NCAR);
- NSF Instrumentation Workshop conducted at NCAR.

FY 2003 Milestones (Completed):
- NCAR Director's Independent Review of Project
- Release of Instrument Development Announcement of Opportunity
- Critical Design Review - Systems
- Structural Modifications Initiated by Lockheed Martin

FY 2004 Milestones:
- Structural Modifications completed by Lockheed Martin
- Instrumentation Development Grants awarded
- Flight testing and FAA STC Certificate for Modified Aircraft
- Receipt of Modified Aircraft at UCAR

FY 2005 Milestones:
- Research Infrastructure and Data Systems Installed
- Preparation for Deployments and progressive science mission flights

FY 2006 Milestone:
- First Deployment

This is an illustration of what HIAPER will look like when completed, including the approved color scheme. *Credit: NCAR and NSF.*

Funding Profile: In FY 2000, $8.50 million was provided for the project, and an additional $12.47 million was appropriated in FY 2001. In FY 2002 Congress appropriated $35.0 million. The final appropriation of $25.53 million was received in FY 2003, $12.53 million of which was carried over into FY 2004. The total estimated construction cost for the project is $81.50million.

Appropriated MREFC Funds for HIAPER
(Dollars in Millions)

FY 2000	FY 2001	FY 2002	FY 2003	Total
$8.50	$12.47	$35.00	$25.53	$81.50

HIAPER Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 1998	0.30						$0.30		**$0.30**
FY 1999	0.40						$0.40		**$0.40**
FY 2000		0.50		8.00				$8.50	**$8.50**
FY 2001		0.40		12.07				$12.47	**$12.47**
FY 2002				35.00				$35.00	**$35.00**
FY 2003[1]				13.00				$13.00	**$13.00**
FY 2004 Estimate				12.53				$12.53	**$12.53**
FY 2005 Request					0.30		$0.30		**$0.30**
FY 2006 Estimate					3.00		$3.00		**$3.00**
FY 2007 Estimate					3.06		$3.06		**$3.06**
FY 2008 Estimate					3.13		$3.13		**$3.13**
FY 2009 Estimate					3.21		$3.21		**$3.21**
Subtotal, R&RA	$0.70				$12.70		$13.40		
Subtotal, MREFC		$0.90		$80.60				$81.50	
Total, each phase		**$1.60**		**$80.60**		**$12.70**			**$94.90**

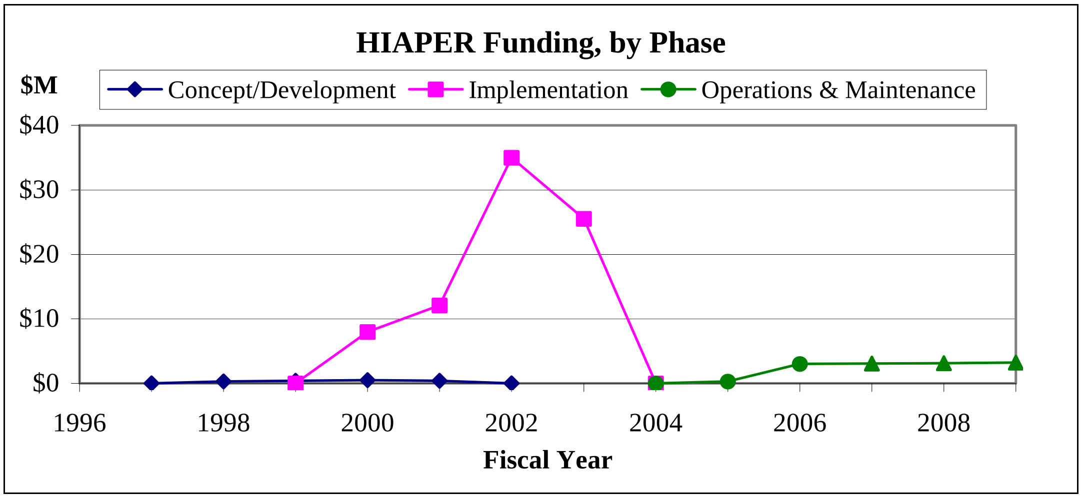
NOTE: The expected operational lifespan is 25 years, pending the full integration of scientific instrumentation. A steady state of about $3.0 million in operations support would occur in or about FY 2006, assuming completion of the project in FY 2004. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.
[1]FY 2003 appropriations totaled $25.53 million. Of this amount, $13.0 million was spent in FY 2003, and the remainder, $12.53 million, was carried over into FY 2004.

Information pertaining to the data in the table is provided below.

- Concept/Development: Initial R&RA funding of approximately $700,000 provided support for workshops to identify the highest priority performance characteristics and platform requirements, and for other workshops, reviews and best practices consultations with federal and nonfederal experts. MREFC funds obligated during this phase of the project include support for the preparation of the Request for Proposals. After the proposal was received at UCAR, an evaluation and selection team was formed to determine if the proposal met the requirements in the RFP.

- Implementation: The full appropriated amounts for FY 2000-02 were required in order to acquire and modify the airframe. Funding was provided to Gulfstream to secure a production slot, and the rest of the funds were held until the contract was negotiated, approved by NSF and signed by UCAR and GAC. With HIAPER fully funded, a green airframe has been acquired and the structural modifications required to integrate scientific instrumentation and complete the project have begun. Instrumentation will be developed in FY 2004-05, and integrated into the aircraft in FY 2005. The total construction cost for the project is $81.50 million.

- Operations and Maintenance: The aircraft will be maintained and operated by the Research Aviation Facility at NCAR. The intent is to operate the aircraft as a fully certified (FAA Airworthiness Certification) platform rather than a public use aircraft. Additional follow-on instrumentation will be developed during the operational phase of HIAPER, funded by the R&RA grants program within ATM, or other activities within NSF or its federal partners. HIAPER, in contrast to many research facilities, will accommodate instrumentation from other agencies, international partners as well as new instruments that are developed over the 25-year operational time period. Instruments for HIAPER typically will be modular and able fly on a variety of platforms, not exclusively HIAPER.



Future Science Support: Along with direct operations and maintenance support for HIAPER, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $10.0 to $12.0 million, once the facility reaches full operations.

IceCube Neutrino Observatory

Project Description: IceCube will be the world's first high-energy neutrino observatory and will be located under the ice at the South Pole. It represents a new window on the universe, providing unique data on the engines that power active galactic nuclei, the origin of high energy cosmic rays, the nature of gamma ray bursters, the activities surrounding supermassive black holes, and other violent and energetic astrophysical processes. IceCube will be constructed by the IceCube Consortium, led by the University of Wisconsin (UW). Approximately one cubic kilometer of ice will be instrumented with photomultiplier (PM) tubes to detect neutrino-induced, charged reaction products produced when a high energy neutrino interacts in the ice within or near the cubic kilometer fiducial volume. Digital optical modules (DOMs), each containing a PM and associated electronics, will be distributed uniformly from 1.5 km to 2.5 km beneath the surface of the South Pole ice cap, a depth where the ice is highly transparent and bubble-free. IceCube will record the energy and arrival direction of high-energy neutrinos ranging in energy from 100 GeV (10^{11} electron Volts[eV]) to 10 PeV (10^{16} eV). The principle tasks in the IceCube Project are: production of the needed DOMs and associated electronics and cables; production of an enhanced hot water drill and a DOM deployment system capable of drilling holes for and

The IceCube cable assembly is delivered by ski-equipped C-130 (LC-130) to Amundsen-Scott South Pole Station in January 2004. *Credit: the United States Antarctic Program.*

deploying installation of DOM strings in the ice at the Pole; installation of a surface array of air shower detectors to both calibrate and eliminate background events from the IceCube DOM array; construction of a data acquisition and analysis system; and associated personnel and logistics support.

Principal Scientific Goals: IceCube will be the world's first observatory capable of studying the universe with high-energy neutrinos. Measurement of the number, direction, timing, and energy spectrum of such neutrinos will provide unique new insights regarding the dynamics of active galactic nuclei, the acceleration mechanisms and locations of the sources of high energy cosmic rays, the properties and dynamics of gamma ray bursters, and the types of processes that take place near the event horizon of supermassive black holes at the centers of galaxies. Many of these phenomena take place at cosmological distances in regions shielded by matter and shrouded by radiation. Since neutrinos carry no charge and interact very weakly with matter, easily passing through the entire earth, they are unique messenger particles for understanding the astrophysics of such extreme phenomena and are capable of bringing us information about previously undiscovered cosmic objects, ones that are invisible to existing observatories that record electromagnetic signals or charged particles. IceCube data on sources will also complement data from existing astrophysical observatories in the optical, x-ray, and gamma ray regions of the electromagnetic spectrum, providing new tests of theories of the underlying dynamics of these objects.

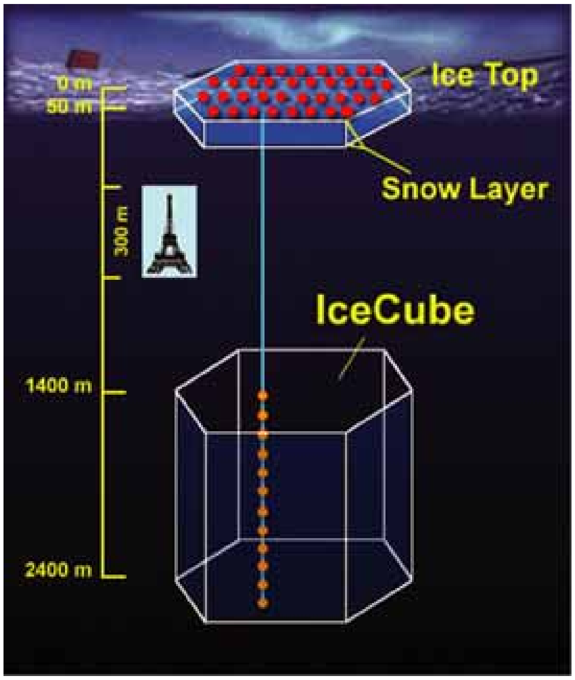
This picture shows the "IceTop" section of IceCube. The deep detector array comprising 4,800 digital optical monitors will be placed at depths up to 2,450 meters in the ice while the surface array, known as IceTop, will comprise 320 DOMs and will be placed at a depth of 1 meter. All components of the array will be connected to a central instrumentation support facility, the Counting House. *Credit: the United States Antarctic Program.*

Principal Education Goals: IceCube provides a vehicle for helping to achieve national and Agency education and outreach goals based on the conduct of visionary science in the exciting South Pole environment. These goals include broadening the scientific workforce base in the U.S. and creating a technologically facile work force with strong ties to fundamental research that is the core of a strong economy. Specific outcomes will include: the education and training of next generation leaders in astrophysics, including undergraduate students, graduate students, and postdoctoral research associates; K-12 teacher scientific/professional development, including development of new inquiry-based learning materials; increased diversity in science through partnerships with minority institutions; and enhanced public understanding of science through broadcast media and museum exhibits. Some of these outcomes will result from separate R&RA grants to universities and other organizations for work associated with IceCube, selected following the standard NSF merit review process.

Partnerships and Connections to Industry: The IceCube Collaboration consists of 12 U.S. institutions and institutions in three other countries, Belgium, Germany, and Sweden. Substantial foreign contributions. are anticipated. The U.S. Department of Energy, through its Lawrence Berkeley Laboratory, is also participating.

Management and Oversight: With strong international participation, IceCube has an interim management structure that provided the framework for the Start-up Project funded in FY 2002 and FY 2003. The University of Wisconsin has in place an external Scientific Advisory Committee, an external Project

Advisory Panel, and a high-level Board of Directors (including the Chancellor) providing for their oversight of the project, and has appointed both a Project Director and a Project Manager. Internally, NSF has appointed a Project Coordinator to manage and oversee the NSF award, and has established an internal Project Advisory Team comprised of representatives from the Office of Budget, Finance, and Award Management, the Office of General Counsel, the Mathematical and Physical Sciences (MPS) Activity, and the Office of Polar Programs (OPP), and chaired by the Project Coordinator. Oversight and funding responsibility for IceCube construction are the responsibility of OPP; support for research, education, and outreach using IceCube will be shared by OPP and MPS as well as other organizations and international partners.



IceCube will occupy a volume of one cubic kilometer. Here we depict one of the 80 strings of optical modules (number and size not to scale). IceTop located at the surface, comprises an array of sensors to detect air showers. It will be used to calibrate IceCube and to conduct research on high-energy cosmic rays. *Credit: NSF/University of Wisconsin and Darwin Rianto, University of Wisconsin.*

Current Project Status: The IceCube project has been funded to date through a $15.0 million appropriation in FY 2002 for 'startup funding' and a $24.54 million appropriation in FY 2003 for continuation of startup activities. The primary tasks funded to date are: production and testing of the Enhanced Hot Water Drill (EHWD) system for drilling the required deep-ice holes into which digital optical modules (the photo-detectors that are the central elements of the IceCube detector) will be placed; production of the digital optical module deployment system; design of the data acquisition system and software requirements; specification of the requirements, design, and pre-production testing of the IceTop Surface Array; software system architecture and detector simulations; and planning for detector verification. Progress to date has been steady. The construction of the EHWD is complete and the drill is in the Integration Verification, and Testing phase. Key elements of the EHWD have been shipped to the South Pole for assembly this austral summer season (2003/2004), in anticipation of first drilling and deployment of DOM strings next season (2004/2005). A DOM production facility has been completed at UW, including a new dark freezer laboratory for testing strings of DOM strings in extreme colds extending down to –80° C. Preproduction DOMs are under construction that will be used in an exhaustive period of environmental testing scheduled for Spring 2004. UW has made structural management changes to improve their internal oversight of the project. A permanent Project Director was hired by UW in October 2003, and he has now taken charge of the project. In anticipation of FY 2004 funding of construction, NSF has scheduled a full baseline review of the project for February 2004. The FY 2004 Estimate funding is $41.75 million.

Major milestones for IceCube are below:

FY 2004 Milestones:

Deliver EHWD system and DOM deployment system to the South Pole; and

Begin production of digital optical modules and data acquisition and handling system (DAQ).

FY 2005 Milestones:

Deliver initial DOM strings, IceTop modules, and initial elements of the DAQ to South Pole;
Assemble the EHWD and DOM deployment systems;
Drill, deploy, and test initial DOM strings and corresponding IceTop modules; and
Establish drill camp and move new counting house building into place.

Projected outyear milestones (FY 2006-2010) are based on current project planning and represent a general outline of anticipated activities. These activities are also dependant on weather conditions and the Antarctic logistics schedule.

FY 2006 Milestones:

Continue DOM and IceTop module production;
Continue to drill, deploy and test DOM strings and IceTop modules, including installing and testing the associated DAQ elements; and
Commission new counting house.

FY 2007-10 Milestones:

Continue DOM and IceTop module production; and
Continue to drill, deploy and test DOM strings and IceTop modules, including installing and testing the associated DAQ elements.

FY 2011 Milestones:

Complete DOM and IceTop module production, string deployment, and the DAQ;
Complete the calibration, testing, and commissioning of the full IceCube array; and
Commence full operations.

Funding Profile: $15.0 million was appropriated in FY 2002 for startup activities for IceCube and $24.54 million was appropriated in FY 2003 for continuation of startup activities. The FY 2004 Estimate is $41.75 million to initiate construction of the full IceCube project.

Appropriated and Requested MREFC Funds for IceCube
(Dollars in Millions)

FY 2002	FY 2003	FY 2004	FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009	Total
$15.00	$24.54	$41.75	$33.40	$34.30	$35.30	$36.30	$31.01	$251.60

IceCube Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2001	0.50						$0.50		**$0.50**
FY 2002				10.12				$10.12	**$10.12**
FY 2003				25.75				$25.75	**$25.75**
FY 2004 Estimate				45.42				$45.42	**$45.42**
FY 2005 Request				33.40				$33.40	**$33.40**
FY 2006 Estimate				34.30				$34.30	**$34.30**
FY 2007 Estimate				35.30				$35.30	**$35.30**
FY 2008 Estimate				36.30				$36.30	**$36.30**
FY 2009 Estimate				31.01				$31.01	**$31.01**
FY 2010 Estimate					10.40		$10.40		**$10.40**
FY 2011 Estimate					10.60		$10.60		**$10.60**
FY 2012 Estimate					10.90		$10.90		**$10.90**
Subtotal, R&RA	$0.50				$31.90		$32.40		
Subtotal, MREFC				$251.60				$251.60	
Total, Each Phase		**$0.50**		**$251.60**		**$31.90**			**$284.00**

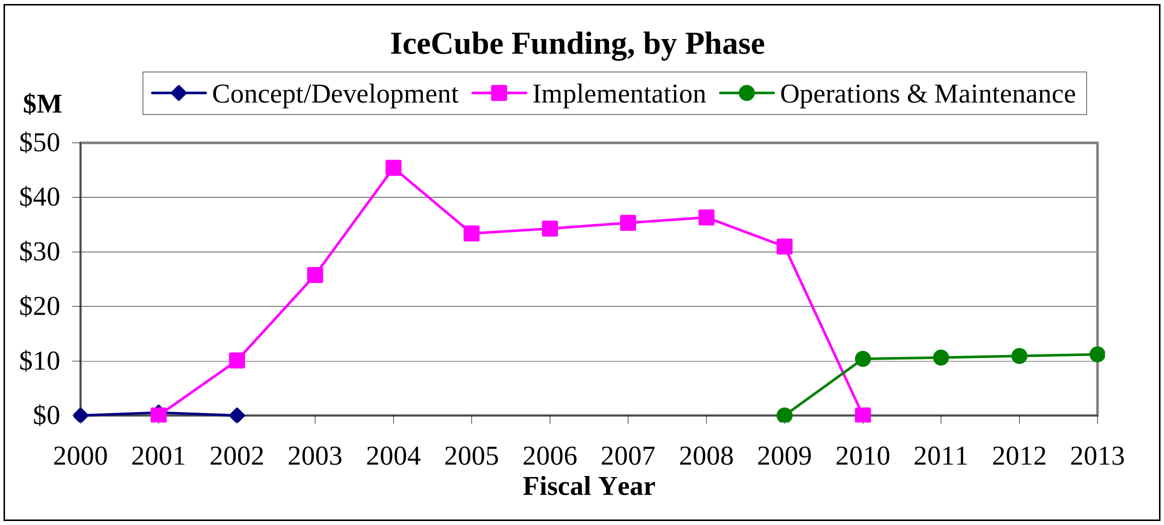
NOTE: The expected operational lifespan of this project is 25 years after construction is complete in FY 2011. Operations support in FY 2010 is estimated at $10.40 million, and is estimated to remain at that corresponding level of effort in subsequent years.. Operations estimates for 2010 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is provided below.

- <u>Concept/Development</u>: $500,000 was provided in FY 2001 through the R&RA Account to support drill conceptual development and design, R&D on advanced data acquisition and analysis techniques, and development of interface electronics and associated software for digital detector electronics readout. IceCube builds on the work of the Antarctic Muon and Neutrino Detector (AMANDA), which demonstrated proof-of-principle. NSF's FY 2002 appropriation included $15.0 million for 'start-up' design and development of the IceCube project. NSF's FY 2003 appropriation included $24.5 million for continued startup activity. Those investments focused on state-of-the art drill and electronics development and acquisition.

- <u>Implementation</u>: The total cost of the construction project, including the $15.0 million appropriated in FY 2002 and $24.5 million in FY 2003 for start-up activities, is estimated currently at $251.60 million and will extend through FY 2011. A review of the IceCube project will be conducted in February 2004 to provide a solid project baseline scope, cost, and schedule. The FY 2004 Estimate provides $41.75 million to initiate construction of the full IceCube project; and $33.40 million is requested in FY 2005. The plan is to drill holes and deploy strings of DOMs in each austral summer season (November through mid-February), beginning in the FY 2005 austral summer season (2004/2005). With good EHWD drill performance, and barring weather-induced complications of logistics support, the full complement of DOMs should be in place by about the end of FY 2011. FY 2003 and FY 2004 amounts include carryover from previous years.

- Operations and Maintenance: Full operation of the IceCube Neutrino Observatory is planned to commence in FY 2011 following completion of drilling and DOM deployment and full detector commissioning planned for FY 2011. Transition to full operations will begin in FY 2010. Of the amounts shown in the table for operations, approximately half is for data analysis that will be carried out by the collaborating U.S. IceCube institutions, the other half being for direct operations and maintenance support (IceCube-specific logistics, system engineering, operation and maintenance of the data acquisition and data handling data systems, data quality monitoring, IT upgrades, and calibrations). The general operations of South Pole Station, reported in a separate section, also contribute to supporting IceCube. Costs included for IceCube here include only those that are project specific and incremental to general operations. The expected operational lifespan of this project is 25 years beginning in FY 2011.



Future Science Support: NSF will support activities at institutions working on more refined and specific data analyses, data interpretation (theory support), and instrumentation upgrades, through ongoing research and education programs. The annual support for such activities is estimated at $2.0 million once the facility reaches full operations.

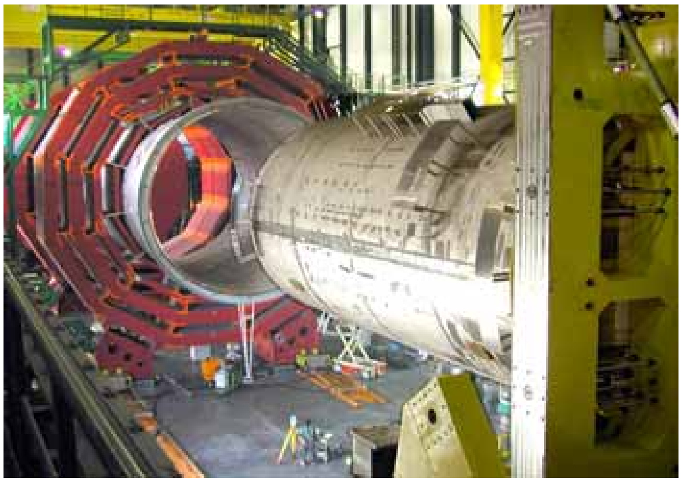
Associated Research and Education Activities: Besides the training of next generation astrophysicists, IceCube will encourage the creation of new links to K-12 teachers for the purpose of scientific/professional development of secondary school teachers, reaching into the classroom with new inquiry-based IceCube learning materials, as well as using the unique South Pole environment to convey the excitement of astrophysics and science generally to K-12 students. Extra measures will be undertaken to interest underrepresented minorities in science. The plan includes partnership with two largely minority institutions (Clark-Atlanta University, Atlanta GA, and Southern University, Baton Rouge, LA). Public outreach will be carried out through broadcast media and museum exhibits based on the IceCube science and the South Pole environment. Funding for Education and Outreach (E&O) activities will come from the R&RA account. Annual E&O budgets are estimated at $400,000.

Large Hadron Collider

Project Description: The Large Hadron Collider (LHC) will be the premier facility in the world for research in elementary particle physics. The facility will consist of a superconducting particle accelerator providing two, counter-rotating beams of protons, each beam having an energy up to 7 TeV (1TeV=10^{12}

electron volts). The U.S. is involved in the construction of two particle detectors, A Toroidal LHC Apparatus (ATLAS) and the Compact Muon Solenoid (CMS). Each will be constructed to characterize the different reaction products produced in the very high-energy proton-proton collisions which will occur in intersection regions where the two beams are brought together.

The LHC is an international project under construction at the CERN laboratory in Geneva, Switzerland. NSF has awarded grants to Northeastern and Columbia Universities under cooperative agreements with subcontracts to over 50 U.S. universities. In FY 2003, the funding of LHC construction by NSF was completed. A total of 34 international funding agencies participate in the ATLAS detector project, and 31 in the CMS detector project. NSF and DOE are providing U.S. support. CERN is responsible for meeting the goals of the international LHC project. The ATLAS and CMS detectors are expected to take data approximately 200 days/year. The remaining time is to be used for maintenance and testing.



Photograph of the Compact Muon Solenoid (CMS), one of two particle detectors the U.S. is constructing for the international Large Hadron Collider project. *Credit: LHC project.*

The U.S. LHC collaboration has been a leader in the development of Grid-based computing. The Grid will enable the enhanced participation of U.S. universities, and thus the training of students, in both state of the art science and computational techniques, in a project that is centered overseas. The Grid is expected to have a broad application throughout the scientific and engineering communities.

Principal Scientific Goals: The LHC will enable a search for the Higgs particle, the existence and properties of which will provide a deeper understanding of the origin of mass of known elementary particles. The LHC will also enable a search for particles predicted by a powerful theoretical framework known as supersymmetry which will provide clues as to how the four known forces evolved from different aspects of the same 'unified' force in the early universe, and can investigate the possibility that there are extra-dimensions in the structure of the universe.

Principal Education Goals: Through the participation of young investigators, graduate students, undergraduates, and minority institutions in this international project, LHC serves the goal of helping to produce a diverse, globally-oriented workforce of scientists and engineers. Further, innovative education and outreach activities, such as the QuarkNet project, allow high school teachers and students to participate in this project (see the URL: http://quarknet.fnal.gov/). Many highly-trained students in high-energy physics move into industrial jobs.

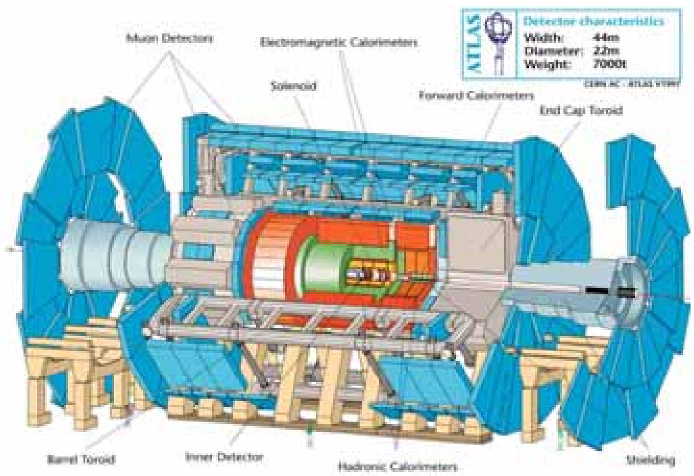
Connections to Industry: Major procurements of components of both warm and superconducting magnets, as well as high-speed electronics, are performed through U.S. industries. Major developments in Grid computing are also valuable outcomes.

Management and Oversight: A program director in the Physics Subactivity of the Mathematical and Physical Sciences (MPS) Activity is responsible for day-to-day project oversight. The NSF program director also convenes an internal Project Advisory Team, including staff from the Office of Budget, Finance and Award Management, the Office of the General Counsel, the Office of Legislative and Public

Affairs, and MPS. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance.

U.S. LHC program management is performed through a Joint Oversight Group (JOG), created by the NSF and DOE membership. The JOG has the responsibility to see that the U.S. LHC Program is effectively managed and executed to meet commitments made under the LHC International Agreement and its Protocols.

Current Project Status: An External Review Committee (ERC), reporting to the CERN Council in June, 2002, identified issues relevant to completion of the LHC project. In the report, the ERC stated that it "believes that the design of the LHC is excellent and that it will reach design specifications". However, the ERC did find that the projected cost increases that became apparent before this report arose from "serious weaknesses in cost awareness and control, as well as in contract management and financial reporting." NSF has been working closely with CERN management on these issues. It is important to note that NSF funding for the U.S. LHC Construction Project has been completed and that the NSF cost has not increased.



This is a diagram of the particle detector ATLAS (A Toroidal LHC Apparatus). ATLAS and the Compact Moun Solenoid (CMS) represent the U.S. contribution to the construction of the Large Hadron Collider at the CERN laboratory in Geneva, Switzerland. *Credit: LHC project.*

In September 2002, CERN management released an Action Plan to address the recommendations of the External Review Committee. A schedule delay was foreseen at that time, largely a result of delays in the delivery of superconducting cable for the LHC magnets. In December 2002, the CERN council accepted a proposal to revise the 1996 financial framework for the LHC. The revised framework makes LHC completion in 2007 a priority, representing a two-year delay from the original plan. The proposal addresses items including accountability, staffing, management, cost awareness, control and reporting, and annual reviews. Most of CERN's resources are committed to the project, leaving only a very limited non-LHC experimental program.

A second External Review committee reported to the Council in December 2003. They noted that the LHC is the most challenging project ever attempted by CERN and the accomplishments to date deserve great praise. However, CERN Project Management still has a challenging job ahead to avoid further cost overruns and significant delays.

Under the current challenging schedule, a period of beam commissioning starting in the Spring of 2007, will be followed by the start of the LHC physics data taking runs in the latter half of 2007. While both experiments may benefit from the extended LHC schedule by having additional time to optimize their installation plans, the U.S. collaborators continue on the original baseline schedule, to avoid any increases in labor and costs. The entire U.S. LHC activity is being maintained within the funding cap set forth in the original U.S. funding guidance for the project.

The NSF-supported components of the ATLAS and CMS detectors are scheduled for completion in FY 2005, with the final year of appropriated construction funding in FY 2003. The U.S. ATLAS construction project, as of November 2003, was 85 percent complete. All but $2.60 million of the $60.80 million NSF MREFC funds for ATLAS have been obligated. The U.S. CMS project is 82 percent complete. All but $960,000 of the $20.20 million NSF MREFC funds for CMS have been obligated. Milestones for both projects are being completed in the anticipated years. U.S. cost performance has been excellent, with material contracts typically below estimates, and labor costs tracking close to plan. The U.S. strategy aims for the completion of the U.S. deliverables within baseline cost and with a slightly extended schedule that takes the LHC construction delay into account. FY 2003 milestones have been met.

Major remaining milestones for the NSF components of LHC are outlined below:

FY 2004 Milestones:

- US ATLAS
  - Complete delivery of Liquid Argon Forward Calorimeter (Section A);
  - Complete delivery of Silicon Strip Modules;
  - Complete production of Transition Radiation Tracker (Modules and Barrel); and
  - Complete Muon Chamber production.
- US CMS
  - Complete delivery of Electromagnetic (EM) Calorimeter Photodiodes;
  - 50% of Silicon Tracker Rods completed; and
  - Start production of the Front End electronics for the EM Barrel Calorimeter.

FY 2005-2006 Milestones:

- Start ATLAS and CMS detector installation and testing in underground halls.

FY 2007 Milestone:

- First data taking using both ATLAS and CMS detectors.

<u>Funding Profile</u>: Funding for the overall LHC project, including the ATLAS and CMS detectors and the accelerator, is provided through an international partnership involving NSF, the Department of Energy (DOE), and the CERN member states, with CERN member states providing the major portion. Other countries that are not member states are also participating.

The total U.S. contribution to the construction project will be $530.85 million, with $450.0 million from the DOE and $80.85 million from NSF. NSF and DOE will jointly provide a total contribution of $331.0 million for the detector construction, while DOE will provide the entire U.S. contribution ($200 million) for the accelerator construction. There are two other major detectors being constructed, ALICE and LHC-B, in which the U.S. does not play a role.

This is a photograph of a partially complete segment of the ATLAS detector. *Credit: LHC project.*

Appropriated MREFC Funds for LHC
(Dollars in Millions)

FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Total
$22.00	$15.90	$16.36	$16.90	$9.69	$80.85

Large Hadron Collider Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand Total**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 1996	1.20						$1.20		**$1.20**
FY 1997	1.50						$1.50		**$1.50**
FY 1998	1.50						$1.50		**$1.50**
FY 1999	1.50		0.15	22.00	0.16		$1.81	$22.00	**$23.81**
FY 2000				15.90	0.53		$0.53	$15.90	**$16.43**
FY 2001				16.36	2.30		$2.30	$16.36	**$18.66**
FY 2002				16.90	1.60		$1.60	$16.90	**$18.50**
FY 2003				9.69	5.00		$5.00	$9.69	**$14.69**
FY 2004 Estimate					7.00		$7.00		**$7.00**
FY 2005 Request					9.00		$9.00		**$9.00**
FY 2006 Estimate					14.00		$14.00		**$14.00**
FY 2007 Estimate					19.00		$19.00		**$19.00**
FY 2008 Estimate					24.00		$24.00		**$24.00**
FY 2009 Estimate					25.00		$25.00		**$25.00**
Subtotal, R&RA	$5.70		$0.15		$107.59		$113.44		
Subtotal, MREFC				$80.85				$80.85	
Total, each phase		**$5.70**		**$81.00**		**$107.59**			**$194.29**

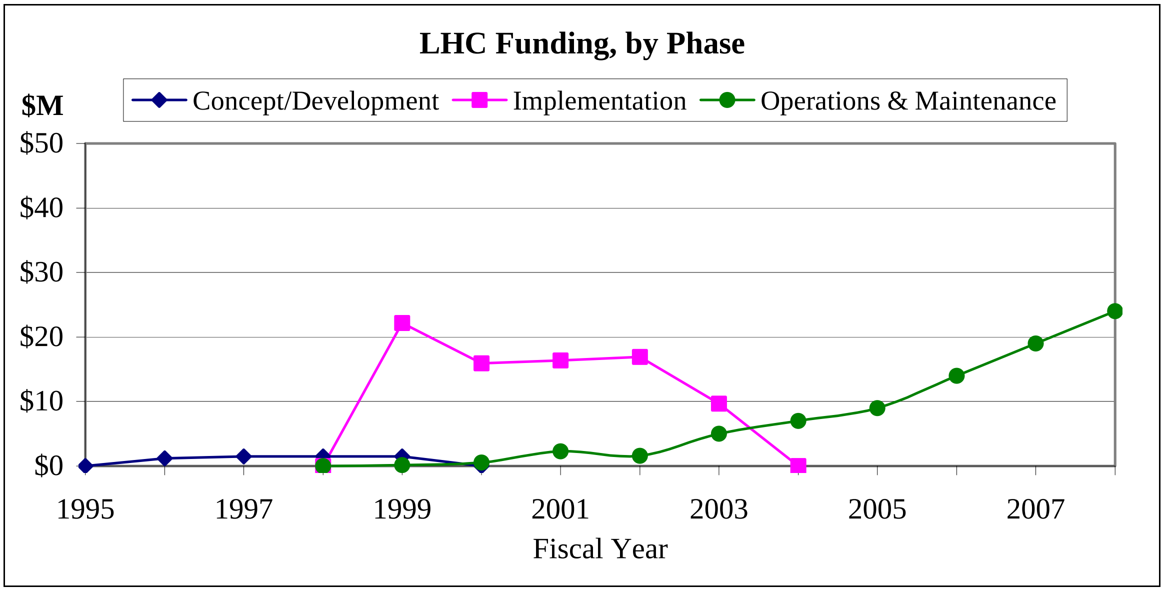
NOTE: A steady state of $25.0 million in operations support is anticipated by FY 2009. The estimated operational lifespan of this project is approximately 20 years. Operations estimates for FY 2005 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

Information pertaining to the data in the table is provided below.

- Concept/Development*:* The LHC has been under discussion since FY 1989. NSF funding in FY 1996-99 supported technical design studies.

- Implementation: NSF components of the ATLAS and CMS detectors, constructed with funds provided FY 1999-FY 2003, are anticipated to be completed, tested and ready to install in FY 2005. The overall LHC project is now anticipated for completion at CERN in FY 2007. (In FY 1999, $150,000 in R&RA funds were provided to meet the scheduled award total of $22.15 million. This R&RA action was noted in subsequent NSF MREFC budget justifications to Congress.) Final implementation funding was provided in FY 2003.

- Management and Operations: FY 1999-2003 funding primarily represents investments in university computing infrastructure and software development for remote access, to allow university scientists and students to participate in LHC research as well as other projects. Estimated funding for FY 2004 and beyond reflects the NSF share of operations as the ATLAS and CMS detectors approach and initiate operations. Components of these detectors, by far the largest ever constructed in particle physics, become inaccessible when additional components are installed, and all become inaccessible when data taking begins. To insure satisfactory performance, components must be operated, tested and repaired as soon as installed. Estimated funding during the same period also includes the development of LHC grid software and computing (S&C). Detector operations costs and S&C costs are approximately equal. It is anticipated that over the lifetime of the LHC project, upgrades and new components to address emerging research questions will be considered. Funds for such activities are not included here.



Future Science Support*:* Along with direct support for operations and maintenance for LHC, NSF will support science and engineering research performed at the facility, through ongoing research and education programs. The annual support for such activities is presently estimated to be about $5.0 million once the facility reaches full operations. Both ATLAS and CMS have well-developed outreach activities (see Education Goals above).

George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Project Description: NEES will provide a national, networked simulation resource of fifteen geographically distributed, shared use next-generation experimental research equipment sites with teleobservation and teleoperation capabilities. This facility will transform the environment for earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, databases, and model-based simulation to improve the seismic design and performance of U.S. civil and mechanical infrastructure systems. Research equipment includes shake tables, geotechnical centrifuges, a tsunami wave basin, large-scale laboratory experimentation systems, and field experimentation and monitoring installations. NEES equipment will be located at academic institutions (or at off-campus field sites) throughout the U.S., networked together through a high performance Internet system, and operated during FY 2005-14 by a NEES Consortium. The NEES award for system integration is located at the University of Illinois at Urbana-Champaign. The NEES award for consortium development was made to a non-profit organization, the Consortium of Universities for Research in Earthquake Engineering.

Principal Scientific Goals: To enhance understanding and provide more comprehensive, complete, and accurate models of how civil and mechanical infrastructure systems respond to earthquake loading (site response, soil-foundation-structure interaction, tsunami effects, and structural and nonstructural response). This will enable the design of new methods, modeling techniques, and technologies for earthquake hazard mitigation.

This illustrates random waves generated by the Oregon State Tsunami Wave Basin, the world's leading facility for studying the effects of large waves. State-of-the-art information technology allows real-time research to be shared over the internet with remote collaborators, other researchers, and students. In addition, access to archived data will allow replay and "post-game" analysis of interesting phases of the tsunami experiment. *Credit: Oregon State University.*

Principal Education Goals: To engage engineering, science, and other students in earthquake engineering discovery through on-site use of experimental facilities, telepresence technology, archival experimental and analytical data, and computational resources with the aim of integrating research and education.

Connections to Industry: There are no specific project partnerships at this time. However, through the Congressionally mandated National Earthquake Hazards Reduction Program (NEHRP), Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), NSF, and U.S. Geological Survey (USGS) participate to support research related to earthquake hazard mitigation. Connections to industry include equipment and instrumentation acquisition by awardees from private firms; and private engineering consultants and engineering firms engaging in NEES research or using data and models developed through NEES.

Management and Oversight: The NSF Program Manager for NEES and the NSF Equipment Project Coordinator are located in the Civil and Mechanical Systems (CMS) Subactivity in the Engineering (ENG) Activity. Oversight is supported by the NSF Project Advisory Team consisting of representatives from the Office of General Counsel, the Office of Budget, Finance and Award Management, and the Biosciences, Geosciences, Computer and Information Science and Engineering, and Social and Behavioral Sciences Activities. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance.

Current Project Status: NEES is currently under construction through the end of FY 2004. Sixteen awards (Phases 1 and 2) have been made to establish equipment sites at fifteen institutions, one award for system integration, and one award for consortium development. All awards are the result of competitive program solicitations. The organizational structure and policies for a NEES Consortium are under development by the earthquake engineering community. Milestones for NEES are outlined below:

FY 2004 Milestones:

Complete equipment construction and calibration of all Phases 1 and 2 equipment;
All equipment sites networked and operational;
Coordinate outreach and training activities for equipment sites as they become operational;
Complete testing of network system;
Network system operational; and
NEES Consortium management structure completed for operation in FY 2005.

<u>Funding Profile</u>: NSF received $7.70 million in FY 2000 to initiate construction of NEES. Total MREFC funding for this project will be $81.76 million during FY 2000-04, with an additional $1.10 million provided to the project through the Education and Human Resources (EHR) Account.

Appropriated and Requested MREFC Funds for NEES
(Dollars in Millions)

FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	Total
$7.70	$28.14	$24.40	$13.47	$8.05	$81.76

NEES Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation			Operations & Maintenance		Totals			Grand
	R&RA	MREFC	R&RA	MREFC	EHR	R&RA	MREFC	R&RA	MREFC	EHR	Total
FY 1995	0.15							$0.15			**$0.15**
FY 1996											
FY 1997											
FY 1998	0.11							$0.11			**$0.11**
FY 1999											
FY 2000		0.36		7.34					$7.70		**$7.70**
FY 2001	0.44	0.03		28.11	1.10			$0.44	$28.14	$1.10	**$29.68**
FY 2002				24.40					$24.40		**$24.40**
FY 2003				13.47					$13.47		**$13.47**
FY 2004 Estimate				8.05					$8.05		**$8.05**
RY 2005 Estimate						20.00		$20.00			**$20.00**
FY 2006 Estimate						20.40		$20.40			**$20.40**
FY 2007 Estimate						20.87		$20.87			**$20.87**
FY 2008 Estimate						21.39		$21.39			**$21.39**
FY 2009 Estimate						21.93		$21.93			**$21.93**
Subtotal, R&RA	$0.70					$104.59		$105.29			**$105.29**
Subtotal, MREFC		$0.39		$81.37					$81.76		**$81.76**
Subtotal, EHR					$1.10					$1.10	**$1.10**
Total, Each Phase		**$1.09**			**$82.47**		**$104.59**				**$188.15**

NOTE: The expected operational lifespan of this project is 10 years after construction is complete in FY 2005. A steady state of $20 million in operations support is anticipated by FY 2005. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

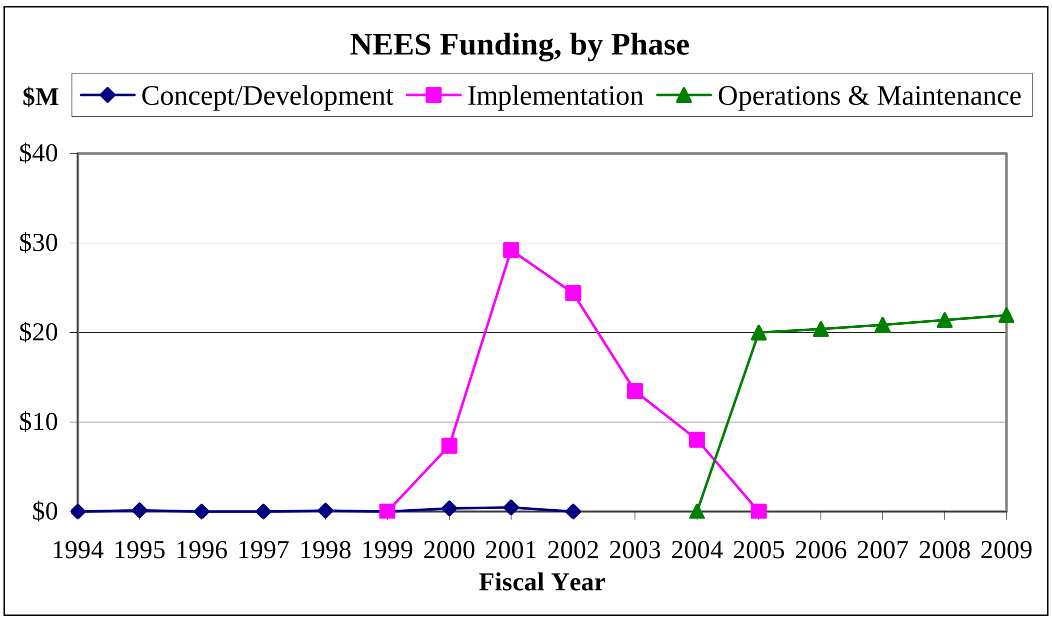
Information pertaining to the data in the table is provided below.

- <u>Concept/Development</u>: R&RA support for planning, design and development included early workshops on experimental needs of the earthquake engineering community and on refinement of ideas for experimental systems in FY 1995 and FY 1998. During this period, the community also developed an action plan at NSF's invitation. Additional R&RA support focused on an international workshop to foster long term working relationships for experimental earthquake engineering research and national workshops and study to develop long-term NEES research concepts and plans (FY 2001). MREFC funds supported planning, design and development specifically for a scoping study of the NEES network system (user and system architecture requirements), including a community workshop for broader input on user requirements prior to the full system integration award being made by NSF.

- Implementation: MREFC funds during this phase support a range of equipment acquisition, as well as system integration and consortium development. To encourage the broadest participation for establishment of geographically distributed NEES equipment sites, the FY 2000 competitive program solicitation for NEES research equipment specifically encouraged participation from EPSCoR states. As a result of the merit review process, one award was made to an institution from an EPSCoR state for which the EPSCoR program provided partial funding through the EHR account in FY 2001.

- Operations and Maintenance: With completion of the construction period in FY 2004, NEES will enter its 10-year operational period through FY 2014 and will be managed by the NEES Consortium. The NEES Consortium will provide the leadership, management, and coordination for all the NEES resources and will establish a broad and integrated partnership that includes participation of the full membership of the earthquake engineering community, both within the U.S. and abroad.

As an Internet-based resource, access to the NEES network will be 24/7 to anyone with Internet capabilities. The NEES experimental facilities are expected to be fully utilized annually as shared use research sites coordinated by the NEES Consortium and for research by personnel at the host institution. NEES experimental resources and data are expected to be used annually by approximately 1000 U.S. researchers and students.



Future Science Support: Along with direct operations and maintenance support for NEES, NSF will support research performed at NEES equipment sites through ongoing research and education programs. In addition, NSF has initiated grand challenge research projects that will utilize a number of NEES experimental sites, data, and computational resources to comprehensively address major research questions in earthquake engineering and seismic hazard mitigation. The annual support for such activities once the facility reaches full operations is estimated to reach about $15.0 million.

South Pole Station

Project Description: South Pole Station Modernization (SPSM) will provide a new station to replace the current U.S. station at the South Pole, built 30 years ago and currently inadequate in terms of capacity, efficiency, and safety. The new station will be an elevated complex with two connected buildings, supporting 150 people in the summer, and 50 people in the winter.

Principal Scientific Goals: Support science at the South Pole and maintain U.S. presence at the South Pole in accord with U.S. policy.

Principal Education Goals: Support education associated with the research projects at the South Pole.

Connections to Industry: SPSM's primary connection to industry is through the Raytheon Polar Services Company (RPSC), the U.S. Antarctic Program support contractor. In addition, there are approximately 385 separate subcontractors for supplies and technical services.

Management and Oversight: The Office of Polar Programs (OPP) has the overall management responsibility for SPSM, including development of the basic requirements, design, procurement and construction. OPP has contracted for procurement and construction management for all phases of the project, including design reviews of all drawings and specifications; conformance of the designs and procurements with established standardization criteria; assistance in establishing functional interfaces; transition from the existing to the new facilities; and systems integration. Naval Facilities Engineering Command, Pacific Division (PACDIV) selects, monitors, and manages architectural and engineering firms for design, post-construction services, and construction inspection for the project. The project status, including cost expenditures and cost projections, is monitored on a periodic basis by OPP and the project's Project Advisory Team with members from OPP and the Office of Budget, Finance and Award Management. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance.

Current Project Status: The original estimate for SPSM was $127.90 million. A change in project scope increasing station capacity from 110 people to 150 people, as well as a project schedule extension, increased the cost estimate to $133.44 million (+$2.52 million for increased scope; +$3.02 million due to weather-induced schedule delays). Additional weather delays last year again adversely impacted planned material deliveries resulting in a further revised schedule. The current projection is for conditional acceptance (i.e., occupation and operations) of the entire station by the end of FY 2007, with demolition/retrograde of the old station and work on punchlist items occurring in FY 2008. The milestones shown below will be updated based on the new projections.

Activity	Procurement	Transport to Antarctica	Airlift to South Pole	Start Construction	Conditional Acceptance
Vertical Circular Tower	FY98	FY99	FY99/00 (00)	FY00 (01)	FY02
Quarters/Galley	FY98	FY99	FY00/FY01	FY01 (02)	FY03
Sewer Outfall	FY98	FY99	FY00	FY01	FY02 (01)
Fuel Storage (100K gallons)	FY98	FY98	FY99	FY99	FY99
Medical/Science	FY99 (98)	FY00 (99)	FY01/02 (00)	FY02	FY04
Communications/Administration	FY99 (98/99)	FY01 (00)	FY02/03 (01)	FY03 (02)	FY05 (03)
Dark Sector Lab	FY98	FY99	FY99/00 (00)	FY00 (01)	FY04 (01)
Water Well	FY00 (98)	FY01 (99)	FY01/02 (00)	FY02 (01)	FY02
Remote RF Building	FY99 (98/99)	FY00	FY01	FY01 (02)	FY01 (03)
Emergency Power/Quarters	FY99	FY01	FY02/03 (01/02)	FY03	FY05
Liquid nitrogen and helium facility	FY02 (99)	FY03 (00)	FY04 (01)	FY04 (02)	FY04 (03)
Quarters/Multipurpose	FY99 (00)	FY02 (01)	FY04 (02/03)	FY05	FY06
Electronic Systems and Communications	FY00/03 (99/00)	FY01/04 (00/01)	FY01/05 (01/02)	FY01 (03)	FY06 (04)
Warehousing, SEH and Waste Management	FY99 (01)	FY02/03 (02)	FY04 (03)	FY06 (04)	FY07 (05)
Station Equipment	FY02/03 (01)	FY03/04 (03)	FY04/05 (04)		FY05

Funding Profile: SPSM has received appropriations totaling $132.49 million through FY 2003. The FY 2004 Estimate includes $1.29 million. Using an updated (extended) schedule, the estimated total cost of SPSM is $136.96 million. SPSM expenditures to date total $74.2 million. Based on industry estimation standards, and taking into account work remaining, it is anticipated that the estimated completion costs could range from $133.8 to $143.3 million. The cost estimate is updated annually. No funds are being requested in the FY 2005 Budget Request.

Appropriated and Requested MREFC Funds for South Pole Station Modernization
(Dollars in Millions)

	FY 2002 and prior years	FY 2003 Approp	FY 2004 Estimate	FY 2005 Request	Est Future Requests	Total
South Pole Station Modernization	$126.49	$6.00	$1.29	$0.00	$3.18	$136.96

Advance funding provided in the project's early years made possible advance bulk buys of materials, which is ultimately more cost-efficient. However, this project's overall outlay is relatively slow due to the unusual logistics and shortened Antarctic season. As a result, the project has carried over fairly significant amounts each year since FY 1998, resulting in obligations that are significantly lower than appropriated amounts.

The following funding profile chart includes actual obligations for past years and anticipated obligations for future years.

South Pole Station Modernization Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
FY 1994 & Earlier	12.90						$12.90		**$12.90**
FY 1995	1.10						$1.10		**$1.10**
FY 1996	1.60						$1.60		**$1.60**
FY 1997	0.80						$0.80		**$0.80**
FY 1998				24.93				$24.93	**$24.93**
FY 1999				4.28				$4.28	**$4.28**
FY 2000				15.49				$15.49	**$15.49**
FY 2001				10.14				$10.14	**$10.14**
FY 2002				15.03				$15.03	**$15.03**
FY 2003				12.65				$12.65	**$12.65**
FY 2004 Estimate				20.00				$20.00	**$20.00**
FY 2005 Request				18.00				$18.00	**$18.00**
FY 2006 Estimate				10.00				$10.00	**$10.00**
FY 2007 Estimate				2.91	15.00			$2.91	**$2.91**
FY 2008 Estimate					15.38				
FY 2009 Estimate					15.76		$15.76		**$15.76**
Subtotal, R&RA	$16.40				$46.13		$32.16		
Subtotal, MREFC				$133.44				$133.44	
Total, each phase		**$16.40**		**$133.44**		**$46.13**			**$165.60**

NOTE: A steady state of operational support is anticipated at $15 million by FY 2007, slightly higher than the current operational costs. The expected lifespan of the modernized station is 25 years, through FY 2031. Operations estimates for FY 2007 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

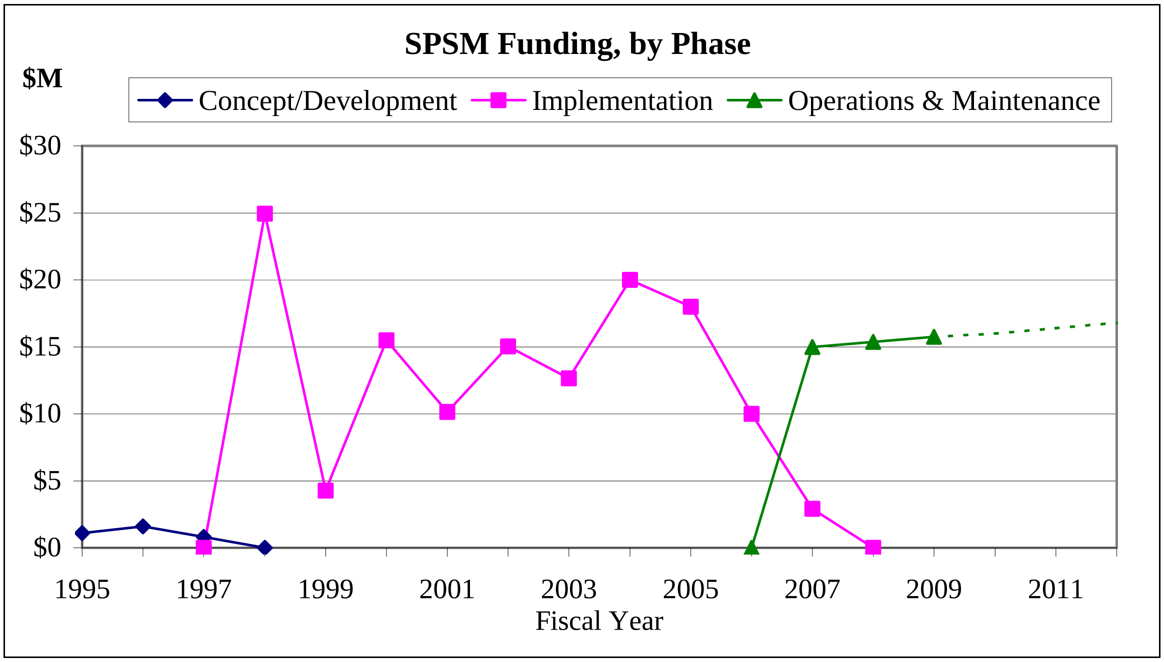
Information on the data in the table is provided below.

- Concept/Development: Design, development, planning and closely related activities in support of this project included preparation of more than 40 engineering studies and reports. The documents ranged widely in subject matter including subjects such as snowdrift minimization modeling, detailed analysis of power and heating requirements, preparation of a draft Environmental Impact Statement, energy conservation measures, efficiency and maintainability of diesel generators, fuel storage support system evaluation, design code criteria matrix, concept for signal/communication systems, gray-water system evaluation, minimization of ventilation requirements, control of diesel engine exhaust emissions, and jacking plan and concept.

This is a recent picture of South Pole Station. Another major portion of the new station, containing medical facilities, was approved by NSF for conditional occupancy on 1/28/04. *Credit: the United States Antarctic Project, NSF.*

- Implementation: Funding supports construction of an elevated station complex with two connected buildings, supporting 150 science and support personnel in the Austral summer, and 50 science and support personnel in the winter. Costs include materials, labor, logistics for transportation of all material and personnel to the South Pole, construction support, inspection, and equipment, as well as demolition and disposal of the existing station.

- Operations and Maintenance: This support represents the continued presence of a U.S. station at South Pole rather than new funds. Operational costs of the modernized station are expected to be slightly higher than operational costs of the current station, with some lower costs due to efficiencies gained, and some higher costs due to increased station size and increases in Science Support and Information Systems. A steady state of operational support is anticipated at $15.0 million by FY 2007. The expected lifetime of the modernized station is 25 years, through FY 2031. These estimates are currently being reviewed to improve accuracy, taking into account estimated station population and cargo loads.



Future Science Support: Along with direct operations and maintenance support for South Pole Station, NSF will support science and engineering research through ongoing research and education programs. The annual support for such activities is currently estimated to be approximately $8.3 million.

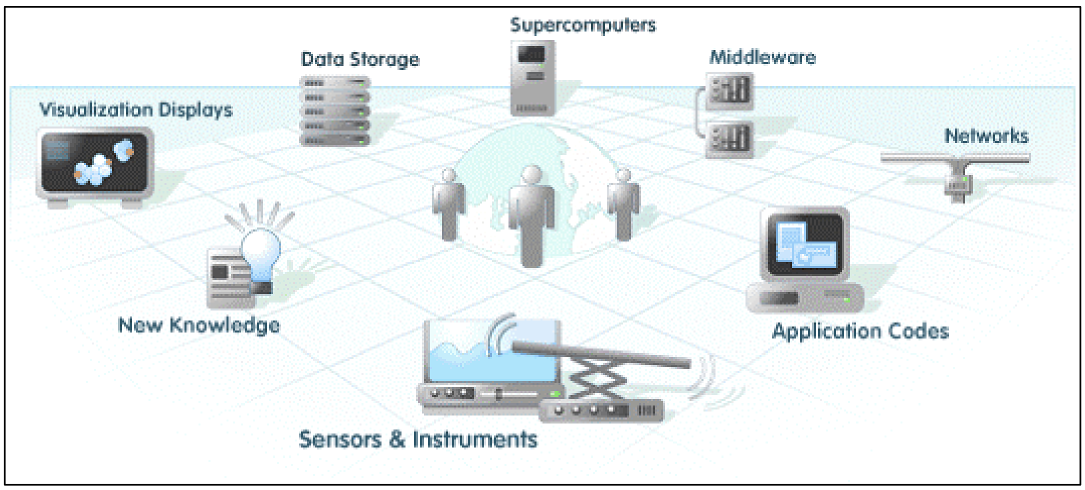
Terascale Computing Systems: Terascale Computing System, Distributed Terascale Facility and Extensible Terascale Facility

Project Description: The NSF Terascale Computing Systems project provides access to scalable, balanced, terascale computing resources for the broad-based academic science and engineering community served by NSF through a series of MREFC construction projects.

A Terascale Computing System (TCS), with peak performance of 6 teraflops, has been built by the Pittsburgh Supercomputer Center (PSC) in partnership with the Compaq Computer Corporation (now Hewlett Packard) under an award made in FY 2000.

A Distributed Terascale Facility (DTF), initiated in FY 2001, is under construction by The National Center for Supercomputing Applications (NCSA) and the San Diego Supercomputer Center (SDSC), with Argonne National Laboratory (Argonne) and the California Institute of Technology (Caltech), and in partnership with IBM, Intel, Qwest, Oracle and SUN. Based on multiple Linux clusters, DTF will link four sites through high-performance networks to create a very high-performance, distributed facility that allows advanced data handling, remote site interaction, and large-scale storage. Initial operation of the Distributed Terascale Facility will begin in January 2004.

In 2002 NSF provided enhancements to the existing Terascale Facilities and initiated the creation of an Extensible Terascale Facility (ETF) by extending the DTF "backbone network" to TCS, and by placing extensible hubs in Chicago and Los Angeles that will permit further expansion of this distributed facility. This ETF "backplane network" will enable science and engineering researchers to conduct analyses at unprecedented scale, to merge multiple data resources seamlessly, and to advance discovery at the frontiers of science and engineering. This Extensible Terascale Facility, called the Teragrid, will provide the national community with at least 10 teraflops of capability in a single system (NCSA) and over 20 teraflops across the ETF including the 6 teraflop TCS system in an integrated facility. Users will have access to at least 500 terabyte of storage at a single site (SDSC) and nearly 1 petabyte across the ETF. The full ETF is expected to be fully operational by September 2004.



The National Science Foundation (NSF) has announced the first steps it is taking to develop a state-of-the-art cyberinfrastructure likely to revolutionize the conduct of science and engineering research and education. These steps leverage the agency's recent investments in the Extensible Terascale Facility and its six-year investments in the Partnerships for Advanced Computational Infrastructure. *Credit: the Directorate for Computer and Information Science and Engineering, NSF.*

In FY 2003, NSF made awards to extend the ETF to three new sites: Indiana University and Purdue University, Oak Ridge National Laboratory (ORNL), and the University of Texas. These extensions enhance the capabilities of NSF's Extensible Terascale Facility by providing computing resources integrated with scientific instruments and data collections. The new awards will connect neutron scattering instruments at ORNL and other unique computational and data resources in Indiana and Texas to the ETF backbone network for use by the nation's research and education community. The awards funded the high-speed connections required to share local resources across the Teragrid.

In FY 2004, NSF will upgrade the Pittsburgh facility for higher performance. In FY 2005 and beyond, the Terascale facilities will be managed as part of NSF Cyberinfrastructure plans to create an integrated system of state-of-the-art computing, communications and information resources, tools and services. The plans for Cyberinfrastructure are described in the Tools chapter.

Principal Scientific Goals: To provide state-of-the-art capabilities for simulation and modeling for a vast array of scientific, engineering and mathematical problems in traditional disciplines like physics, chemistry, geosciences, and engineering, as well as in disciplines such as biology and the social and economic sciences, where computing is emerging as a critical new tool. A secondary goal made possible by the distributed architecture of ETF is to seamlessly link large, managed scientific data archives and the high-performance computational resources that can be used to mine, analyze, visualize, and perform related simulations on the data.

Principal Education Goals: To provide access and training to U.S. students, graduate students, and postdoctoral fellows in the use and applications of high-performance computing hardware and software, and to insure that there is a highly-trained scientific workforce with experience in applying state-of-the-art supercomputer technology to basic research problems of national importance in all areas of science and engineering.

Partnerships and Connections to Industry: Several industries are partners in the construction of TCS, DTF, and ETF. Primary industrial partners include Hewlett Packard, IBM, Intel, Juniper, Force 10, Qwest, SUN, and Oracle.

Management and Oversight: Oversight of this project is provided through a Program Manager in the Shared Cyberinfrastructure Subactivity in the Computer and Information Science and Engineering (CISE) Activity. Oversight is supported by the NSF Project Advisory Team consisting of representatives from the Office of General Counsel, the Office of Budget, Finance and Award Management, CISE, Education and Human Resources, Biological Sciences, Geosciences, Mathematical and Physical Sciences, and Engineering Activities. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. An external Technical Advisory Panel makes periodic site visits to the Terascale facility institutions to review construction progress and provide technical advice to the Program Manager. The Technical Advisory Panel participates in resolution of major technical, managerial, or scheduling concerns; provides technical guidance/advice, especially with regard to the integration and coordination with other NSF Partnerships for Advanced Computational Infrastructure (PACI) program activities; and reviews and, where required, approves technical reports and information to be delivered by the Awardees.

The DTF and ETF Terascale Activities have a centralized management organization with a single Project Director. An executive committee, comprised of the Principal Investigators who participated in the Terascale awards, advises the Project Director on the construction, management and operation of the Terascale facilities. Also reporting to the Project Director are an External Advisory Committee, an Institutional Oversight Committee, and a User Advisory Committee.

Current Project Status: TCS was dedicated on October 29, 2001. It began allocated usage in April 2002. The first stage of DTF is complete and in testing with "friendly" users; it will begin allocated usage in early 2004. ETF will begin allocated usage in October of 2004.

Milestones for the Terascale Computing Systems are outlined below:

FY 2002 Milestones (Completed except as noted):

Terascale Computing System

Begin full operations of TCS (initial site – 2nd quarter).

Distributed Terascale Facility:

Begin construction of DTF (second site – 1st quarter);

Complete infrastructure preparation at four DTF sites (power, cabinets, air conditioning – 2nd quarter);

Contract for High Performance Network connections between Chicago and Los Angeles (2nd quarter);

Take delivery of backplane networks (3rd quarter); and

Take delivery of initial DTF cluster computers (4th quarter – Completed in 1st quarter FY 2003).

Extensible Terascale Facility:

Review and award supplements to TCS and DTF awardees for hardware and networking upgrades to fully integrate them with DTF backplane, and to create an Extensible Terascale Facility (ETF); (4th quarter) and

Hold workshop for additional sites that are interested in connecting to ETF.

FY 2003 Milestones:

Terascale Computing System:

Install TCS computing, storage and networking upgrades awarded for integration of TCS into ETF (2nd quarter).

Distributed Terascale Facility:

Complete installation and testing of initial clusters and DTF backplane networks (1st quarter);

Installation and testing of High Performance Network connections (1st quarter);

Complete installation and testing of operating software (OS, middleware, Globus) (2nd quarter);

Complete construction and integration of all DTF clusters (3rd quarter); and

Conduct performance testing on DTF (4th quarter).

Extensible Terascale Facility:

Install Hub Routers in Chicago and Los Angeles (1st quarter);

Competition to extend ETF to additional sites (2nd quarter).

Install computing and storage upgrades at all 5 ETF sites (3rd quarter);

Complete integration of TCS with DTF (4th quarter); and

Complete high speed connection between Chicago and the Pittsburgh Supercomputing Center (4th quarter);

FY 2004 Milestones:

Terascale Computing System:

Continue full operations.

Make award for upgrade of Terascale Computing System.

Distributed Terascale Facility:

DTF construction completed; acceptance and friendly user testing starts (1st quarter); and

DTF enters production use (2nd quarter).

Extensible Terascale Facility:

Full integration of all 5 sites into ETF including ETF hardware upgrades (3rd quarter);

Begin Allocated usage of ETF (4th quarter);

Begin integration of additional sites into ETF (2ndquarter), and

Complete integration of extensions sites (4th quarter).

Funding Profile: The recommendation to fund ETF in FY 2002 was presented at the National Science Board meeting in August 2002. In order to make certain that all questions raised during the review had been addressed and responded to in writing, the NSB postponed approval of the award to the next meeting, scheduled for October, 2002, which resulted in a carryover of funds into FY 2003. The NSB approved the award at their October meeting, and the funds have subsequently been obligated. The FY 2003 Request included $20.0 million to extend ETF to additional resource sites that included: additional computational resources; large data archives; large instrumentation facilities; or large sensor networks.

MREFC Appropriations for Terascale Computing Systems
(Dollars in Millions)

FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	Total
$36.00	$44.90	$35.00	$9.94	$9.94	$135.78

Terascale Computing Systems Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance[3]		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 1998	0.06						$0.06		0.06
FY 1999									
FY 2000				36.00				$36.00	36.00
FY 2001				44.90	2.37		$2.37	$44.90	47.27
FY 2002[1]					7.06		$7.06		7.06
FY 2003				44.83	11.17		$11.17	$44.83	56.00
FY 2004 Estimate[2]				10.05	10.00		$10.00	$10.05	20.05
FY 2005 Request					97.90		$97.90		97.90
FY 2006 Estimate					99.56		$99.56		99.56
FY 2007 Estimate					101.56		$101.56		101.56
FY 2008 Estimate					103.89		103.89		103.89
FY 2009 Estimate					106.49		106.49		106.49
Subtotal, R&RA	$0.06				$540.00		$540.06		$540.06
Subtotal, MREFC				$135.78				$135.78	$135.78
Total, Each Phase		**$0.06**		**$135.78**		**$540.00**			**$675.84**

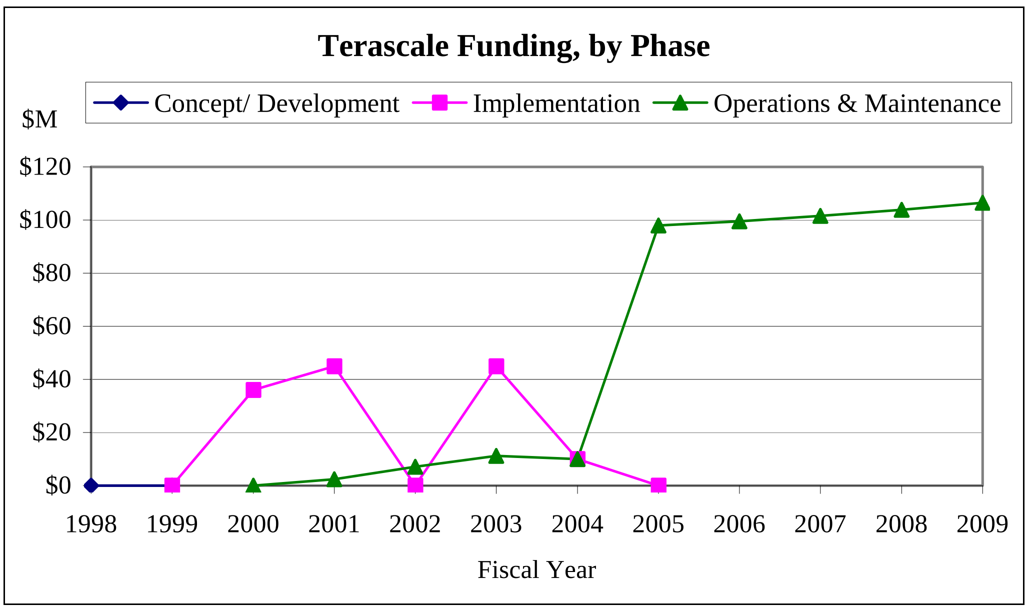
NOTE: A strategic plan for the long-term support of NSF's Terascale Facility as part of the Cyberinfrastructure effort is under development at the time of this request. See the Cyberinfrastructure section under Tools for detailed information.
[1]FY 2002 MREFC funding for Terascale was carried over into FY 2003 due to the NSB meeting schedule. The award was approved in October, 2002 and the funds were subsequently obligated.
[2]The FY 2004 Estimate includes implementation funds totaling $110,000 carried over from FY 2003.
[3]Operations funding in FY 2005 and beyond represents operations and maintenance support for Widely-shared Cyberinfrastructure, of which support for the operation and maintenance of the Terascale Computing Systems is about $10.0 million in FY 2005. Terascale will be fully integrated with Cyberinfrastructure in future years. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available. For further information on Widely-shared Cyberinfrastructure, please refer to the Tools chapter.

Information pertaining to the data in the table is provided below.

- Concept/Development: Planning for Terascale Computing Systems began in 1998, with a series of 3 workshops held at NSF to assess the need within the academic research community for computational resources with multi-teraflop capability. Because it was anticipated that Terascale Computing Systems would be constructed by partnerships involving academic institutions and commodity hardware vendors, NSF employed a peer-reviewed, competitive solicitation process in FY 2000 and 2001 to select the best designed systems for funding. In FY 2002 the original systems have been upgraded, and funding for the extension of DTF to form the ETF was provided. In FY 2003 ETF was extended with additional awards integrating additional sites into it. In FY 2004, $9.94 million from MREFC funds will be used to upgrade the Pittsburgh Terascale facility.

- Implementation: TCS was funded at Pittsburgh Supercomputer Center in FY 2000. It was fully operational in first quarter of 2002. DTF was funded at UCSD and NCSA in FY 2001. Construction continued through FY 2003. Funds in FY 2002 enhanced and augmented TCS and DTF, fully integrated TCS and DTF into a single grid-enabled facility, and enabled the DTF to extend beyond the five initial sites. Funds in FY 2003 supported connections of new nodes. In FY 2004, upgrades as called for by rapid advances in computing technologies and systems will be funded at the Pittsburgh Terascale facility.

- Management and Operations: The Terascale facilities incurred operations costs of approximately $7.06 million in FY 2002. Operations costs were $11.17 million in FY 2003. Operations for FY 2004 are estimated at $10.0 million. Operations funding in FY 2005 and beyond represents operations and maintenance support for Widely-shared Cyberinfrastructure, of which support for the operation and maintenance of the Terascale Computing Systems is about $10.0 million in FY 2005. Terascale will be fully integrated with Cyberinfrastructure in future years. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available. For further information on Widely-shared Cyberinfrastructure, please refer to the Tools chapter.



Future Science Support: Along with the direct operations and maintenance support for Terascale Computing Systems facilities, NSF will support science and engineering research performed at the facilities, through ongoing research and education programs. Terascale Facilities provide support for scientists and engineers funded through all programs supported by the NSF. The annual support for research and education using the Terascale facilities is estimated to be about $160.0 million.

SECOND PRIORITY: NEW STARTS IN FY 2005 AND FY 2006

National Ecological Observatory Network (NEON)

Project Description: NEON will be a continental scale research instrument consisting of geographically distributed infrastructure, networked via state-of-the-art communications technology. Cutting-edge lab and field instrumentation, site-based experimental infrastructure, natural history archive facilities and/or computational, analytical and modeling capabilities, linked via a network will comprise NEON.

NEON will transform ecological research by enabling studies on major environmental challenges at regional to continental scales. Scientists and engineers will use NEON to conduct real-time ecological studies spanning all levels of biological organization and temporal and geographical scales. NSF disciplinary and multi-disciplinary programs will support NEON research projects and educational activities. Data from standard measurements made using NEON will be publicly available.

Principal Scientific Goals: Collectively, the network of observatories will allow comprehensive, continental-scale experiments on ecological systems and will represent a virtual laboratory for research to obtain a predictive understanding of the environment. Important ecological questions confronting the U.S. will be addressed using NEON.

The National Ecological Observatory Network (NEON), a collaborative research platform of geographically distributed infrastructure, will be connected via the latest information technology. NEON will address pressing environmental questions on regional to continental scales. *Credit: The Directorate for Biological Sciences, NSF.*

Principal Education Goals: The NEON's knowledge base, real time and continuous network data, simulation and observation capabilities, and networked communication will be an asset for formal and informal education and training. NEON will serve as a model to foster the NSF goal of integration of research and education by creating a research-intensive and collaborative learning environment. NEON will provide a creative and innovative educational platform to address the NSF Directorate for Biological Sciences education goals (experiential learning, biosphere literacy, and broadening career horizons).

Partnerships and Connections to Industry: Potential federal partners have expressed interest in NEON, including National Park Service, National Forest Service, NASA, USGS, EPA, National Marine Sanctuaries and USDA Agricultural Research Sites. Private foundations, such as the Santa Fe Institute, the Turner Foundation, Nature Serve, and The Nature Conservancy have also expressed interest. NEON-generated information will be useful to natural resource industries, such as forestry and fisheries. NEON's technological and networking infrastructure will be forging new technological frontiers and thus, will require partnerships with industry for development, deployment, and operation.

Management and Oversight: The Division of Biological Infrastructure within the BIO Directorate manages NEON. The NEON Program Officer in consultation with a BIO-NEON committee, which includes the Deputy Director for Large Facility Projects, formulates the programmatic development of NEON, i.e. drafting, release and review of program announcements, etc. A NEON Project Advisory Team, which includes individuals from all NSF directorates and includes the Office of Budget, Finance and Award Management, the Office of General Counsel, the Office of Legislative and Public Affairs, and the Office of Polar Programs, provides internal oversight. The NSF Deputy Director for Large Facility

Projects is a member of the PAT and will provide advice and assistance. In addition, a sub-committee of the BIO Advisory Committee will provide external advice to the NEON Program Officer about specific programmatic elements.

The NEON Program Officer ensures NEON coordination with other NSF observatories and networks. Coordination with other Federal Agencies occurs through the NEON Federal Agency Coordinating Committee. In addition, NEON is represented on the Architecture subcommittee of the Interagency Working Group for Global Earth Observation System, an activity of the CENR.

Current Project Status:

Planning Activities over the past year: There were three activities to further refine NEON science and infrastructure requirements and NEON governance and management. Two NEON Coordination and Implementation Conferences provided open fora for the scientific community to define how to form, manage, and govern NEON. A "scoping" workshop explored how the scientific community would use a network of ecological observation sites to deepen its understanding of the carbon cycle at sub-regional to continental scales. Two publications, the National Research Council (NRC) report and an American Institute of Biological Sciences (AIBS) white paper, were published. The white paper summarized the previous ten NEON workshop reports, synthesized the prior planning efforts, and provided the rationale for a national research platform.

NRC Report: In November 2003, the National Research Council (NRC) released a report entitled "NEON: Addressing the Nation's Environmental Challenges" that strongly endorsed NEON and provided recommendations for its overall implementation. The report identified several major environmental challenges that occur at regional to continental scales, which require nationally distributed infrastructure.

NEON will apply emerging technologies (sensor, analytical, communication and information) to investigate the structure and dynamics of U.S. ecosystems and to forecast biological change. *Credit: The Bigfoot Project* www.fsl.orst.edu/larse/bigfoot)

Program Announcement for NEON Coordinating Consortium (NCC) and Project Office: The FY 2004 Estimate level does not fund NEON in the MREFC Account, but encourages NSF to continue planning and development activities. A program announcement will be released in FY 2004 to solicit proposals to refine NEON, which includes: developing the Project Execution Plan, establishing a coordination and governance structure, and setting up the NEON Project Office for administration and management. The NCC will establish a governance board, science and technical advisory committees, membership organization, and the NEON Project Office, and provide the scientific leadership, organizational structure, and overall governance of NEON.

Major milestones for NEON are listed below.

FY 2004 Milestones:

NEON Coordinating Consortium and Project Office awarded (4th quarter)
Refine NEON Project scope, budget, and schedule for research
Preliminary baseline design for NEON networking, informatics, education, training, and outreach

FY 2005 Milestones:

Final baseline design for NEON networking infrastructure, informatics, and education, training, and outreach
Preliminary Project Execution Plan for NEON research infrastructure

FY 2006 Milestones:
Final Project Execution Plan for NEON research infrastructure
Initiate construction of NEON networking infrastructure, informatics, and education, training and outreach
Evaluation of the NCC and Project Office

FY 2007 Milestones:
Installation and construction NEON research infrastructure
Continued construction of NEON networking infrastructure, informatics, and education, training and outreach

FY 2008 – FY 2010 Milestones:
Continued construction NEON research infrastructure
Continued construction of NEON networking infrastructure, informatics, and education, training and outreach

Funding Profile: In FY 2004, NSF requested $12.0 million in the MREFC Account to initiate construction of the first two NEON observatories. While the FY 2004 Estimate level does not provide funding, NSF will consider the recommendations in the NRC report, and continue to refine NEON planning with funds within the Research and Related Activities Account.

In FY 2004 the NEON Coordinating Consortium and Project Office will be established to refine NEON Project scope, budget, and schedule for research infrastructure. The NCC and Project Office will establish the governance and management structure for NEON, mechanisms for obtaining a community-driven definition of the location and types of infrastructure needed to address and prioritize the environmental grand challenges, and develop the preliminary baseline definition for the networking; informatics; and education, training, and outreach infrastructure in NEON.

In FY 2005, the NCC and Project Office will complete the preliminary Project Execution Plan for NEON research infrastructure. The Project Office will prepare the Final baseline design for NEON networking infrastructure, informatics, and education, training, and outreach.

Requested MREFC Funds for NEON
(Dollars in Millions)

FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Total
$12.00	$16.00	$20.00	$20.00	$20.00	$12.00	$100.00

NEON Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation[1]		Operations & Maintenance		Totals		**Grand**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	**Total**
FY 1998	0.01						$0.01		**$0.01**
FY 1999	0.03						$0.03		**$0.03**
FY 2000	0.17						$0.17		**$0.17**
FY 2001	0.10						$0.10		**$0.10**
FY 2002	1.00						$1.00		**$1.00**
FY 2003	0.92						$0.92		**$0.92**
FY 2004 Estimate	4.00						$4.00		**$4.00**
FY 2005 Request	4.00			12.00			$4.00	$12.00	**$16.00**
FY 2006 Estimate	1.00			16.00	0.25		$1.25	$16.00	**$17.25**
FY 2007 Estimate	1.00			20.00	0.25		$1.25	$20.00	**$21.25**
FY 2008 Estimate	1.00			20.00	3.00		$4.00	$20.00	**$24.00**
FY 2009 Estimate	1.00			20.00	6.00		$7.00	$20.00	**$27.00**
FY 2010 Estimate	1.00			12.00	9.00		$10.00	$12.00	**$22.00**
Subtotal, R&RA	$15.23				$18.50		$33.73		
Subtotal, MREFC				$100.00				$100.00	
Total, each phase	**$15.23**			**$100.00**	**$18.50**				**$133.73**

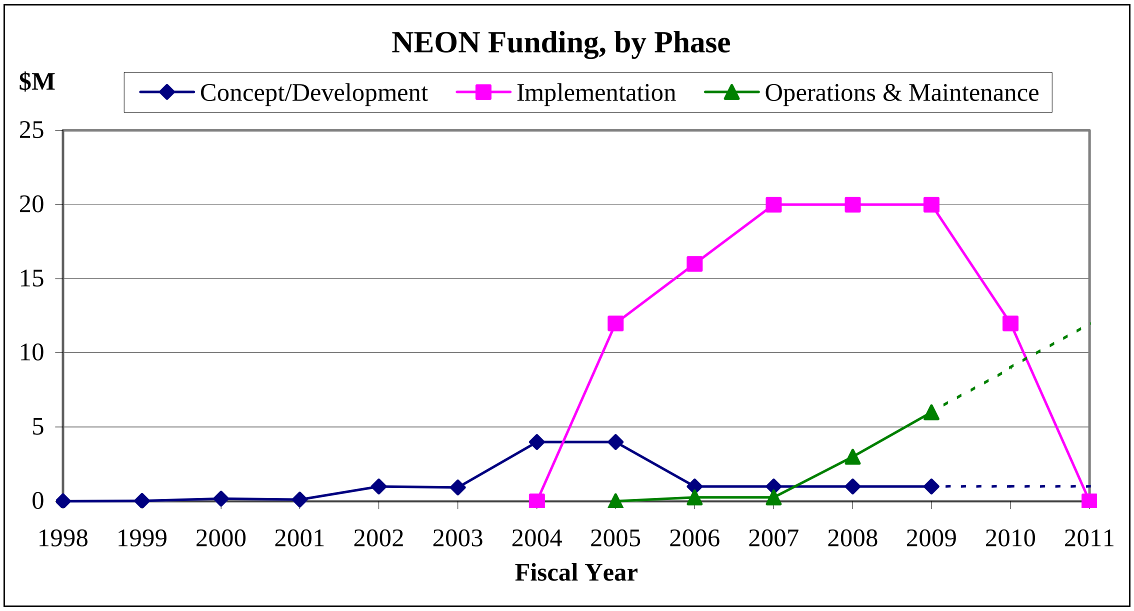
NOTE: The expected operational lifespan of this project is 30 years after construction is complete in FY 2010. A steady state of $9.0 million in operations support is anticipated by FY 2010. Operations estimates for FY 2006 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.
[1]FY 2006-10 implementation funding will be contingent upon the Project Execution Plans for research infrastructure, networking and informatics, and education, outreach, and training.

Information pertaining to the data in the table is provided below.

- Concept/Development: In FY 2002-2003 workshops were funded to specifically address the information technology needs, instrument array design and development, and data, information management architectures and synthesis of a regional-based implementation of NEON. In FY 2003, the National Research Council's study endorsed the concept for a continent-wide implementation of NEON along with a central governance management structure. In FY 2004, a solicitation will be released for a NEON Consortium and Project Office to provide the central management and governance of NEON and to develop the project execution plans for a continental implementation strategy based on nationally significant ecological research challenges. In FY 2005, funding for NEON enabling technologies will be supported.

- Implementation: Total construction costs for NEON will be determined from the project execution plan developed for research, networking, and education infrastructure. In FY 2005-06 MREFC funds will be used to baseline and develop the final design for NEON infrastructure. Initial construction of NEON networking and informatics infrastructure will begin in FY 2006.

- Operations and Maintenance: Initial operations support will commence in FY 2006 as construction is completed on NEON networking, and informatics infrastructure. Operations and maintenance support will increase as the research platform is established.



Future Science Support: Along with direct operations and maintenance support for NEON, NSF will support research performed using the NEON platform through ongoing research and education programs. The annual support for such activities once the research platform reaches full operations is estimated to be at least $12.0 million.

It is estimated that 1,400 field biologists will use NEON annually. A larger number of scientists, students, resource managers and decision makers will make use of NEON data, both directly and indirectly, through the network capabilities and data distribution and sharing technologies via the network and the internet.

Scientific Ocean Drilling Vessel (SODV)

Project Description: This project is to support the contracting, conversion, outfitting and acceptance trials of a deep-sea drilling vessel for long-term use in a new international scientific ocean drilling program. Commercial drillships are not routinely configured or equipped to meet the requirements of scientific research. It will be prepared for year-around operations and will be capable of operating in all ocean environments. The vessel will accommodate a scientific and technical staff of approximately 50. The converted drillship will provide the United States facility contribution to the Integrated Ocean Drilling Program which began on 1 October 2003. (For more information on the IODP, please refer to the Tools chapter.) The IODP is co-led by the NSF and the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan. European and other Asian nations are also participating in the program.

Pictured above is the JOIDES *Resolution*, the current drillship of the Ocean Drilling Program. MREFC funds are requested in FY 2005 to modify this or a similar ship to provide the Integrated Ocean Drilling Program with light drillship capability. *Credit: Joint Oceanographic Institutions (JOI).*

Principal Scientific Goals: The IODP will recover sediment and crustal rock from the seafloor using scientific ocean drilling techniques, and emplace observatories in drillholes to study the deep biosphere, the flow of fluids in sediments and the crust, the processes and effects of environmental change, and solid earth cycles and geodynamics. MEXT will provide a heavy drillship for deep drilling objectives of the programs. NSF will provide a light drillship and science support services for high-resolution studies of environmental and climate change, observatory and biosphere objectives.

Principal Education Goals: To engage students and the public in geoscience discovery through distance learning initiatives, preparation of classroom modules on IODP research initiatives, and outreach displays at museums and educational/teaching institutions.

NSF Management and Oversight: The project is managed and overseen by a project manager in the Division of Ocean Sciences in the Directorate for Geosciences. The project director receives advice and oversight support from a NSF Project Advisory Team, which consists of representatives from the Geosciences Activity, the Office of Polar Programs, the Office of Budget, Finance and Award Management, and the Office of General Counsel. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. A scientific-user-community advisory committee has been established to provide recommendations and advice on vessel conversion planning.

Current Project Status: Following proposal review and evaluation, NSF signed a contract with JOINT Oceanographic Institutions, Inc. (JOI) in September 2003 to provide drillship and science services for the IODP. JOI has contracted for drilling services in 2004 and 2005 on the *JOIDES Resolution,* which was used in ODP and is capable of addressing some IODP objectives. A separate task of the NSF-JOI contract is to plan and implement the SODV MREFC project, which will provide an enhanced vessel for long-term IODP use. Initial conceptual planning has been completed for the SODV within the U.S. scientific community, including vessel, drilling and laboratory requirements. Detailed planning by JOI will continue in FY 2004 under R&RA funding in the Geosciences Directorate, with project implementation (MREFC funding) beginning in FY 2005 with vessel contracting. The project schedule is outlined below:

FY 2004 Milestones:

- Solicit drilling contractor capabilities, recommendations and interest (1^{st}-2^{nd} quarter)
- Prepare initial MREFC Project Execution plan for approval (1^{st} – 2^{nd} quarter)
- Prepare RFP for drilling contractor (2^{nd} and 3^{rd} quarter)
- Refine laboratory requirements (2^{nd} and 3^{rd} quarter)
- Release RFP and evaluate responses (3^{rd} and 4^{th} quarter)

FY 2005 Milestones:

- Inspect vessels (1^{st} quarter)
- Vessel decision and contracting – initiate SODV MREFC project (1^{st} quarter)
- Initiate equipment procurement – (2^{nd} quarter)
- Sign shipyard contract – (3^{rd} quarter)
- Begin shipyard conversion of drillship (4^{th} quarter)

FY 2006 Milestones:

- Complete shipyard conversion (1^{st} quarter)
- Outfit laboratories (1^{st} quarter)
- Vessel acceptance trials (1^{st} and 2^{nd} quarters)
- Vessel commissioning and acceptance – terminate SODV MREFC project (3^{rd} quarter)
- Vessel scientific operations begin (3^{rd} quarter)

Funding Profile: Planning through FY 2003 cost approximately $2.70 million. In 2004, approximately $2.1 million will be provided to initiate contract activity, planning and design. In FY 2005 and FY 2006, $40.85 million and $59.94 million is requested through the MREFC Account respectively, for a total MREFC request of $100.79 million for conversion/equipping/testing of the drillship.

Requested Funds for the SODV
(Dollars in Millions)

FY 2005 Request	FY 2006	Total
$40.85	$59.94	$100.79

SODV Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance[1]		Totals		**Grand Total**
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2000	0.10						$0.10		**$0.10**
FY 2001	0.20						$0.20		**$0.20**
FY 2002	0.30						$0.30		**$0.30**
FY 2003	2.10						$2.10		**$2.10**
FY 2004 Estimate	2.10				35.60		$37.70		**$37.70**
FY 2005 Request	0.50	4.00		36.85	31.60		$32.10	$40.85	**$72.95**
FY 2006 Estimate		1.00		58.94	37.00		$37.00	$59.94	**$96.94**
FY 2007 Estimate					65.00		$65.00		**$65.00**
FY 2008 Estimate					67.00		$67.00		**$67.00**
FY 2009 Estimate					69.00		$69.00		**$69.00**
FY 2010 Estimate					70.73		$70.73		**$70.73**
FY 2011 Estimate					72.49		$72.49		**$72.49**
FY 2012 Estimate					74.31		$74.31		**$74.31**
Subtotal, R&RA	$5.30				$522.72		$528.02		
Subtotal, MREFC		$5.00		$95.79				$100.79	
Total, each phase		**$10.30**		**$95.79**		**$522.72**			**$628.81**

NOTE: The expected operational lifespan of this project is 15 years, beginning in FY 2006. A steady state of about $53 million in operations support is expected to occur in or about FY 2006 as the SODV vessel begins full operations. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

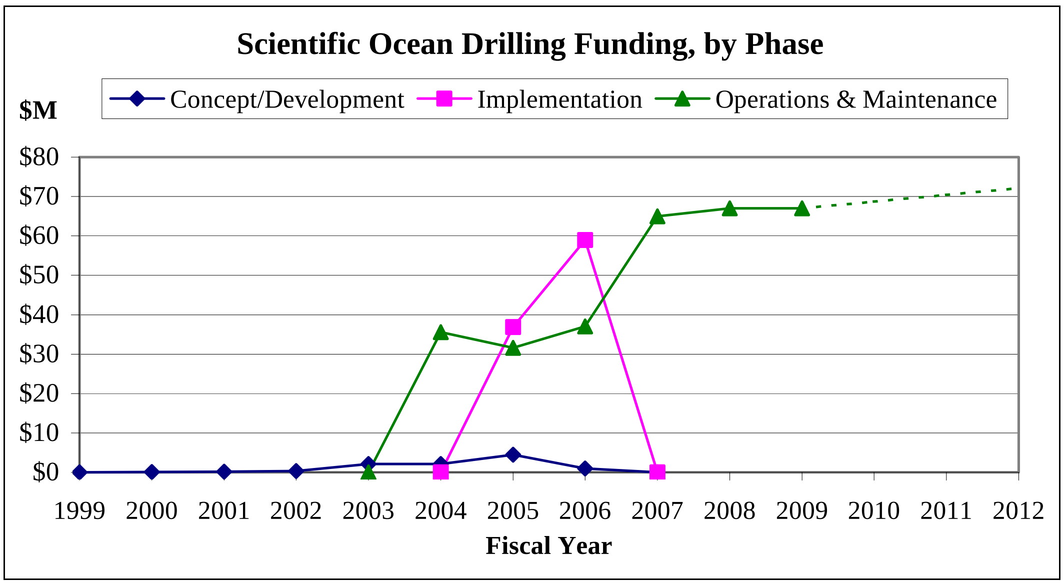
[1]R&RA operations and maintenance funds in FY 2004 will support ODP drilling operations on the *JOIDES Resolution.* Operations and maintenance support for FY 2005 and beyond represents funding for the Integrated Ocean Drilling Program (IODP), of which the SODV is the largest part. For further information on the IODP, please refer to the Tools chapter.

Information pertaining to the data in the table is provided below.

- Concept/Development: Activities supported by the R&RA Account began immediately upon contract award in September 2003. This includes: efforts necessary to begin IODP planning in FY 2003 with Japanese partners and the scientific user community; planning and initiating IODP drilling operations from the *JOIDES Resolution,* development of the SODV Project Execution Plan by the contractor; development of the Environmental Impact Statement for the non-riser drilling vessel; initiation of planning for shore based support of the program, including core storage, data management systems, and logistics.

- Implementation: The MREFC funds in FY 2005-06 are requested for the vessel conversion, including construction of laboratory and other scientific spaces, equipping of laboratories with instrumentation, computers and support equipment, and modifications to the drilling equipment of the contracted vessel. Funding is also requested for vessel lease during modification and for sea-trial operations of approximately four months duration in FY 2006.

- Operations and Maintenance: Following conversion, the drillship will be managed, operated and maintained by JOI (and subcontractors) with funding from the R&RA account, for use in the Integrated Ocean Drilling Program. Operations cost estimates are based on NSF experience in management of the IODP precursor, the Ocean Drilling Program. Specific missions will be reviewed and prioritized by a science advisory committee composed of representatives from IODP member nations. Significant coordination and integration of planning, procedures and operations will be required with Japanese operators of their drillship in the IODP.



Future Science Support: Along with direct operations and maintenance support for IODP, NSF will support research performed at the facility, through ongoing research and education programs. The annual support for such activities is estimated to be about $31.0 million.

Rare Symmetry Violating Processes (RSVP)

Project Description: A collaboration representing almost 30 institutions from the U.S., Canada, Switzerland, Italy, Japan and Russia submitted a proposal through New York University for RSVP in FY 2000. This project will address new physics at the cutting-edge of the sensitivity frontier and represents an extraordinary opportunity to empower a large and growing community led by university-based groups to make major discoveries. Two major experiments are to be pursued through this proposal: MECO (Muon to Electron Conversion) and KOPIO ($K^o_L \rightarrow \pi^o \nu$ ν-bar).

At the sensitivity frontier, reactions occur very rarely and when they occur, they are accompanied by "noise" much larger than the sought after signal. Both of these challenges must be addressed by the experiments, and if successful, they will push this frontier by many orders of magnitude. The scale of these experiments, both in cost and technical complexity, is set by the extraordinary sensitivity required to do this science.

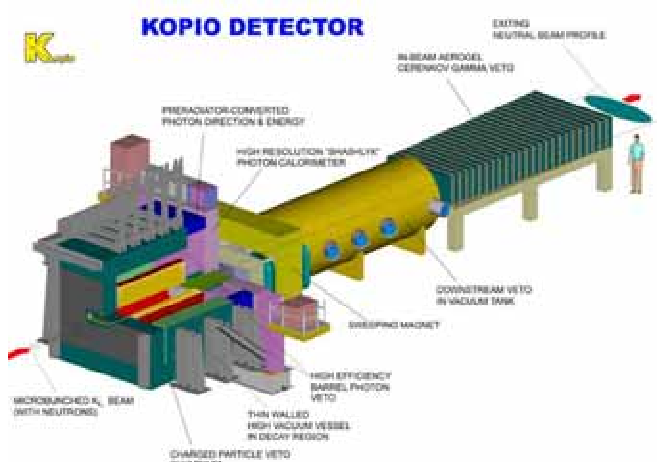
These experiments address two great mysteries, so that if the challenges are met, the rewards are great. Each of the reactions above has special properties that allow these experiments to uncover fundamental new physics relating to the unexplained absence of anti-matter in the universe, and to the postulated existence of "supersymmetric particles" that existed in the early universe and may be responsible for "dark matter." Most of the universe is known to be made of this mysterious dark matter. And anti-matter, thought to be approximately 50 percent of the universe at its birth, has mysteriously disappeared.

These experiments will be performed at the DOE's Brookhaven National Laboratory (BNL) Alternating Gradient Synchrotron (AGS), which has the highest beam intensity in the world at the energies required for these experiments. The AGS is currently being used as an injector for the Relativistic Heavy Ion Collider (RHIC), for which it is needed only a few hours per day. MECO and KOPIO will extend the sensitivity of probes of rare symmetry violating processes by many orders of magnitude.

<u>Principal Scientific Goals</u>: RSVP consists of two complementary experiments:

- <u>MECO</u> is a search for the conversion of muons to electrons and would be able to detect this process even if it is as rare as 1 event for 10^{17} detected muons. Electrons and muons are a part of a family of elementary particles called leptons, and the family relationship is not understood at a fundamental level. Supersymmetry is thought to underlie this relationship.
- <u>KOPIO</u> is a search for the decay of a neutral kaon (K^o_L) to a neutral pion, a neutrino and an anti-neutrino. The goal is to understand better a process called CP violation. This process needs to be understood in this universe, which contains matter rather than a mixture of matter and anti-matter.

<u>Principal Education Goals</u>: RSVP is planning the PRINCIPLES Project, a mathematics, science and technology educational enrichment program for fourth grade teachers and students. BNL, SUNY/Stony Brook and other partners will establish an Elementary Teachers Academy at BNL. The keystone of the Academy will be an in-service seminar course at BNL for elementary school teachers that will address the teaching of Mathematics, Science and Technology through investigations or projects by elementary students - focusing on the fourth grade level. Objectives are to show teachers first-hand (1) how and what general principles underlie specific inquiry-based learning activities, and (2) how recourse to such principles can support use of observation and reasoning by their students as they learn. The ultimate goal is to improve student performance in assessments requiring use of these skills. In addition, the strong university makeup of the RSVP collaborations lends itself well to student and postdoctoral educational opportunities. Each of the institutions will train undergraduate and graduate students and postdoctoral associates. They will receive a broad education in detector construction and operation and in data analysis and the interpretation of results.



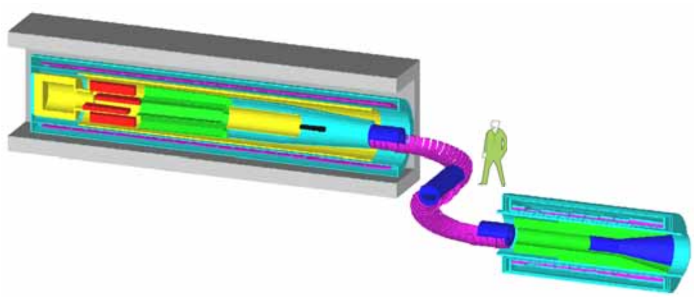
RSVP will address new physics at the cutting edge of the sensitivity frontier, and represents an extraordinary opportunity to empower a large and growing community to make major discoveries. Two major experiments are to be pursued through this proposal: MECO and KOPIO. A diagram of KOPIO is pictured above. *Credit: R. Ruggiero and E. Garber, Brookhaven National Laboratory.*

This opportunity is increasingly rare in particle physics, as most experiments are carried out by much larger collaborations.

Partnerships and Connections to Industry: RSVP will have strong connections to industry through instrument development and construction and through the MECO magnet construction.

Management and Oversight: RSVP will, through an NSF/DOE memorandum of understanding currently under development, be a university-led, NSF-supported activity, running concurrently with RHIC. NSF funding includes only incremental AGS operating costs. AGS "landlord responsibilities" rest with the DOE Nuclear Physics program. This sensitivity frontier program is an excellent example of the effective use of governmental facilities.

Management and oversight of RSVP will be provided through the Physics (PHY) Subactivity in the Mathematical and Physical Sciences (MPS) Activity. A designated Program Officer in PHY will maintain primary oversight responsibility, with assistance from an internal Project Advisory Team (PAT) with representation from MPS, the Office of Budget, Finance and Award Management, the Office of General Counsel, the Office of International Science and Engineering and the Office of Legislative and Public Affairs. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. Additional staff may be required during construction, particularly staff trained in large project management principles.



A diagram of the Muon to Electron Conversion (MECO) Experiment, one of two experiments proposed as part of the Rare Symmetry Violating Processes project. MECO is a search for the conversion of muons to electrons. *Credit:*

A comprehensive Project Execution Plan (PEP) has been drafted and has been reviewed favorably, with minor improvements suggested. The collaboration has benefited from BNL's tested methodology for the development, management and oversight of large projects, with major university participation, at national laboratories. The successful experience of the U.S. Large Hadron Collider (LHC) detector project, now nearing completion, provides confidence in this methodology. The draft version of the PEP includes project-tracking elements such as detailed costs and schedules (Work Breakdown Structure format), milestones, oversight and reporting responsibilities and change controls. The plan includes experienced university-based project managers, a host laboratory role for BNL that involves Environment, Health and Safety responsibilities for the entire project, and review procedures by the experimenters, by BNL, and by the NSF. A direct reporting path from the Project Manager to the NSF Program Officer is part of this plan. NSF management and oversight includes periodic baseline, cost, schedule, and technical reviews for the project and subproject throughout its lifecycle.

Current Project Status: R&D is continuing on critical project components and is expected to continue through FY 2004. RSVP's construction schedule is still under review and discussion. From 2000 through 2003, NSF conducted cost, management, and scientific and technical reviews of RSVP. Each panel consisted of external reviewers, and each rated the project highly. The management reviews indicated areas of potential improvement, which have since been implemented by the collaborators. The last review of RSVP occurred on 20-21 January 2003. At this review, each experiment presented to the NSF review panel a detailed plan for achieving construction readiness. The panel strongly endorsed the plans and recommended that the NSF fund the R&D proposals of both KOPIO and MECO. The review panel concluded that the roadmaps to construction readiness were well thought out and provided a basis for applying resources to bring the RSVP experiments to construction readiness in a timely way. The review panel recommended starting construction of RSVP as soon as possible after baseline reviews are conducted. The baseline reviews that establish the Work Breakdown Structures are expected to take place in Spring 2004.

The milestones listed below are preliminary and will likely be revised as the project's schedule is finalized.

FY 2004 Milestones:
- Complete MECO magnet acquisition plan.
- Begin KOPIO beam studies at AGS.
- Begin MECO detector studies

FY 2005 Milestones (Requested Construction Start):
- Complete KOPIO and MECO AGS and beam design modifications.
- Begin KOPIO detector construction.
- Begin MECO detector design and construction.
- Complete MECO magnet engineering design and start construction

FY 2006 Milestones:
- Begin KOPIO delivery of modules
- Begin MECO trigger and data acquisition design
- Begin MECO magnet coil production.

FY 2007 Milestones:
- Complete construction of AGS beams for KOPIO and MECO
- Begin KOPIO and MECO detector installation
- Complete design of the KOPIO and MECO data acquisition and trigger systems

FY 2008 Milestones:
- Complete data acquisition system and trigger construction and installation.
- Complete delivery and installation of MECO magnet coils.
- MECO Magnet acceptance tests
- KOPIO Trigger and data acquisition tests

FY 2009 Milestones:
- Complete construction and installation
- Perform engineering runs

FY 2010 Milestones:
- First data runs

Funding Profile: Through FY 2003, $4.0 million has been spent for concept and development of RSVP through the R&RA Account. The total construction cost of the project is estimated at $144.91 million over five years. The current funding plan is presented below.

Requested MREFC Funding for RSVP
(Dollars in Millions)

FY 2005 Request	FY 2006	FY 2007	FY 2008	FY 2009	Total
$30.00	$42.66	$44.00	$20.25	$8.00	$144.91

RSVP Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation[1]		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2001	0.90						$0.90		**$0.90**
FY 2002	1.20						$1.20		**$1.20**
FY 2003	1.90						$1.90		**$1.90**
FY 2004 Estimate	6.00						$6.00		**$6.00**
FY 2005 Request				30.00				$30.00	**$30.00**
FY 2006 Estimate				42.66				$42.66	**$42.66**
FY 2007 Estimate				44.00				$44.00	**$44.00**
FY 2008 Estimate				20.25	5.30		$5.30	$20.25	**$25.55**
FY 2009 Estimate				8.00	8.50		$8.50	$8.00	**$16.50**
FY 2010 Estimate					8.50		$8.50		**$8.50**
FY 2011 Estimate					13.50		$13.50		**$13.50**
FY 2012 Estimate					15.00		$15.00		**$15.00**
Subtotal, R&RA	$10.00				$50.80		$60.80		
Subtotal, MREFC				$144.91				$144.91	
Total, each phase		**$10.00**		**$144.91**		**$50.80**			**$205.71**

NOTE:. The estimated operational lifetime of the experiments will be least 10 years after the end of construction. A steady state of about $15.0 million in operations support is expected to occur on or about FY 2012. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

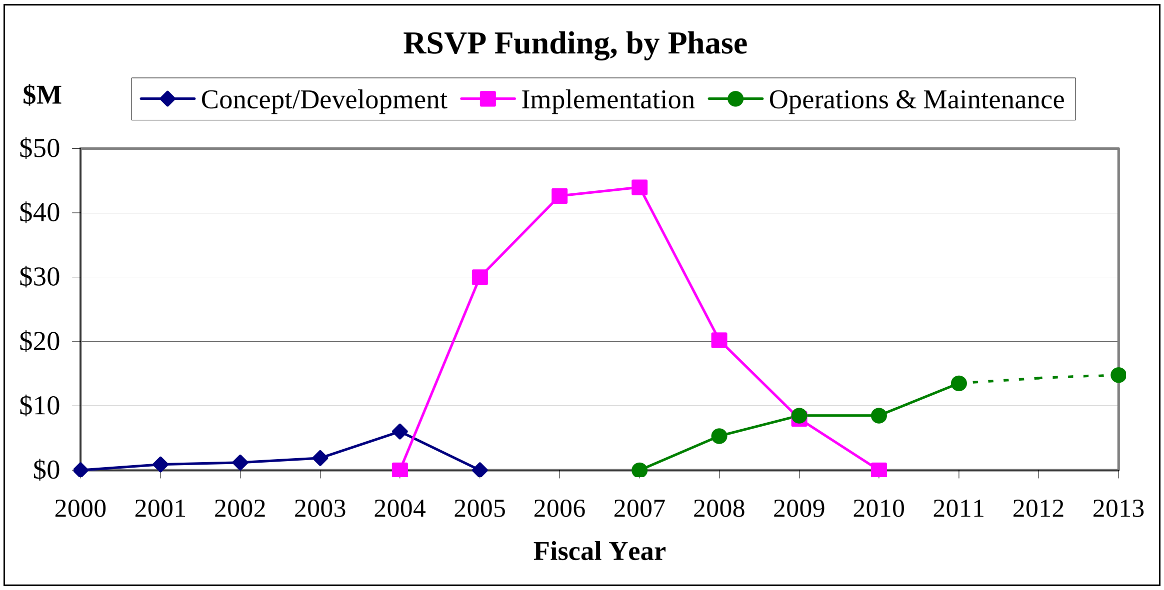
[1]The total project cost for RSVP has had several reviews. However, the total shown is still an estimate, and the funding stream has not yet been baselined. A baseline review is scheduled for June 2004.

Information on the data in the table is provided below.

- Concept/Development: The technical needs of RSVP require a strong R&D program that is now in progress. R&D teams have been formed, and prototype detector elements have been built and tested. In addition to R&D on all KOPIO and MECO components, a major component of MECO is a sequence of high-field, superconducting solenoids appropriately instrumented for particle detection and readout. These solenoids have very tight and challenging field requirements, and the MECO collaboration, with a group at the MIT Plasma Science and Fusion Center, has completed a detailed conceptual design of the magnet system that proves its feasibility and lays the groundwork for industrial production. KOPIO requires a low-energy, time-structured K^o beam, which allows a precise determination of the incident kaon momentum on an event-by-event basis using time-of-flight techniques. R&D is underway on the KOPIO Alternating Gradient Synchrotron (AGS) modifications. All R&D is under periodic review by technical panels.

- Implementation: Funding during this phase of the project will provide support for the construction of two beamlines at the AGS and associated beam instrumentation at the site. This work will be performed by BNL personnel. For the KOPIO detector, universities will construct the critical beam, catcher, radiator and veto counter assemblies. The MECO superconducting magnets will be constructed by industry after a conceptual design is complete, but MECO collimators, targets, beam stops, and calorimeters will be constructed at universities.

- Operations and Maintenance: Support for operations and management will phase in as the project is under construction. Initial funds provided through R&RA will support project managers for MECO and KOPIO and a project management office. Test beam operations can begin in FY 2008 and will ramp up as detector elements are completed. Full operations costs are expected to be approximately $15.0 million beginning in about FY 2012.



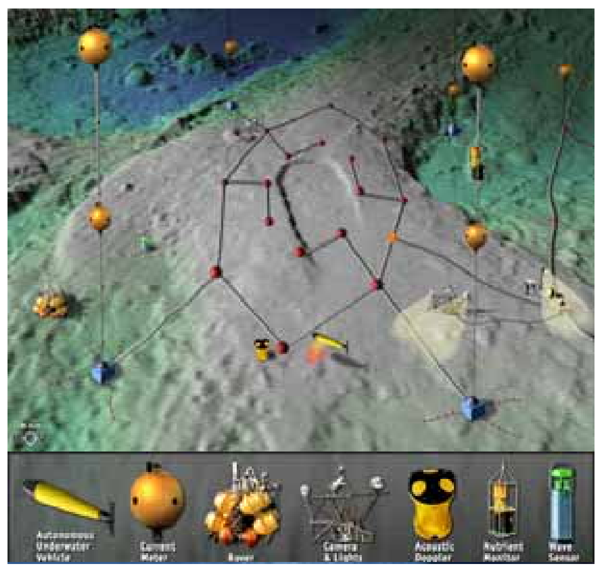
Future Science Support: Along with direct support for operations and maintenance, NSF will also support physics research performed at this facility, through ongoing physics research and education grants. Support for such activities is presently estimated to be about $4.0 million per year from NSF, once the facility reaches full operations.

Ocean Observatories Initiative (OOI)

Project Description: This project will construct an integrated observatory network that will provide the oceanographic research and education communities with continuous access to the ocean. The OOI will have three elements: 1) a regional cabled network consisting of interconnected sites on the seafloor spanning several geological and oceanographic features and processes, 2) relocatable deep-sea buoys, and 3) an expanded network of coastal observatories, developed through new construction or enhancements to existing facilities. The primary infrastructure for all components of the OOI consists of an array of seafloor junction boxes connected to cables running along the seafloor to individual instruments or instrument clusters. Depending upon proximity to the coast and other engineering requirements, the junction box is either terminated by a long dedicated fiber-optic cable to shore, or by a shorter cable to a surface buoy that is capable of two-way communications with a shore station. The observatory infrastructure of the OOI will be operated as a shared-use facility with open community access to data.

<u>Principal Scientific Goals</u>: Scientific problems requiring OOI infrastructure are broad in scope and encompass nearly every area of ocean science. Once established, seafloor observatories will provide earth and ocean scientists with unique opportunities to study multiple, interrelated processes over timescales ranging from seconds to decades; to conduct comparative studies of regional processes and spatial characteristics; and to map whole-earth and basin scale structures. This project will establish facilities to meet the following goals: continuous observation at frequencies from seconds to decades; spatial scales of measurement from millimeters to kilometers; high power and bandwidth capabilities as well as two-way data transmission; an ability to operate during storms and in harsh conditions; an ability to accommodate plug and play sensors, instruments, and imaging systems; profiling systems for cycling instruments up and down the water column, either autonomously or on command; docking stations enabling autonomous underwater vehicles to download data and recharge batteries; ability to assimilate data into models and make three-dimensional forecasts of the oceanic environment; means for making data available in real time to researchers, schools, and the public over the Internet; and low cost relative to the cost of building and maintaining ships and manned submersible systems.

<u>Principal Education Goals</u>: Scientific discoveries arising from the OOI will provide new opportunities for ocean education and outreach through the capabilities for real-time data transmission and, particularly, real-time display of visual images from the seafloor. Educational links will be made with GEO's Digital Library for Earth Science Education (DLESE), and OCE's Centers for Ocean Science Education Excellence (COSEE). In addition, with the planned establishment of the National Integrated Ocean Observing System, there will be an unprecedented need for oceanographers skilled in the use and manipulation of large, oceanographic, time-series datasets. The facilities comprising the OOI will provide the ideal platforms to train this new generation of oceanographers.



Example of a seafloor cabled observatory experimental site, part of the Ocean Observatories MREFC project. Moorings from seafloor nodes extend observational capabilities from the seafloor and below to within the water column. Associated instrumentation including underwater vehicles are also shown. *Credit: Division of Ocean Sciences, NSF.*

<u>Partnerships and Connections to Industry</u>: Some of the component technologies that are part of the OOI are currently in use or in development as part of the telecommunication and exploration industries. These groups have been involved in conceptual design reviews of proposed OOI components and systems and will be important participants in the construction and implementation phase of the OOI.

<u>Management and Oversight</u>: The project will be managed and overseen by a program manager in the Ocean Sciences Subactivity (OCE) in the Geosciences Activity (GEO). The program manager will receive advice and oversight support from an NSF Project Advisory Team that includes representatives from GEO, the Office of Budget, Finance and Award Management, the Office of International Science and Engineering, the Office of General Counsel, and the Office of Legislative and Public Affairs. The NSF Deputy Director for Large Facility Projects is a member of the PAT and will provide advice and assistance. The management structure proposed for the acquisition and implementation phase of the OOI is based on a structure that has been successfully used by the Ocean Drilling Program. In this structure, management, coordination, and oversight of the OOI will be the responsibility of the Executive Director of the Ocean Observatory Project Office to be established through a cooperative agreement with NSF. The Director will be accountable to an Executive Committee under which will be established Scientific

and Technical Advisory Committees. The Executive and Advisory Committees will draw their membership from individuals with expertise in ocean observing science and engineering. Experiments utilizing OOI infrastructure will be selected on a peer-reviewed basis. This project will be coordinated with the National Integrated Ocean Observing System (IOOS) that will support operational mission objectives of agencies such as the National Oceanic and Atmospheric Administration (NOAA), Navy, the National Aeronautics and Space Administration (NASA), and the Coast Guard.

Current Project Status: Current activities are concentrating on the development of implementation plans for the three components of the OOI to facilitate the high priority science developed through community input. For coastal observatories a workshop organized through the Coastal Ocean Processes Program (May 2002) to provide advice on the use of observing infrastructure for advancing coastal science. The report was published in December 2002. This activity was followed in November 2003 by a more focused workshop to address implementation issues related to coastal observing systems of the OOI. For the regional cabled observatory component of the OOI, a workshop was held in August 2002 to document the high priority science requiring the use of submarine cable technology. The report from this workshop was published in April 2003. This activity was followed by a workshop in October 2003 whose goal was to focus on the location and design of a regional cabled observatory. In February 2003 a community activity was held to address deployment issues related to a global network of moored buoy systems to facilitate multi-disciplinary science. The report of this group is to be completed in January 2004. A large, multi-disciplinary workshop was held in January 2004 to develop an initial science plan for the OOI across coastal, regional, and global scales. The report from this workshop is expected in Spring 2004. In addition to these activities, OCE sponsored a National Research Council study to provide recommendations for an overall implementation plan for the OOI. This report was released in July 2003. In early 2004 a cooperative agreement will be established for the Ocean Observatory Project office.

The construction schedule for this project is still under review and discussion. The milestones listed below are preliminary and will likely be revised as the project's schedule is finalized.

FY 2002 Milestone (Completed):
- Establish NSF Program Management Team

FY 2003 Milestones (Completed):
- Project Management
  - Complete Program Solicitation for the Ocean Observatory Project Office
  - Issue Program Solicitation
  - Proposals submitted
  - Proposal evaluation and selection

FY 2004 Milestones:
- Project Management
  - Recommend award for Project Office (Completed)
  - Completion of OOI Internal Management Plan (1^{st} – 2^{nd} quarter)
  - Completion of OOI Initial Science Plan (2^{nd} quarter)

FY 2005 Milestones:
- Project Management
  - Completion of OOI Science Plan
  - Systems engineering review of OOI
  - Complete design of data management and archiving system
  - Completion of OOI Project Execution Plan

FY 2006 Milestones:
- Project Management
  - Submission of Project Execution Plan for review to the Deputy Director, Large Facilities Projects
  - Implementation of data management and archiving system
- Coastal Observatories
  - Issue Program Solicitation for establishment of coastal observing infrastructure
- Deep-Sea Buoys
  - Design and testing of moored buoyed systems
  - Issue Program Solicitation for establishment of moored buoy infrastructure
- Regional Cabled Network
  - Cable-route surveys and planning
  - Design, inspection and testing of cables, connectors, nodes, and shore equipment
  - Purchase of fiber optic cable

FY 2007 Milestones:
- Coastal Observatories
  - Issue Program Solicitation for establishment of coastal observing infrastructure
  - Construction and deployment of coastal observing infrastructure
- Deep-Sea Buoys
  - Design and testing of capabilities needed for buoy installation
  - Installation of deep-sea buoys
  - Issue Program Solicitation for establishment of moored buoy infrastructure
- Regional Cabled Network
  - Physical (hardware and software) system integration and testing prior to deployment
  - Preparation of shore facilities and installation of equipment.

FY 2008 Milestones:
- Coastal Observatories
  - Issue Program Solicitation for establishment of coastal observing infrastructure
  - Construction and deployment of coastal observing infrastructure
- Deep-Sea Buoys
  - Design and testing of capabilities needed for buoy installation
  - Installation of deep-sea buoys
  - Issue Program Solicitation for establishment of moored buoy infrastructure
- Regional Cabled Network
  - Installation and subsequent inspection of first cable backbone section
  - Installation of science nodes on first backbone section

FY 2009 Milestones:
- Coastal Observatories
  - Issue Program Solicitation for establishment of coastal observing infrastructure
  - Construction and deployment of coastal observing infrastructure
- Deep-Sea Buoys
  - Design and testing of capabilities needed for buoy installation
  - Installation of deep-sea buoys
  - Issue Program Solicitation for establishment of moored buoy infrastructure
- Regional Cabled Network
  - Testing and commissioning of first backbone section
  - Installation and subsequent inspection of second cable backbone section
  - Installation of science nodes on second backbone section
  - Installation of initial science experiments on first backbone section

FY 2010 Milestones:
- Coastal Observatories
  - Construction and deployment of coastal observing infrastructure
- Deep-Sea Buoys
  - Installation of deep-sea buoys
- Regional Cabled Network
  - System testing and commissioning
  - Installation of initial science experiments on second backbone section

Funding Profile: NSF expects to spend approximately $25.20 million in concept and development activities through FY 2005. The total construction cost for OOI is $245.70 million beginning in FY 2006. Management, operations and maintenance will be funded through the R&RA Account.

Requested MREFC Funds for OOI
(Dollars in Millions)

FY 2006 Request	FY 2007	FY 2008	FY 2009	FY 2010	Total
$24.76	$63.44	$65.00	$47.30	$45.20	$245.70

Ocean Observatories Initiative Funding Profile
(Dollars in Millions)

	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 2001	1.60						$1.60		**$1.60**
FY 2002	11.00						$11.00		**$11.00**
FY 2003	4.60						$4.60		**$4.60**
FY 2004 Estimate	5.00						$5.00		**$5.00**
FY 2005 Request	3.00						$3.00		**$3.00**
FY 2006 Estimate				24.76	10.00		$10.00	$24.76	**$34.76**
FY 2007 Estimate				63.44	15.00		$15.00	$63.44	**$78.44**
FY 2008 Estimate				65.00	20.00		$20.00	$65.00	**$85.00**
FY 2009 Estimate				47.30	30.00		$30.00	$47.30	**$77.30**
FY 2010 Estimate				45.20	50.00		$50.00	$45.20	**$95.20**
FY 2011 Estimate					51.25		$51.25		
FY 2012 Estimate					52.53		$52.53		**$52.53**
Subtotal, R&RA	$25.20				$228.78		$253.98		**$253.98**
Subtotal, MREFC				$245.70				$245.70	**$245.70**
Total, Each Phase		**$25.20**		**$245.70**		**$228.78**			**$499.68**

NOTE: The expected operational lifespan of this project is 30 years, beginning in FY 2011. A steady state of about $50 million in operations support is expected to occur in or about FY 2010. Operations estimates for FY 2010 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

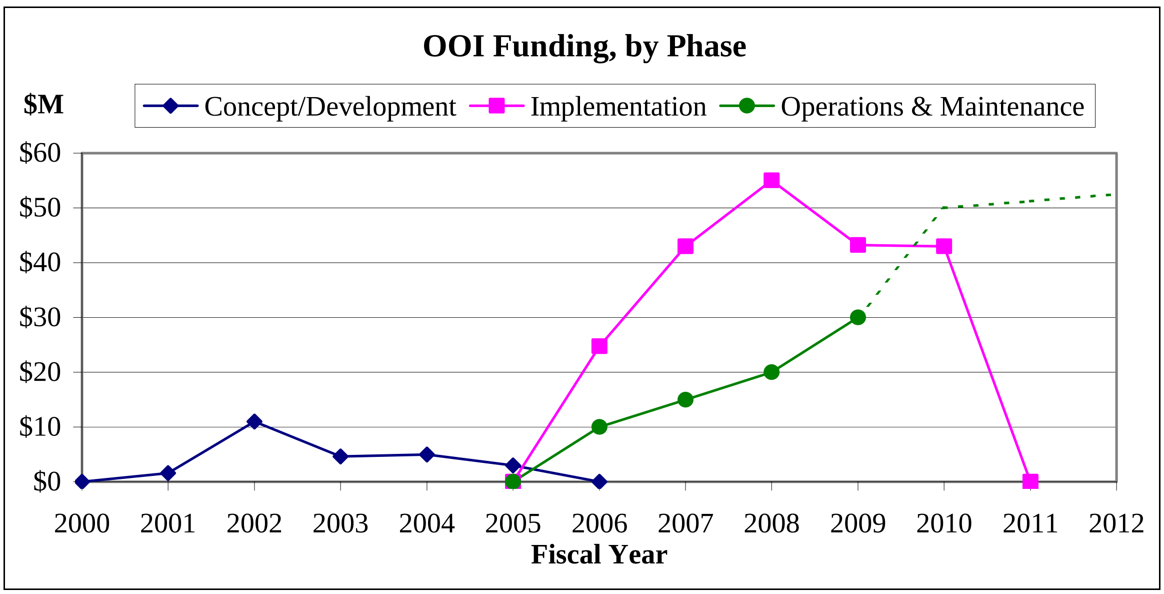
Information pertaining to the data in the table is provided below.

- Concept/Development: R&RA funding has supported workshops to identify the observatory infrastructure needed to address the high priority science requiring time-series measurements.

Specific design characteristics and platform requirements were developed through conceptual design reviews and best practices consultations with industry and academic experts. In FY 2002 an unsolicited proposal from the Monterey Bay Aquarium Research Institute resulted in a $6.9 million award to establish an advanced cabled observatory in Monterey Bay to both advance scientific goals as well as create a valuable systems and instrumentation testbed for potential future cabled ocean observing systems. R&RA funds will also be used to support the ocean observatories project office.

- Implementation: Funds requested for this phase will construct: a regional cabled network consisting of interconnected sites on the seafloor spanning several geological and oceanographic features and processes; several relocatable deep-sea buoys; and new construction or enhancements to existing facilities leading to an expanded network of coastal observatories.

- Operations and Maintenance: Access to OOI Infrastructure will be determined by peer review and all data will be openly accessible. OOI Infrastructure will be maintained and operated by the OOI Program Office. Future development of more complex sensor packages for the OOI infrastructure will be funded using R&RA funds within OCE. Observing platforms of the OOI will accommodate instrumentation from other agencies, international partners, as well as new instruments that are developed.



Future Science Support: Along with direct operations and maintenance support for the OOI, NSF will support research performed using this infrastructure through ongoing research and education programs. The annual support for such activities is estimated to be about $50.0 million, once the network is fully implemented.

Alaska Region Research Vessel

Project Description: The Alaska Region Research Vessel (ARRV) is proposed to replace the R/V *Alpha Helix*, which, at 38 years is the oldest ship in the national academic research fleet. At present, science activities in this region are limited by the capabilities of the R/V *Alpha Helix* and the oversubscribed schedules of other aging vessels that operate in the region. The ARRV would operate in the challenging

An artist's rendition of the Alaska Region Research Vessel (ARRV), planned to replace the aging R/V *Alpha Helix*. The ice-strengthened ARRV would operate in the challenging seasonal ice covered Alaskan waters, expanding current capabilities in the region. *Credit: Glosten Associates, Inc*

waters of the Chukchi, Beaufort, and Bering Seas, as well as the open Gulf of Alaska, coastal Southeast Alaska and Prince William Sound.

As we strive to understand a variety of complex regional and global ecosystem and climate issues, the need to conduct research at the ice edge and in seasonal ice has become increasingly urgent. The ARRV will provide improved access to the region, enabling further exploration to address these critical issues. With an operating year of 275-300 days per year, the ARRV could support upwards of 500 scientists and students at sea annually.

Principal Scientific Goals: Many cutting edge science projects require an oceanographic platform in the Alaska region to conduct field research ranging from ocean circulation, climate and ecosystem studies to natural hazards and cultural anthropology. Recent climate studies indicate perennial ice in the arctic thinning at 9 percent per decade.

Principal Education Goals: The ARRV will provide a sophisticated and larger platform for scientists, graduate and undergraduate students to participate in complex multidisciplinary research activities and will train the next generation scientists with the latest equipment and technology. Broadband connections capable of relaying data, including high definition video from tools such as remotely operated vehicles, which explore the ocean depths, will bring research into the K-12 classroom and to the general public.

Connections to Industry: Research results facilitated by the ARRV will enhance Arctic climate variability predictions, including the opening up of Arctic global shipping trade routes as the ice continues to recede in the Arctic Ocean. Geophysical studies will optimize U.S. Arctic oil and gas exploration, and fisheries oceanography research will promote optimal management of the richest U.S. fishery resource, which is in the Bering Sea region.

Management and Oversight: The NSF Coordinator will be the Program Manager for Ship Acquisition and Upgrade Program, Integrative Programs Section/Division of Ocean Sciences/GEO, with other staff in the Integrative Programs Section providing program management assistance. Internal oversight will also be provided by a Project Advisory Team (PAT) including staff from GEO, the Office of Budget, Finance and Award Management (BFA) and the Office of the General Counsel (OGC). The awardee will hire a Systems Integration Manager to establish and staff an Office to provide management oversight to the vessel construction phase and to report to the NSF Coordinator. In addition, the University-National Laboratory System (UNOLS) Fleet Improvement Committee, an external committee composed of representatives from the community that meets several times a year, will review progress and provide advice regarding vessel construction.

Seakeeping Model Tests of the ARRV. Testing confirmed both excellent sea keeping in the open ocean and the ability to operate effectively in seasonal ice. *Credit: Glosten Associates, Inc.*

Current Project Status: Final model and tank testing and data analysis were successfully completed in 2003. Results from model testing concluded that the current design has excellent seakeeping and enhanced icebreaking capabilities. In addition, acoustic testing demonstrated that the vessel will have sufficient "quieting" characteristics to support unique fisheries research. Results from the design studies have been shared with the community on several occasions, offering opportunities for interactive exchanges to take place between potential vessel users and the naval architects. Currently, the design phase is nearing completion. Documents prepared during this final design phase will be used for developing the shipyard construction contract. The Federal Oceanographic Facilities Committee (FOFC) continues to endorse the ARRV as the next vessel needed to help renew the aging national academic research fleet, as they originally stated in their 2001 report (Charting the Future for the National Academic Research Fleet: A long-range plan for renewal) submitted to the National Ocean Research Leadership Council (Chaired by the NSF Director).

Milestones for ARRV are outlined below:

FY 2006 Milestones:

Prepare and issue a solicitation to build and operate the ARRV via a cooperative agreement (NSF).
Select the winning proposal through an external merit review process (NSF).
Establish the Systems Integration Office and issue the shipyard construction bid package (awardee).
Adjudicate the construction bids and select the winner (awardee in cooperation with NSF).
Initiate vessel construction (shipyard).
Establish quarterly in depth reviews of construction progress (awardee and NSF).

FY 2007 Milestones:

Continue construction of vessel (shipyard).
Continue detailed reviews of progress.
Launch vessel, continue interior habitability and scientific outfitting.

FY2008 Milestones:

Complete construction and scientific outfitting (24 months from award of construction contract).
Undergo sea trials (ship yard, awardee, NSF).
Finalize acceptance and delivery of vessel to awardee.
Incorporate vessel into the UNOLS ship scheduling process.
Vessel begins operations on NSF and other agency funded scientific missions.
NSF conducts final review of project.

Funding Profile: Recognizing from the outset that the R/V *Alpha Helix* was of marginal size and capability for Alaskan waters, replacement planning has been ongoing since the 1980s. NSF funded design studies in 1980 and 1995, but neither were implemented. After community-derived science mission requirements were developed in 1999, NSF funded the concept design, detailed design and model testing for a replacement vessel and is prepared to initiate a two-year construction phase.

Requested Funds for the ARRV
(Dollars in Millions)

FY 2006 Request	FY 2007	Total
$49.32	$32.88	$82.20

ARRV Funding Profile
(Dollars in Millions)

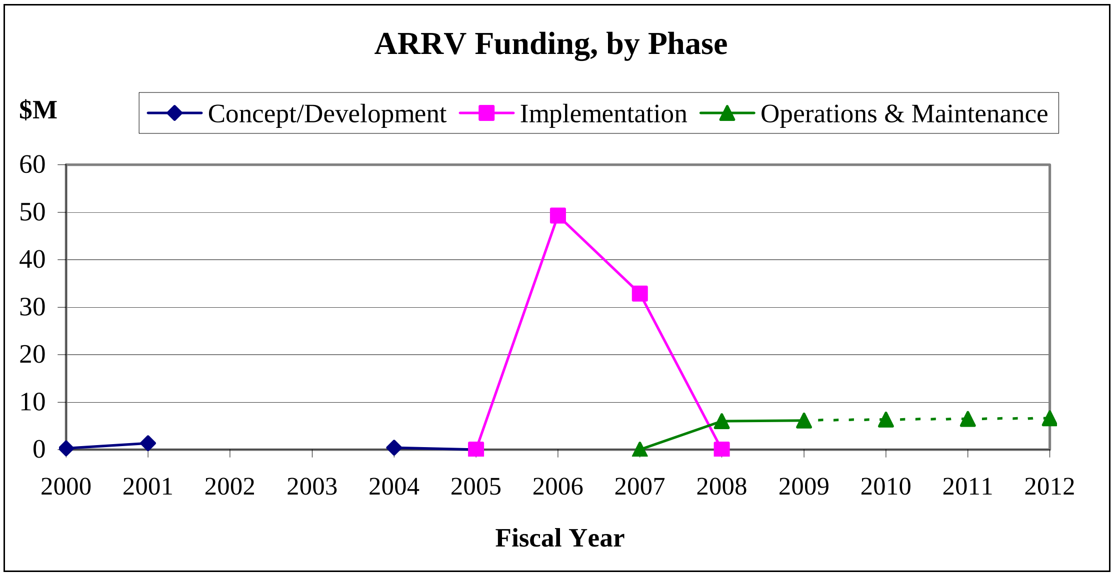
	Concept/ Development		Implementation		Operations & Maintenance		Totals		Grand
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	Total
FY 2000 & Earlier	0.25						0.25		**$0.25**
FY 2001	1.36						$1.36		**$1.36**
FY 2002									
FY 2003									
FY 2004 Estimate	0.40						$0.40		**$0.40**
FY 2005 Request									
FY 2006 Estimate				49.32				$49.32	**$49.32**
FY 2007 Estimate				32.88				$32.88	**$32.88**
FY 2008 Estimate					6.00		$6.00		**$6.00**
FY 2009 Estimate					6.15		$6.15		**$6.15**
FY 2010 Estimate					6.30		$6.30		**$6.30**
FY 2011 Estimate					6.46		$6.46		**$6.46**
Subtotal, R&RA	$2.01				$24.92		$26.93		**$26.93**
Subtotal, MREFC				$82.20				$82.20	**$82.20**
Total, Each Phase		**$2.01**		**$82.20**		**$24.92**			**$109.13**

NOTE: The expected operational service life of the ARRV is 30 years after construction is complete. Ship Operations are estimated to be approximately $6.0 million per year. Operations estimates for FY 2008 and beyond are developed strictly for planning purposes and are based on current cost profiles. They will be updated as new information becomes available.

- <u>Concept/Development:</u> In 1999, science mission requirements were developed by the user community to provide a basis for designing a vessel to replace the R/V Alpha Helix. In FY 2000, Division of Ocean Sciences funds were used to develop preliminary designs for an Alaska region research vessel. In FY 2001 Congress appropriated $1.0 million to further the vessel concept design and conduct model tank testing. Additional Division of Ocean Sciences funds were used in FY 2003 and 2004 to further the design process.

- <u>Implementation:</u> The project will be prepared to go into the construction phase in FY 2006. It is anticipated that the vessel will be constructed over a two-year period and will be ready for sea trials and commissioning and to conduct science activities two years after construction is initiated.

- <u>Operations and Maintenance:</u> Following commissioning, the ship will be managed by the Awardee institution which will maintain and operate the vessel for NSF through a Cooperative Agreement. The vessel will be scheduled through the University-National Oceanographic Laboratory System process, which will allow NSF-funded scientists access to the vessel to conduct research and train students. The annual ship operation costs are estimated to be about $6.0 million.



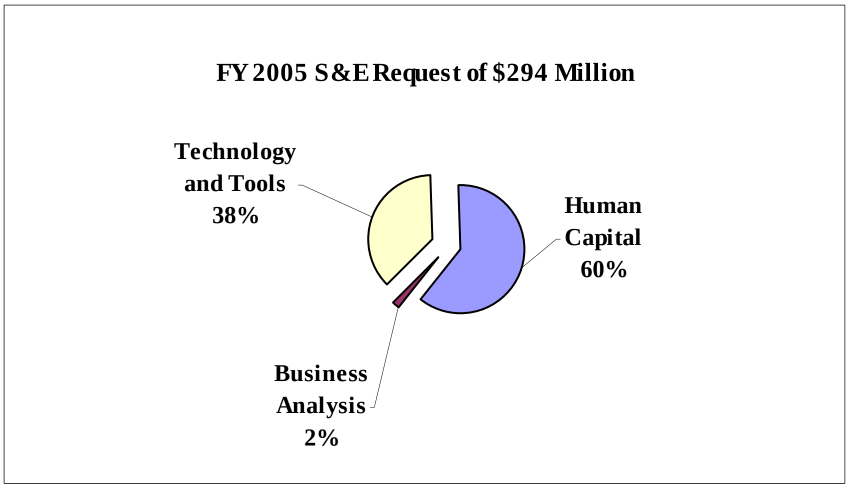
Future Science Support: Along with direct operations and maintenance support for the ARRV as part of the Academic Research Fleet, NSF will support research performed using this infrastructure through ongoing research and education programs. It is anticipated that the ARRV will greatly expand research capabilities in the region, going from about 160 ship operating days with the *Alpha Helix*, up to 275-300 days with the ARRV. It is anticipated that the vastly increased capability of the ARRV, both with regard to its ability to accommodate much larger interdisciplinary research teams and greatly enlarged geographical and seasonal ranges, will dramatically increase the number of proposals addressed to NSF for its utilization.

SALARIES AND EXPENSES

SALARIES AND EXPENSES $294,000,000

The FY 2005 Request for Salaries and Expenses (S&E) is $294.0 million, an increase of $75.3 million, or 34.4 percent, over the FY 2004 Estimate of $218.70 million. Adequate funding for Salaries and Expenses, particularly for Information Technology, is critical to the efficient operations of the agency.

The pace of discovery is accelerating, creating exceptional opportunities for investment, but also increasing the NSF workload. The number of proposals NSF processes reached 40,000 in FY 2003, up from 30,000 just two years ago. In addition, the rapidly changing character of research has placed new demands on NSF staff and systems. Proposals today address more complex scientific questions, involve a wider variety of collaborations, and increasingly cross-disciplinary boundaries. NSF also recognizes the need to enhance safety and security for all of its information technology and physical resources. The strategic framework for this investment is discussed in greater detail in the chapter on NSF's Organizational Excellence (OE) portfolio.



This significant increase will support a focused set of overdue investments that foster NSF's continuing commitment to outstanding customer service:

- Human Capital: Funding for Human Capital increases by $20.94 million to a total of $175.91 million, a 13.5% increase over FY 2004. The major components of this increased investment are: $12.15 million for Management of Human Capital; $7.26 million for Personnel Compensation and Benefits, including an increase of 25 full-time equivalent (FTE) employees as well as comparability and locality pay and costs related to employee benefits; and a $1.53 million increase in general operating expenses and travel associated with NSF's programmatic responsibilities.

- Business Analysis: Funding for the Business Analysis increases by $2.56 million to a total funding level of $5.35 million in FY 2005. This represents the third full year of the business analysis, which rests at the center of NSF's strategic framework for ongoing investments in OE.

- Technology and Tools: Funding for Technology and Tools increases by $51.80 million to a total of $112.74 million. The majority of this increased investment – $47.11 million – will continue the development, implementation, operation, and upgrade of NSF's information infrastructure, enable next generation eGovernment capabilities, and improve information and physical security. In addition, $1.1 million of the increased funding for Technology and Tools will provide for increasing rental costs for NSF's workspace, and $3.59 million will support other infrastructure-related costs, discussed below.

Summary of Salaries and Expenses by Function
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Human Capital					
Personnel Compensation & Benefits	128.46	138.69	145.95	7.26	5.2%
Management of Human Capital	2.69	3.55	15.70	12.15	342.3%
Operating Expenses	3.80	6.68	7.00	0.32	4.8%
Travel	4.32	6.05	7.26	1.21	20.0%
Subtotal, Human Capital	139.27	154.97	175.91	20.94	13.5%
Business Analysis	3.65	2.79	5.35	2.56	91.8%
Technology and Tools					
Information Technology	24.36	37.18	84.29	47.11	126.7%
Space Rental	17.10	18.20	19.30	1.10	6.0%
Other Infrastructure	5.04	5.56	9.15	3.59	64.6%
Subtotal, Technology and Tools	$46.50	$60.94	$112.74	$51.80	85.0%
Total, Salaries and Expenses	$189.42	$218.70	$294.00	$75.30	34.4%

NSF Workforce
(Full-Time Equivalents (FTE))

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
NSF S&E -- Regular	1,146	1,200	1,225	25	2.1%
NSF S&E -- Student	32	24	24	-	0.0%
Office of the Inspector General[1]	55	60	60	-	0.0%
National Science Board[2]	9	12	12	-	0.0%
Arctic Research Commission[3]	4	4	4	-	0.0%
Subtotal, FTE	1,246	1,300	1,325	25	1.9%
IPA[4]	142	170	170	-	0.0%
Detailees to NSF	6	5	5	-	0.0%
Contractors Performing Admn. Functions	191	210	210	-	0.0%
Total, Workforce	1,585	1,685	1,710	25	1.5%

[1]The Office of Inspector General is described in a separate section of the justification and is funded through a separate appropriation.
[2]The National Science Board is described in a separate section of the justification and is funded through a separate appropriation.
[3]The Arctic Research Commission is described and funded in the Research and Related Activities section of the justification under Polar Programs.
[4]Intergovernmental Personnel Act (IPAs) are described in the Organizational Excellence section and are funded through the Research and Related Activities and Education Human Resources Appropriations accounts.

HUMAN CAPITAL $175,910,000

The FY 2005 request for Human Capital totals $175.91 million, an increase of $20.94 million or 13.5 percent, over the FY 2004 Estimate of $154.97 million. These investments represent nearly two-thirds of NSF's total OE portfolio, and they consist of four major components: Personnel Compensation and Benefits, Management of Human Capital, Operating Expenses and Travel.

Human Capital Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Personnel Compensation & Benefits	128.46	138.69	145.95	7.26	5.2%
Management of Human Capital	2.69	3.55	15.70	12.15	342.3%
Operating Expenses	3.80	6.68	7.00	0.32	4.8%
Travel	4.32	6.05	7.26	1.21	20.0%
Total, Human Capital	139.27	154.97	175.91	20.94	13.5%

Personnel Compensation and Benefits ($145.95 Million)

The FY 2005 Request increases by $7.26 million, or 5.2 percent, to a total of $145.95 million for Personnel Compensation and Benefits (PC&B) and will provide for 1,225 full-time equivalent (FTE) regular employees, as well as 24 students. PC&B funds the cost of the payroll including the statutory pay raise.

The agency proposes to add 25 FTEs during FY 2005 to respond to the demands of the growing number of proposals, an increased budget, and additional administrative responsibilities. The new positions will allow the agency to relieve growing workload pressures on current NSF program managers in response to increasingly complex science and engineering opportunities and additional attention to award management and oversight.

Management of Human Capital ($15.70 Million)

For FY 2005, the Management of Human Capital budget request is $15.70 million, an increase of $12.15 million, or 342.3 percent over FY 2004. This request recognizes that the agency must invest in its people, in the same way it has invested in its information technology, if it is to achieve excellence in the recruitment, retention, knowledge management, learning, and performance management systems needed to attract, develop and retain the highest quality staff. To maintain its excellence as an organization, NSF must invest in the key to that excellence – its people.

NSF's commitment to its people was recognized in 2003 by the Partnership for Public Service and the American University's Institute for the Study of Public Policy Implementation when they ranked NSF as the second best place in the Federal Government to work. While this commitment continues, NSF must comprehensively research, review and update its human capital practices and policies to assure it will continue to respond effectively to the ever-changing employment market with innovative, value-added programs that maintain its viability as an employer of choice. Many of NSF's human capital programs and policies no longer reflect best industry practices. NSF cannot afford to ignore the need to tailor its human resource initiatives to an ever-changing employment market or to effectively assess and plan for changes in the competencies it will need to meet future mission requirements.

At the end of calendar year 2003, NSF finalized its Human Capital Management Plan (HCMP), which is aligned with the strategic mission, goals and organizational objectives of NSF and provides NSF with a roadmap to improve its human capital programs and policies so it can meet the needs of its current and future staff. The plan also addresses the Foundation's goal of significantly improving its outreach to scientists, engineers, educators, information technology specialists and business professionals in an increasingly competitive hiring environment. One of NSF's strategic objectives for Organizational Excellence, and a core concept of its mission, is to improve the diversity of its science and engineering workforce in order to better address the needs of the nation's diverse populations. The HCMP, in conjunction with NSF's Diversity Plan (currently under development), will guide NSF's efforts in this area.

Strategic learning and career management are a central focus of NSF's long-range human capital plan. These activities are coordinated via the NSF Academy, whose goal is to enhance the skills of the Foundation's workforce, build critical competencies in support of the Foundation's mission and strategic goals and groom future leaders.

Within Management of Human Capital, two integrated and complementary initiatives comprise the budget request: Strategic Human Capital Implementation and The NSF Academy.

Strategic Human Capital Implementation ($10.45 Million)

Significant investments in Human Capital are essential if NSF is to continue attracting and retaining the highest caliber scientists, engineers and educators to fulfill its mission and if it is to ensure that the Foundation's technological and administrative personnel remain innovative and entrepreneurial. Funding in FY 2005 will provide needed capital to fully implement the goals and action strategies outlined in the NSF Human Capital Management Plan. Funding will support the following FY 2005 initiatives:

- ***Competency-Based Job Families ($1.89 Million)*** --As an initial step toward a more meaningful and integrated workforce system, NSF has clustered its 288 distinct position titles into 41 potential job families. A set of competencies has been created for each unique job family. These competencies will serve as the basis for recruiting, educating, developing, motivating and transitioning NSF employees and for NSF's workforce planning efforts. FY 2005 funds are requested to continue to develop the foundation of the competency system including: competency based behavioral indicators, a competency based position library, and a competency based position management methodology. Funding will also support the integration of competencies into NSF's electronic recruiting system, workforce planning and career path initiatives, recruiting and retention enhancements, performance management initiatives, and employee development initiatives.

- ***Workforce Planning and Career Paths ($1.78 Million)*** --In order to more effectively match employees' skills with future job profiles, funds are being requested to continue to refine NSF's job families based on current and future strategic requirements, and to design and implement career paths to help focus recruitment, retention, development, and evaluation efforts. Funds will also allow NSF to comprehensively track and resolve skill gaps stemming from the ever-changing scientific and technological landscape in which it must operate and to successfully deploy its workforce to meet new goals and objectives.

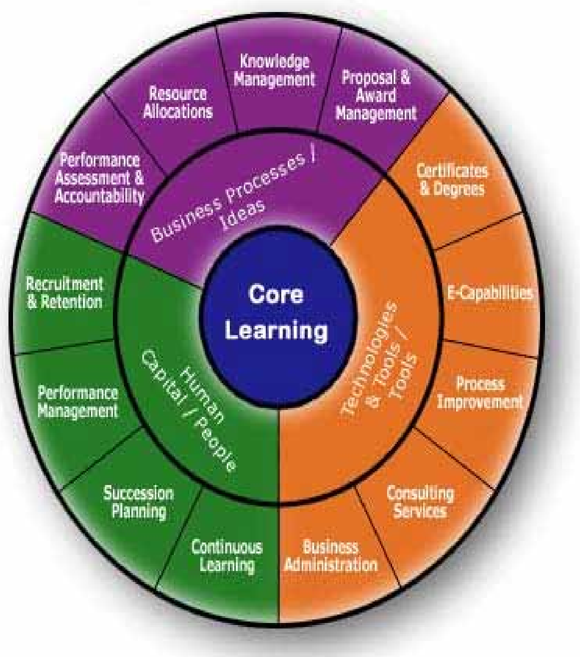
- ***Recruitment and Retention Enhancements ($1.0 Million)*** -- NSF faces the challenge of continually replenishing its staff with individuals who are at the forefront of the most promising fields of science, education and engineering, and who recognize opportunities for cross-disciplinary advances at the frontier of science. This means that NSF must frequently update its recruiting strategies and its branding and marketing campaigns to attract scarce talent in cutting-edge scientific fields and to provide the necessary incentives to assure they will choose NSF as an employer. Included within the FY 2005 request are funds to develop and implement an effective outreach and marketing campaign to ensure the Foundation has a continuing influx of individuals at the forefront of the science, engineering, information-technology, business, and education fields. Outreach and marketing efforts will include: development of broad-based internships for science, engineering, education and information technology professions, participation in targeted recruitment, and implementation of improvements in presentation of recruitment materials. Requested funds will be used to research and implement effective compensation, recruitment, and retention strategies to secure continued employment of the best talent and to align these policies with best practices in the private, public and non-profit sectors. NSF will also identify and implement effective practices and policies to attract and retain scientists, engineers, educators and administrators from minority and underserved populations.

- ***Performance Management-- ($2.0 Million)*** The FY 2005 request includes funds to research, develop and deploy a competency-based performance management system that will directly tie individual and organizational accomplishments to strategic agency goals and that will effectively distinguish between high and low performers in the agency. NSF will develop and implement an automated 360-degree performance assessment process that will adjust performance expectations based on the ever-changing scientific and technological environment in which it works.

- ***Work Life Initiatives ($1.780 Million) --***Creating an environment in which quality of work life and family-friendly policies support the accomplishment of the Foundation's strategic objectives is essential to improve NSF's position as an employer of choice and to retain the highest quality personnel. Although NSF ranked second overall as a best place to work in Government, it ranked 16th out of 28 agencies on its family-friendly culture and benefits. NSF requests funds to embark on a comprehensive assessment of employee attitudes and human capital policies; conduct promising practice research; and implement initiatives that will improve overall employee productivity and satisfaction. In accordance with the requirements of the National Defense Authorization Act for Fiscal Year 2004, the assessment will include questions that are unique to the Foundation and will assess leadership and management practices and employees' satisfaction with their leadership, work environment, rewards and recognition, opportunities for professional development, and their opportunity to contribute to achieving NSF's mission. Requested funds will also support the redesign of NSF's employee assistance program, the subsidy of child care for lower-paid employees, the development of a broad based quality of work life program, and the upgrade of the alternative dispute resolution process.

- ***Strategic Alignment of Human Capital Functions—($1.0 Million)*** In order to effectively implement and manage its strategic human capital initiatives, NSF must make significant investments to reengineer its human capital processes and improve efficiency. Beginning in FY 2003, NSF embarked on a business process reengineering effort in its human resource management division. It has also begun to tactically contract some of its transactional work to outside vendors and will retrain current human resource professionals to assume strategic, customer service roles in the organization. In FY 2005, NSF will fully implement the findings of the business process reengineering effort, continue its research and implementation of strategic human capital endeavors, and further its goal of moving all appropriate transactional work to contractors so that staff can serve as consultants and strategic partners to their stakeholders.

Information Management and Communication ($1.0 Million) -- The requested funds will support NSF's continued improvement to its information management and communication strategies. In FY 2005, funds will support the ongoing development of a comprehensive program designed to collect information to support workforce planning and recruiting and retention initiatives. NSF will also develop a central electronic repository for all of its human capital related policies and procedures and design materials targeted to supervisors and employees. Funding will allow NSF to effectively evaluate its human resource metrics and assure that its accountability measures provide strategic, valued information that drive future human capital decisions and directly support overall performance accountability and assessment initiatives; and, to communicate findings to target audiences both inside and outside of the organization.



The NSF Academy **($5.25 Million)**

This request includes funds for staff resources, creation of new programs and curricula, and development of innovative approaches to electronically manage Academy activities. It will enable the Academy to develop a broad array of opportunities to support life-long learning and enable staff to efficiently and effectively perform critical functions in support of NSF's vision, mission and goals.

Since its establishment in October 2002, the Academy has provided a variety of educational opportunities in support of a limited agenda. Over the past year, NSF's vision of the Academy has evolved and current plans call for significant expansion of activities in response to NSF's Human Capital planning efforts. Components of the initiative are highlighted below:

- ***NSF Tutorials and e-Business Multimedia Courses*** – Creation, enhancement, and delivery of NSF specific tutorials and e-business learning activities will support organizational development and achievement of agency mission. Development of continuous learning opportunities focused on NSF's existing and emerging business processes (e.g., those involving e-jackets, panel systems, proposal review and post-award processing, and oversight) will be the primary thrust of this initiative. These learning activities will utilize an innovative life-cycle approach that replicates the actual flow of e-business processes, thus facilitating and shortening the skill acquisition period for NSF staff. Other tutorials will provide learning activities related to research and education frontiers supported through NSF initiatives.

- ***NSF's Blended Learning Portfolio*** – Significant expansion of portfolio content will accompany the formal linkage of core, technical and leadership competencies to NSF job families and Academy course offerings. Portfolio growth will emphasize further development of courses and programs in work life areas; project management and contract oversight; IT technology and security; and leadership development. Curriculum efforts will require a mixture of delivery methods, with attention to audience, course content, technology, culture, and organizational structure. Delivery methods will range from instructor-led classroom activities to self-paced e-learning, experiential learning, and mentoring. This portfolio includes a diverse set of course offerings that respond to staff and organization skill gaps. It is designed to meet the changing needs of specific NSF job families (e.g. division directors, program managers, administrative managers, or program assistants.)

- ***Introduction to the NSF Enterprise*** – This new activity will include the development of a comprehensive multi-media presentation to orient new employees and provide a resource for existing staff to continually refresh their knowledge regarding NSF administrative practices and mission-critical business processes. Through development of tailored web sites, this activity will focus attention on NSF mission, goals, and culture; information technology; and on the management needs of specific job families. It will provide a workplace technology orientation that will enable employees to use IT systems after their first week of employment. This activity will also offer a venue for organizational knowledge management.

- ***Career Paths and Individual Development Activities*** – A diverse array of initiatives and new strategies will assure that the Foundation retains key personnel, develops future leaders, and supports succession planning. Career development initiatives focused on individual NSF staff will include management, executive and leadership training and extension of NSF's after hours program for employees who are enrolled in career development courses or seeking certifications or college degrees. Career development strategies will focus on in-depth career counseling, development of individual career path maps, and use of electronic career mapping tools to provide online links between career requirements or competencies and job families.

In addition to these Human Capital initiatives, development of a comprehensive, integrated e-Human Capital system and a Learning Management System for the Academy is included within the Technology and Tools section of the Budget Request.

Operating Expenses ($7.0 Million)

Operating Expenses increase by $320,000, or 4.8% percent, to $7.00 million in FY 2005. These include funding for direct costs of the FTE staff for supplies, equipment, and other operating expenses necessary for the management of the NSF's research and education activities.

Travel ($7.26 Million)

Travel increases by $1.21 million or 20 percent, to $7.26 million in FY 2005. These resources fund costs associated with a reliable merit review process and the oversight recommended by the agency's Inspector General. These funds will also be used to intensify management and oversight activities; enable staff to participate in national and international science and engineering conferences and workshops; and provide access to strategic training opportunities.

BUSINESS ANALYSIS $5,350,000

In FY 2002, NSF initiated a comprehensive, multi-year Business Analysis, the outcomes of which will inform Organizational Excellence investments for the foreseeable future.

Business Analysis Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Over FY 2004 Amount	Percent
Business Analysis	2.95	2.49	5.35	2.86	114.9%
National Academy of Public Administration	0.70	0.30	0.00	-0.30	-100.0%
Total, Business Analysis	3.65	2.79	5.35	2.56	91.8%

The goals of the Business Analysis are:

- Document each of the agency's core *Business Processes* and define its contribution to the NSF mission.
- Define process effectiveness and efficiency improvements that leverage past experience, capitalize on best practices in the public and private sectors, and respond to emerging mission-related trends.
- Develop future-looking *Business Process* scenarios and criteria for success.
- Define a *Human Capital Management Plan* to provide next-generation human capital capabilities. The Plan will identify future-looking workforce competencies and describes human capital strategies and approaches to support the *Business Process* scenarios and to capitalize on opportunities afforded by *Technology and Tools* innovations.
- Define an *Integrated Technology and Tools Plan* (business infrastructure tools, knowledge bases, and technologies) that describes an overall integrated technical and information architecture for future systems and capabilities in support of the agency's *Business Processes*.

The Business Analysis project will be complete at the end of FY 2005. However, deliverables are being completed throughout the project. Major products delivered at the end of FY 2003 included a complete baseline documentation of the core business processes, a first version of an agency-wide human capital management plan, and a first iteration of enterprise architecture. This work underscores two fundamental challenges facing NSF as it becomes a fully integrated organization capable of working both within and across disciplinary and organizational boundaries: 1) maintaining the highest levels of quality in merit review and the award process, and 2) maintaining flexibility while promoting efficiency and appropriate agency-wide standards.

During FY 2004 and FY 2005, the Business Analysis effort will address these challenges in a variety of ways.

- From the business process perspective, NSF continues to explore alternative, more efficient methods for conducting the proposal review process that maintain the integrity of the process. Based on findings from the analysis, the Foundation is developing more formal procedures for managing the technical risk of awards and assessing the contribution of NSF-funded projects to the advancement of science and engineering. NSF is also capitalizing on Business Analysis work (e.g., an employee workload survey and analysis) to effectively implement alternative human capital management approaches to increase the utilization or effectiveness of the workforce.

- Guided by Human Capital findings to date, NSF is converting from a task-based to a competency-based human resource management system and consolidating several hundred existing job titles into 40 job families. These changes will directly link workforce planning, recruitment, development, retention, and performance management activities to agency business strategy and will simplify and streamline these activities for NSF management and staff.

- From the Technology and Tools perspective, the Business Analysis is providing a framework for planning and implementing NSF's next generation information technology (IT) environment and establishing agency-wide standards for IT security, functionality, and application development. The first iteration Enterprise Architecture has been used to guide planning for FY 2004 and FY 2005 information technology investments in grants management, human capital, and other business functions, as well as establish priorities for acquisition of critical supporting infrastructure.

The business analysis has already begun to produce a clear roadmap for significant improvements in NSF's business processes, human capital management, and technology and tools management. NSF is confident that the results of this effort will inform the agency's investments in Organizational Excellence for the foreseeable future.

National Academy of Public Administration Review. Consistent with the guidance provided in House Report 107-740, NSF has contracted with the National Academy of Public Administration for a 1-year, $1.0 million review of NSF's organizational, programmatic, and personnel systems, and of the role of the National Science Board. NAPA is scheduled to complete this review in April 2004.

TECHNOLOGY AND TOOLS $112,740,000

The FY 2005 request for Technology and Tools totals $112.74 million, an increase of $51.80 million, or 85 percent, over the FY 2004 Estimate of $60.94 million. These investments represent approximately one-third of NSF's total OE portfolio, and they consist of three major components: Information Technology, Space Rental and Other Infrastructure.

Technology and Tools Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Over FY 2004 Amount	Change Over FY 2004 Percent
Information Technology	24.36	37.18	84.29	47.11	126.7%
Space Rental	17.10	18.20	19.30	1.10	6.0%
Other Infrastructure	5.04	5.56	9.15	3.59	64.6%
Total, Technology and Tools	$46.50	$60.94	$112.74	51.80	85.0%

Information Technology ($84.29 Million)

The FY 2005 Information Technology request is $84.29 million, an increase of $47.11 million, or 126.7 percent over the FY 2004 Estimate. This increase will enable the Foundation to address key President's Management Agenda initiatives, support a world-class infrastructure, address management challenges identified through internal review and oversight, and implement recommendations stemming from the multi-year Business Analysis.

NSF is a Federal leader in the use of information technology and promotes electronic business solutions that are simpler, faster, more accurate, and less expensive. Our requested funding levels reflect the importance and value the Foundation places on the innovations and efficiencies that can be achieved by the thoughtfully planned and well-managed execution of information technology. The agency's paper-based work processes have evolved to capitalize on technology-enabled ways of doing business, allowing the agency to serve as an effective and capable steward of the taxpayer's resources. NSF's return on investment has truly yielded improvements in both effectiveness and efficiency. As a result of the technology innovations implemented by NSF, in FY2003, NSF processed more than:

- 40,000 Electronic Proposals (over 99% of all proposals)
- 190,000 Electronic Reviews
- 7,500 Graduate Research Fellowships
- 25,000 Electronic Grantee Progress Reports
- 10,000 Electronic Post-Award Actions
- 15,000 Electronic Requests
- $3.5 Billion Disbursement of Funds

The culmination of NSF's exemplary performance was highlighted by receipt of the President's 2003 Award for Management Excellence for the Foundation's innovative electronic capabilities to solicit, receive, review, select, award, manage and report results on public research and education investments. The award recognizes NSF's successful FastLane system, an interactive, real-time, web-based system used by over 200,000 scientists, educators, technology experts and administrators, including the country's top researchers, to conduct business over the Internet. The award further recognizes NSF's leadership role in the Federal eGovernment initiatives that directly relate to NSF's science and engineering, research and education mission as well as supporting initiatives that affect all Federal agencies.

While much has been accomplished and a strong foundation for success is in place, NSF's information technology plans for FY 2005 and beyond must respond to new challenges and needs in the following three areas:

- Enabling Human Capital Management
- Continued Leadership and Innovation in eGovernment
- Delivering World Class Customer Services and Secure Infrastructure.

<u>Enabling Human Capital Management</u> ($5.0 Million)

During FY 2004, NSF will define requirements for a new end-to-end Human Capital system to support strategic workforce planning, competency and performance-based human resources management, and improved personnel management services. As part of this initiative, NSF will complete migration to the new Government-wide mandated Payroll System. During FY 2005, NSF plans to acquire commercial technology, and begin implementation of high priority capabilities needed to support human capital management and NSF Academy initiatives. Of the total requested increase, $4.3 million is associated with the end-to-end Human Capital system, and $0.7 million for the adoption of Office of Personnel Management-sponsored learning management system capabilities.

A learning management system is the key software application that enables strategic management of human capital activities such as workforce planning and operational management training. It provides an electronic means of tracking catalogues and curricula, developing learner profiles and individual learning plans, mapping competencies and skills to catalogue offerings, delivering courses, creating content and assembling it for uniquely tailored courses, testing and assessment, and reporting capabilities.

<u>Continued Leadership and Innovation in eGovernment</u> ($14.2 Million)

NSF is in the planning stage for implementing the next generation of information technology capabilities that go far beyond automation of paper-based business processes. NSF is committed to re-engineering its internal processes and implementing solutions that leverage innovative technology and workflow to address the full range of administration and management priorities and functions. This next-generation, technology-enabled solution will be planned for, defined, and implemented in phases, building on the multi-year Business Analysis study. The overall solution set, called the Proposal, Review, and Management Information System or PRAMIS, will include four foci: migration and integration with Government-wide eGov initiatives; continued evolution of "back office" grants management functions; strategic information asset management; and customer relationship management. Each are highlighted below:

– ***Government-wide e-Gov Initiatives***. NSF continues to play a leadership role on many Government-wide e-Gov initiatives. Specifically, NSF is a partner on Grants.gov, is migrating to a new Government-wide Personnel and Payroll system in FY 2004, and actively supports the eHuman Resources Initiatives, eTraining, eTravel, Integrated Acquisition Environment, and eAuthentication. In light of its contributions and accomplishments, NSF has maintained a green status in electronic government since FY 2002.

– ***Proposal, Review, and Award Management functionality***. Using results from the Business Analysis, NSF will implement next generation "back office" grants managements capabilities. These capabilities will be based on re-designed business processes aimed at transforming the current mix of electronic and paper-based sequential award processing to enable dynamic, integrated processing of NSF announcements, proposals, and awards including improvements to pre- and post- award grant monitoring and contract management. Initial phases of "back office" grants management capability will be implemented through the Electronic Jacket pathfinder, which is closely integrated with FastLane. This application is serving as a proof-of-concept for total electronic proposal processing at NSF. Efforts to date have eliminated the need to process, print, and store paper copies of proposal processing files for approximately 70% of the proposals received by NSF, resulting in significant efficiency and productivity savings. FY 2004 and FY 2005 funding supports deployment of next phase critical functions including electronic signature, electronic records for awards, electronic workflow and continued integration with legacy applications.

– ***Strategic Information Asset Management***. This initiative will include development and implementation of a plan to manage NSF's strategic information and associated data infrastructure to facilitate the access, definition, management, security, and integrity of data across the enterprise. The Strategic Information Asset Management project will focus on delivering the capability to address a strong suite of knowledge bases derived from information from various sources, layered with robust decision support and enterprise information system capabilities; content management and improved quality of information products accessible via NSF's web site; reviewer knowledge base that provides improved capability to identify individuals in the science and research community to evaluate the merits of research proposals; analytical tools for improved executive information, program management and oversight, and decision support; and document management capabilities.

– ***Customer Relationship Management.*** This initiative will extend NSF's current customer care services to include improved support for planning, delivering, and evaluating services provided to over 230,000 scientists, educators, and research administrators throughout the grants management lifecycle process. Functionality will address improved call center management for telephone service, analytics for customer-oriented processes and requirements; customer/account management information for integration with NSF's corporate directory; and customer feedback management for collecting and analyzing comments and feedback from the scientific community.

Delivering World Class Customer Services and Secure Infrastructure (\$65.1 Million)

– ***NSF Security Program.*** \$10.0 million, an increase of \$7.0 million over FY 2004, is requested for investments necessary to make continual improvements to the NSF security program. NSF invested hundreds of thousands of dollars and thousands of work hours to enhance an already strong security program in FY 2003. Based on these investments, NSF's IT Security Program is – at a minimum – comprehensive, consistent with law and guidance, and effective. As a result of this extraordinary effort NSF was recognized for its significant improvement in its security posture in FY 2003 with an "A-" rating by the House Government Reform Committee's review of agency self assessments under the Federal Information Security Management Act (FISMA). The FY 2005 request includes key investments essential to sustain and improve NSF's information security program in the areas of policy and procedures, risk assessments and security plans, managed intrusion detection services, vulnerability assessments, and the implementation of additional technical and managerial security controls.

– ***Operational Efficiency***

$55.1 million, an increase of $26.0 million over FY 2004, is requested for investments necessary to make continued improvements in operations and basic information technology infrastructure. These include investment in the Data Center and corporate infrastructure; network, e-mail and telephone infrastructure; customer services and care; and implementation of recommended investments resulting from the NSF Business Analysis and Enterprise Architecture analyses.

- NSF has undertaken a well-planned, phased approach to securely manage a complex information infrastructure that supports re-engineered workflow and business processes using innovative, technology enabled solutions. Planned and approved next generation capabilities to support high priority strategic investment areas will not be advanced without this additional funding. Adequate funding in these areas is critical to the efficient operation of the Agency, as NSF has become increasingly dependent on innovative technologies to handle an increasingly complex workload. This request includes funds to continue implementation of critical investments in hardware, software, and tools necessary to manage and operate an infrastructure that can support NSF electronic business processes.

Space Rental ($19.30 Million)

The FY 2005 Request is $19.30 million, an increase of $1.10 million, or 6.0 percent, over the FY 2004 Estimate. These resources are needed to pay rising GSA rental costs, real estate taxes, and to accommodate the growth in staff that commenced in FY 2003. A small amount of additional space will be leased in Fiscal Years 2004 and 2005 to relieve existing congestion and to accommodate the additional FTE associated with the budget request.

Other Infrastructure ($9.15 Million)

The FY 2005 request for physical infrastructure is $9.15 million, an increase of $3.59 million, or 64.6 percent, over the FY 2004 Estimate. To keep pace with advances in information technology and business processes, changes in the operational infrastructure are necessary. The increases will be used to provide enhanced physical security, including modernization of the badging and physical access system. Re-engineering the facility management services is also necessary to accommodate the continued growth in the volume of proposals submitted and the transition to fully electronic proposal processing.

The following table shows the planned distribution of general operating expenses by object class and is followed by brief detailed explanations of each category.

General Operating Expenses by Object Class
(Dollars in Thousands)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change Amount
Travel and Transportation of persons	4,333	6,050	7,260	1,210
Transportation of Things	221	211	500	289
Rental Payments to GSA	17,099	18,200	19,299	1,099
Communications, Utilities and Misc. Charges	2,056	2,499	2,702	203
Printing and Reproduction	334	310	310	0
Advisory and Assistance Services	6,100	7,708	22,200	14,492
Other Services	4,694	7,307	13,408	6,101
Purchases of Goods & Services from Gov't. Accounts	2,154	1,564	2,099	535
Medical Care	485	485	700	215
Operations and Maintenance of Equipment	8,530	10,321	43,445	33,124
Supplies and Materials	2,517	2,329	2,639	310
Equipment	12,436	23,017	33,479	10,462
Reception and Representation	9	9	9	0
Total	$60,968	$80,010	$148,050	68,040

Totals may not add due to rounding.

Description of categories:

- **Travel and Transportation of Persons** is discussed at the beginning of the GOE section.

- **Transportation of Things** consists of household moves associated with bringing new scientists and engineers to NSF. The increase of $289,000 will cover the increasing costs of household goods moves, and allow more comprehensive relocation benefits for newly hired employees.

- **Rental Payments to GSA** includes the rent charged by GSA for NSF's facility in Arlington, Virginia, and a few floors in an adjacent building. The FY 2005 increase of $1.1 million is required to fund GSA's estimate for currently occupied space, plus an additional floor and a half in the adjacent building.

- **Communications, Utilities, and Miscellaneous Charges** include all costs for telephone lines and services, both local and long distance, postage, and charges for centrally managed photocopying equipment. The increase of $203,000 will offset increases in phone and postage charges, and upgrades to photocopying/scanning machines

- **Printing and Reproduction** includes contract costs of composition and printing of NSF's publications, announcements and forms; as well as printing of stationary and specialty items. These expenses do not increase over the FY 2004 Estimate.

- **Advisory and Assistance Services** include development, learning and career enhancement opportunities offered through the Academy, contracts for position classifications, work life initiatives, outreach and contractual costs for the Business Analysis and related services. The FY 2005 increase of $14.5 million is needed to expand programs, curricula, and methodologies that support life-long learning opportunities and develop employee competencies; initiate development of a competency based human resource system covering workforce planning, recruitment and retention, performance management, career mapping and employee development; support implementation of improved work-life programs such as Child Care and an enhanced Employee Assistance Program; broaden diversity recruiting initiatives, marketing and branding programs; implement broader human resource flexibilities to attract and retain employees; fund the Business Analysis that will define major improvements in efficiency and effectiveness of core business processes and develop and implement a Human Capital Management Plan and an Integrated Technology and Tools Plan.

- **Other Services** include warehousing and supply services, mail handling, proposal processing, equipment repair and maintenance, building-related costs, furniture repair, contract support for conference room services, security investigations and miscellaneous administrative contracts. These costs increase by $6.1 million in FY 2005 to fund office space build-outs and renovations, physical security initiatives and improvements, ongoing development of NSF's intranet and external web site, enhanced security investigation contract services, and offset increased costs resulting from upgraded security sensitivity designations.

- **Purchases of Goods and Services from Government Accounts** include reimbursable services purchased from GSA. These costs include security guard services, off-hours heating and air conditioning support, and some construction services. The increase of $535,000 will provide for additional guards in the newly acquired space, offset increased costs for security guards, and fund GSA-handled facility build-out.

- **Medical Care** includes costs associated with the health services contract, providing limited on-site medical services to the agency's staff. This includes performing physical examinations for the NSF staff on assignment at the South Pole. The increase of $215,000 covers increased costs of contracted health services and the purchase of improved medical equipment.

- **Operations and Maintenance of Equipment** includes management and operation of the central computer facility 24 hours/day, 365 days/year; operation of the customer service center and FastLane help desk; maintenance of database server hardware and related peripherals; software licensing fees; data communications infrastructure and network systems support; electronic mail support; and remote access (e.g., Internet and World Wide Web). The increase of $33.1 million is needed for increased costs to operate and maintain basic infrastructure equipment and services, including internal and external network for staff, visitors and panelists; increased costs due to the rising volume of Help Desk calls; increased maintenance costs for FastLane, legacy applications, and newly integrated infrastructure services contracts; and offset rising to maintain and improve NSF's enterprise-wide security program.

- **Supplies and Materials** include office supplies, library supplies, paper and supplies for the NSF central computer facility, and miscellaneous supplies. The increase of $310,000 will offset rising costs associated with electronic journals and databases that facilitate program staff locating reviewers to evaluate proposals.

- **Equipment** costs include new and replacement computing equipment, desktop computers, data communications equipment, video-teleconferencing equipment, office furniture, file cabinets, and support equipment such as audio-visual equipment. Also included are software development costs associated with developing and maintaining central application systems that support proposal, award, financial, and administrative activities. These costs increase in FY 2004 by approximately $10.5 million to support the following activities: investments in next generation grants management capability and other eGovernment initiatives; investments in a new Human Capital system; web site initiatives; acquisition of hardware and software to improve operational efficiency to meet increasing workloads; implementation of a robust directory-enabled technical architecture to support next generation capability; and investments to define and implement the new Enterprise Architecture.

- **Reception and Representation** expenses are funds that may be used for official consultation, representation, or other extraordinary expenses at the discretion of the NSF Director or his/her designee. These expenses do not increase over the FY 2004 Request.

NATIONAL SCIENCE BOARD

NATIONAL SCIENCE BOARD $3,950,000

The National Science Foundation (NSF) Appropriations Act of 2002 provided for a separate appropriation line item for the National Science Board (NSB) beginning in FY 2003. Accordingly, this FY 2005 Budget Request identifies the resources needed to support the Board, including amounts for personnel compensation and benefits, authorized travel, employment of experts and consultants, and other appropriate expenses. The NSB Request is $3.95 million, an increase of $70,000, or 1.8 percent, over the FY 2004 Estimate of $3.88 million. The FY 2005 Budget Request will enable the NSB to fulfill its policy-making and oversight responsibilities for the NSF and provide guidance on significant national policy issues in science and engineering research and education, as required by statute.

National Science Board Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request	Change over FY 2004 Amount	Percent
Personnel Compensation and Benefits	1.04	1.54	1.62	0.08	5.2%
Other Operating Expenses	1.84	2.34	2.33	-0.01	-0.4%
Total	$2.88	$3.88	$3.95	0.07	1.8%
Full-Time Equivalent Employees	9	12	12	0	0.00%

Background on the National Science Board

As an independent federal agency, NSF does not fall under any cabinet department; rather NSF's activities are guided by the NSB. The Board was established by the Congress in 1950 and provided with dual responsibilities to: a) oversee and guide the activities of, and establish policies for, the NSF; and (b) serve as an independent national science policy body that renders advice to the President and the Congress on policy issues related to science and engineering that have been identified by the President, Congress, or the Board itself. The NSB has 24 members appointed by the President and confirmed by the Senate. NSB members, who serve six-year terms in intermittent appointments, are drawn from industry and universities, and represent a variety of science and engineering disciplines and geographic areas. They are selected for their preeminence in research, education or public service. The NSF Director is also a full voting member (*ex officio*) of the Board.

In recent years, the NSB has met about five to six times a year to review and approve major NSF awards and new programs. It also initiates and conducts studies and reports on a broad range of policy topics, and publishes occasional policy papers or statements on issues of importance to U.S. science and engineering research and education. The Board analyzes NSF's budget to ensure progress and consistency along the strategic direction set for NSF and to ensure balance between initiatives and core programs. In addition, it identifies issues that are critical to NSF's future, and approves NSF's strategic budget directions and the annual budget submission to the Office of Management and Budget.

National Science Board Activities

The Board is required to establish the Foundation's policies within the framework of applicable national policies as set forth by the President and the Congress, and therefore approves and supports the strategic Government Performance and Results Act (GPRA) goals of the Foundation, including those identified in the President's Management Agenda (PMA). The Board conducts continuous assessment of the quality, relevance and performance of the Foundation's award making, as called for in the R&D Investment Criteria of the PMA. The NSF Director's Report on Merit Review is presented to the Board each year, allowing the NSB to monitor the quality and effectiveness of this keystone Foundation process. The Board has received reports from the chair of the Foundation's Advisory Committee on GPRA Performance Assessment, and reviews and approves the summary results of the Foundation's annual GPRA performance goals and the updates of the NSF Strategic Plan.

The NSB issues policy guidance in the form of official statements and resolutions dealing with topics such as the Foundation's merit review criteria, cost sharing with universities, and funding and oversight of major research infrastructure projects. The Board is also responsible for direct review and approval of the largest Foundation awards, and is responsible for the review and approval of major facilities and research infrastructure projects at all stages of development, including budget planning, review of proposals and management effectiveness, and approval of awards.

Much of the work of the Board is accomplished in committees, which make recommendations to the full Board for approval. In 2001, the Board established a Committee on Strategy and Budget (CSB) to focus on strategic planning and budget initiatives for NSF and lead the review of the Foundation's annual budget request. CSB also led the development of the Board's response to a Congressional directive for NSB to prepare a report to the Congress addressing NSF's budgetary and programmatic growth provided for by the NSF Act of 2002. The NSB report entitled, *Fulfilling the Promise: Report on the Budgetary and Programmatic Expansion of the National Science Foundation*, was presented to the Congress in December 2003 and focused on: a) how the increased funding should be used, b) the impact that the increases will have on the Nation's Science and Technology (S&T) workforce, c) how to enable institutions of higher education to expand their participation in NSF-funded activities, d) the national S&T research infrastructure needed to support NSF's increased funding, and e) the impact the budgetary increases will have on the size and duration of NSF grants.

The Committee on Education and Human Resources (EHR) focuses on Foundation activities in such priority areas as Science and Engineering (S&E) workforce development, math and science education, and underrepresented populations and regions in S&E programs. Occasionally, the Board establishes subcommittees, temporary formal task forces and *ad hoc* task groups to study and report on specific policies issue related to science and engineering research and education. The EHR Subcommittee on Science and Engineering Indicators manages the process for development and review of the Board's biennial statistical report on S&E indicators. The EHR Task Force on National Workforce Policies for Science and Engineering recently completed its assessment of long-term national workforce trends and needs in science and engineering and their relationship to existing federal policies. A task force report with specific recommendations for strategies that will address long-term S&E workforce needs was presented to, and deliberated by, the full Board. A final report entitled, *The Science and Engineering Workforce/Realizing America's Potential*, was published by the NSB in November 2003.

The members of the Committee on Programs and Plans (CPP) review proposals for major awards (i.e., Major Research Equipment and Facilities Construction awards), the health of the Foundation's peer review system, and program performance and accountability. The Board monitors the critical infrastructure that supports research in Antarctica through the CPP Subcommittee on Polar Issues. A new CPP *ad hoc* Task Group on Long-lived Data Collections (LLDCs) is focusing on identifying policy issues and concerns for the future related to long-lived data collections for researchers supported by NSF. Issues being explored include long-term funding and re-competition, adoption of standards, maintenance of data in laboratories of individuals versus data in large managed collections, accessibility, and planning for cross-disciplinary users. The *ad hoc* LLDC Task Group will address LLDC policy issues as perceived by the research community, emerging policy issues, and concerns for the future. A new CCP *ad hoc* Task

Group on High Risk Research is focusing on studying and developing policies that will assist NSF to develop and strengthen its ability to identify and fund innovative, potentially transformative, research, and to evaluate its success in doing so. The *ad hoc* Task Group on High Risk Research will solicit input from the scientific community on improving the processes by which high-risk research activities are identified, reviewed, and funded as well as the processes by which the selection and funding procedures are evaluated.

The standing Committee on Audit and Oversight (A&O) oversees the operations of the Foundation's Office of Inspector General (OIG), as well as NSF compliance with new procedures for financial accountability and information technology security. The NSF Inspector General reports directly to the A&O Committee and assists the Board in overseeing the complex and challenging operation of NSF. In November 2003, the A&O Committee reviewed and recommended full Board endorsement of the NSF Office of Inspector General's (OIG) *Semiannual Report to the Congress*. This report, endorsed by the full Board, highlights the activities of the OIG for the six-month period ending September 30, 2003.

National Science Board FY 2005 Budget Request

The Board's Budget Request for FY 2005 seeks resources to carry out its statutory authority and to strengthen the Board's oversight responsibilities for the Foundation in an era of significant budgetary and programmatic expansion. The Foundation continues to provide accounting, logistical and other necessary resources in support of the NSB and its missions, including expert senior S&E staff serving as a cadre of Executive Secretaries to Board Committees.

By statute, the Board is authorized five professional positions and other clerical staff as necessary. The Board, in consultation with the Congress, has defined these professional positions as senior science and engineering policy NSB staff, and the clerical positions as NSB staff that support Board operations and related activities. Together, the NSB Office (NSBO) staff provides the independent resources and capabilities for coordination and implementation of S&E policy analyses and development and operational support that are essential for the Board to fulfill its mission.

At the urging of Congress, in FY 2003 the Board began examining options for augmenting its professional staffing levels. At its May 2003 meeting, the Board decided to begin a process to assess the feasibility of recruiting for positions that would broaden its policy support, provide additional legal advice, and enhance the Board's capabilities in advanced information technology. As an initial step in this process, in August 2003 the Board appointed a new NSB Executive Officer who also serves as the NSBO Director. At the direction of the Congress, the NSB Executive Officer now reports directly to the NSB Chair. In October 2003, the NSB Chair notified the Congress that he had charged the NSB Executive Officer with identifying options for broadening the NSBO staff capabilities to better support the broad mission of the NSB. The National Academy of Public Administration (NAPA) is also currently examining issues related to NSF's organizational, programmatic, and personnel structures, as well as potential changes in the NSB's functions and processes related to recent legislative mandates and increases in NSF funding. The NAPA report is due to be published in mid-FY 2004 and will also be factored into the NSB Executive Officer's staffing assessment. Hence, the fiscal impact of the results of this assessment will begin in FY 2004. However, the full impact of increasing the number of professional positions closer to the statutory level is expected to occur in FY 2005, with increased attention to addressing new skill requirements.

Personnel Compensation and Benefits and General Operating Expenses
(Dollars in Thousands)

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Request
Personnel:			
Personnel Compensation and Benefits	1,042	1,540	1,620
General Operations:			
NSBO Staff Development and Training	1	20	25
Advisory and Assistance Services	1,452	1,400	1,450
Other Services	3	260	210
Travel and Transportation of Persons	228	451	446
Communications, Supplies and Equipment	141	200	190
Representation Costs	9	9	9
TOTAL	$2,876	$3,880	$3,950

Enhanced Board responsibilities established in the NSF Authorization Act of 2002 (PL 107-368) and directed by Congressional Report language include: an expanding role in prioritization and approval of Major Research Equipment and Facilities Construction projects; new requirements for meetings open to the public; and responsibilities for reporting on the Foundation's budgetary and programmatic expansion, with specific focus on projected impact on the science and technology workforce, research infrastructure, size and duration of grants awarded, and underrepresented populations and regions. The National Academies, in response to a Congressional request, will also soon be releasing their final report of a study examining how NSF sets priorities among multiple competing proposals for construction and operation of large-scale research facility projects to support a diverse array of disciplines. This report will provide recommendations for: (a) optimizing and strengthening the process used by the NSF to set priorities among large research facility project proposals and to manage their incorporation into the President's budget, (b) improving the construction and operation of NSF-funded large research facility projects, and (c) the role of the current and future availability of international and interagency research facility projects in the decision-making process for NSF funding of large research facility projects. Recommendations from this study will be considered with due diligence by the Board as they develop and implement options for meeting their enhanced responsibilities.

In addition to its essential NSBO resources and capabilities, external advisory and assistance services are especially critical to support production of NSB reports, and supplement NSBO's general research and administration services to the Board. These external services provide the Board and its NSBO with the flexibility to respond both independently and quickly to congressionally mandated studies (i.e., NAPA and the National Academies), the natural and rapid evolution of the U.S. S&E enterprise, and to topics and issues related to the U.S. maintaining its global leadership in S&E related innovation and discovery.

OFFICE OF
INSPECTOR GENERAL

OFFICE OF INSPECTOR GENERAL $10,110,000

The Appropriations Act that funds the National Science Foundation (NSF) provides for a separate appropriation heading for NSF's Office of Inspector General (OIG). Accordingly, the FY 2005 Budget Request identifies the resources needed to support OIG, including amounts for personnel compensation and benefits, contract services, training, travel, supplies, materials, and equipment.

The FY 2005 Budget Request for OIG is $10.11 million, which represents an increase of $170,000 over the FY 2004 Estimate of $9.94 million.

Office of Inspector General Funding
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Estimate[1]	FY 2005 Request	Change over FY 2004 Amount	Change over FY 2004 Percent
Personnel Compensation and Benefits	6.27	7.48	7.60	0.12	1.6%
Other Operating Expenses	2.43	2.46	2.51	0.05	2.0%
Total	$8.70	$9.94	$10.11	$0.17	1.7%
Full-Time Equivalent Employment	55	60	60	0	0.0%

[1] - FY 2004 Conference mark of $10 million, minus .59% rescission.

<u>OIG Responsibilities</u>

In February 1989, the National Science Board established OIG pursuant to the Inspector General Act Amendments of 1988. The statute confers on OIG the responsibility and authority to:

- Conduct and supervise audits of NSF programs and operations, including organizations that receive NSF funding.
- Conduct investigations concerning NSF programs and operations, including organizations that receive NSF funding.
- Evaluate allegations of research misconduct, such as fabrication, falsification, or plagiarism, involving individuals who participate in NSF-funded activities.
- Provide leadership, coordination, and policy recommendations for:
    - Promoting economy, efficiency, and effectiveness in the administration of NSF programs and operations, and
    - Preventing and detecting fraud and abuse in NSF programs and operations.
- Issue semiannual reports to the National Science Board and Congress to keep them informed about problems, recommended corrective actions, and progress being made in improving the management and conduct of NSF programs.

As set forth in the OIG Strategic Plan, the primary functions of the Office are audits, performance reviews, and investigations. Reflecting the diverse skills, training, and experience necessary to oversee NSF's varied programs, OIG staff includes scientists, attorneys, certified public accountants, investigators, evaluators, and information technology specialists. The focus of an investigation, audit, or other review may be on a single entity or individual, an organization, a project involving multiple disciplines, or a broad program or functional area.

OIG audits grants, contracts, and cooperative agreements funded by the Foundation's programs. OIG performs audits and reviews of the operations of both internal agency programs and external organizations that receive NSF funding to ensure that financial, administrative, and programmatic activities are conducted economically and efficiently. The Office is also responsible for the audit of the Foundation's annual financial statements, which are required for all NSF accounts and activities by the Government Management Reform Act of 1994. OIG contracts with a public accounting firm to conduct the financial statements audit, and the cost is allocated proportionately to the accounts audited. In addition to overseeing the audit, OIG performs systemic audits of financial, budgetary, and data processing systems used by NSF to develop the financial statements. The Office also performs multidisciplinary reviews of financial, management, and program operations that identify broader problems and highlight best practices.

OIG investigates possible wrongdoing by organizations and individuals who submit proposals to, receive awards from, conduct business with, or work for the Foundation. Allegations of research misconduct are also investigated. OIG assesses the validity and seriousness of the allegations and recommends proportionate action. When appropriate, the Office refers the results of these investigations to the Department of Justice or other authorities for criminal prosecution or civil litigation. OIG refers other cases to the Foundation for administrative resolution and recommends modifications to agency policies and procedures. The Office works closely with institutions on the conduct of their internal investigations and performs outreach activities aimed at preventing and detecting fraud, waste and abuse and at raising the awareness of funded researchers, institutional administrators, and agency employees about the OIG's role and NSF's rules and expectations.

Personnel Compensation and Benefits and General Operating Expenses
(Dollars in Thousands)

	FY 2003 Actual	FY 2004 Estimate[1]	FY 2005 Request
Personnel Compensation and Benefits	6,270	7,480	7,600
Travel and Transportation of Persons	152	250	275
Advisory and Assistance Services	1,953	1,870	1,875
Communications, Equipment, Other	322	341	360
Total:	$8,697	$9,941	$10,110

[1] - FY 2004 Conference mark of $10 million, minus .59% rescission

To complement the growth in the NSF budget, OIG has planned a commensurate increase in audits of (1) organizations that receive NSF funding and (2) agency operations to assess the efficiency, effectiveness, and integrity of their programs. The budget requested for FY 2005 will allow OIG to continue to focus on NSF activities that have been identified as priorities, particularly as NSF's financial exposure grows due to its efforts to make larger awards that extend over longer periods of time. Approximately 75 percent of the request is dedicated to OIG personnel costs, with the balance providing funding for continued contract support for audits and investigations, ongoing outreach activities to the research community, and required upgrades in OIG technological capability.

OIG will maintain its efforts in the areas that the Office has identified as priorities, consistent with the OIG Strategic Plan and the Management Challenges identified by OIG. The Office's primary effort has been to increase audit attention in eight areas that pose the greatest risk to the agency: financial management, acquisition, information technology, human capital, award administration, awardee financial accountability and compliance, the management of agency programs and projects, and OMB Circular A-133 audits. In particular, the Office is focusing on assessments of (1) NSF's multiyear Business Analysis contract and workforce plan, which is scheduled to be completed in FY 2005; (2) NSF's management of large programs and operations, including Math and Science Partnerships and Polar Operations; (3) infrastructure projects funded from the Major Research Equipment and Facilities Construction Appropriation, especially those with international partners; and (4) NSF's efforts to improve its award administration and monitoring, with special attention on post-award oversight. Each of these areas has been identified as a Management Challenge for the agency, and NSF has a number of initiatives under way to address and improve these critical operations.

Within budgetary limits, OIG will continue to devote some staff time to Quality Control Reviews of non-federal CPA firms conducting audits for grantees under the Single Audit Act (OMB Circular A-133). Because NSF relies on these audits as an important element of its post-award monitoring procedures, it is critical that the quality of the audits be assured. Over the past few years, Quality Control Reviews of the CPA firms conducting A-133 audits have raised significant concerns about their quality.

In addition, criminal, civil and administrative investigative cases are becoming more complex, resulting in increased interactions with NSF, awardee administrators, and the Department of Justice. These cases require more staff time and a higher degree of skilled analysis. With current resources, the Office is conducting more in-depth analyses of indicators of grant fraud that may be found during audits and other reviews. Also, the NSF OIG has played a leading role in establishing a peer review process for investigative activities within the Inspector General community. This process will enhance the quality of OIG investigations throughout the Government. The NSF OIG also continues its role as the community leader for investigating misconduct in science and research. Resources used in support of these efforts enhance the effectiveness of all IG investigative activities.

If the number of investigative cases remains static, the request level would allow the current level of effort for the OIG's outreach programs. These help NSF staff, awardee institutions, and researchers become more aware of the system and grant management problems that OIG has identified and the preventive or corrective measures that they can take. Both auditors and investigators are needed to participate in outreach activities. As NSF programs expand in complexity and number, the OIG has seen an increase in the number of requests for assistance from universities and research institutions. Our outreach also involves international collaborations and audits. Because international programs are an integral part of NSF's portfolio, the OIG has initiated efforts to better understand the accountability and audit requirements of international partners. These activities are also coordinated with other OIGs to avoid duplication and to ensure consistency in approaches to issues.

CHANGES BETWEEN
FY 2004 REQUEST
AND FY 2004 ESTIMATE

CHANGES BETWEEN FY 2004 REQUEST AND FY 2004 ESTIMATE

The FY 2004 Estimate for the National Science Foundation is $5,577.83 million, or 1.8 percent more than requested. This represents an increase of $208.49 million, over the FY 2003 Actual of $5,369.34 million.

Changes Between FY 2004 Request and FY 2004 Estimate
(Dollars in Millions)

	FY 2003 Actual	FY 2004 Request	FY 2004 Estimate	Change between FY 2004 Estimate & FY 2004 Request Amount	Percent
Research & Related Activities	4,054.43	4,106.36	4,251.36	145.00	3.5%
Education & Human Resources	934.88	938.04	938.98	0.94	0.1%
Major Research Equipment	179.03	202.33	154.97	-47.36	-23.4%
Salaries & Expenses	189.42	225.70	218.70	-7.00	-3.1%
National Science Board	2.88	0.00	3.88	3.88	N/A
Office of Inspector General	8.70	8.77	9.94	1.17	13.3%
Total, NSF	$5,369.34	$5,481.20	$5,577.83	$96.63	1.8%

Totals may not add due to rounding.

The FY 2004 Estimate for the **Research and Related Activities** (R&RA) Appropriation is $4,251.36 million, an increase of 3.5 percent over the FY 2004 Request. Funding levels for the FY 2004 Estimate include the 0.59 percent rescission.

Per Congressional direction, the FY 2004 Estimate includes $342.15 million within the R&RA account for Polar Research and Operations, an increase of $12.22 million over the FY 2004 Request.

The FY 2004 Estimate also includes $89.47 million within the Biological Sciences Activity for plant genome research.

Of the appropriated increases within the Computer and Information Science and Engineering Activity (CISE), $247.19 million is provided for Information Technology Research and $22.24 million for Domain-specific cyberinfrastructure.

Per Congressional direction, the FY 2004 Estimate within the Mathematical and Physical Sciences Activity will provide $54.98 million for the National Radio Astronomy Observatory (NRAO) program, which will include targeted funds for the Expanded Very Large Array and the Green Bank Observatory. The FY 2004 Estimate will also provide $6.0 million for continued advanced planning of the Rare Symmetry Violating Process (RSVP) project.

Of appropriated funding for Social, Behavioral and Economic Sciences, $6.0 million will target the Children's Research Initiative.

Of funds provided for Integrative Activities at the FY 2004 level, $109.35 million will be provided for Major Research Instrumentation.

The FY 2004 Estimate includes $253.51 million for nanotechnology programs across the directorates, an increase of $4.52 million over the FY 2004 Request.

The **Education and Human Resources** (EHR) Account will be funded at $938.98 million, an increase of 0.1 percent over the FY 2004 Request. Per Congressional direction, the Experimental Program to Stimulate Competitive Research (EPSCoR) will receive $94.44 million, an additional $19.44 million over the FY 2004 Request level. Of the amount appropriated for Elementary, Secondary and Informal Education, $62.13 million has been provided for the Informal Science Education program. Within the level of funding for Undergraduate Education, $45.23 million will be provided for the Advanced Technological Education program, $24.85 million for the STEM Talent Expansion Program, and $7.95 million for the Noyce Scholarship Program.

Sufficient funding will be provided at the FY 2004 level to reach a graduate stipend level of $30,000.

Within the funding level for Human Resource Development $34.30 million will be provided for the Louis Stokes Alliances for Minority Participation, $23.86 million for the Historically Black Colleges and Universities Undergraduate program (HBCU-UP), $14.91 million for the Alliance for Graduate Education and Professoriate, and $14.91 million for the Centers of Research Excellence in Science and Technology (CREST) program.

The **Major Research Equipment and Facilities Construction** (MREFC) Account is funded at $154.97 million, a decrease of 23.4 percent from the FY 2004 Request. Within MREFC, $50.70 million will be provided for construction of the Atacama Large Millimeter Array (ALMA) radio telescope, $43.24 million for EarthScope, $41.75 million for the IceCube Neutrino Detection project, and $8.05 million for the Network for Earthquake Engineering Simulation. Terascale Computing Systems are being provided $9.94 million. $1.29 million will be provided for construction costs associated with the South Pole Station. Additionally, NSF will consider the recommendations in the National Academy of Sciences report and continue to refine the National Ecological Observatory Network (NEON) plan from funds provided under Research and Related Activities.

The **Salaries and Expenses** (S&E) appropriation totals $218.70 million. These funds provide for the operation, management, and direction of all Foundation programs and activities, and include necessary funds to develop and coordinate NSF programs.

The **National Science Board** (NSB) will be funded at $3.88 million.

The **Office of Inspector General** (OIG) will be funded at $9.94 million.

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
BIOLOGICAL SCIENCES					
MOLECULAR AND CELLULAR BIOSCIENCES					
Molecular & Cellular Biosciences Research	$121,891	$116,860	$121,770	$4,910	4.2%
Total	121,891	116,860	121,770	4,910	4.2%
INTEGRATIVE BIOLOGY AND NEUROSCIENCE					
Integrative Biology & Neuroscience Research	107,470	103,380	107,410	4,030	3.9%
Total	107,470	103,380	107,410	4,030	3.9%
ENVIRONMENTAL BIOLOGY					
Environmental Biology Research	108,276	104,770	108,260	3,490	3.3%
Total	108,276	104,770	108,260	3,490	3.3%
BIOLOGICAL INFRASTRUCTURE					
Research Resources	42,410	54,990	48,630	-6,360	-11.6%
Human Resources	32,620	24,970	31,590	6,620	26.5%
Total	75,030	79,960	80,220	260	0.3%
EMERGING FRONTIERS					
Emerging Frontiers	73,373	82,250	79,760	-2,490	-3.0%
Total	73,373	82,250	79,760	-2,490	-3.0%
PLANT GENOME RESEARCH					
Plant Genome Research	84,450	75,000	89,470	14,470	19.3%
Total	84,450	75,000	89,470	14,470	19.3%
Total, BIO	$570,490	$562,220	$586,890	$24,670	4.4%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING					
COMPUTER & NETWORK SYSTEMS					
Computer & Network Systems	$117,150	$118,720	$114,934	-$3,786	-3.2%
Total	117,150	118,720	114,934	-3,786	-3.2%
COMPUTING & COMMUNICATION FOUNDATIONS					
Computing & Communication Foundations	81,150	81,910	78,925	-2,985	-3.6%
Total	81,150	81,910	78,925	-2,985	-3.6%
INFORMATION & INTELLIGENT SYSTEMS					
Information & Intelligent Systems	82,150	82,980	80,052	-2,928	-3.5%
Total	82,150	82,980	80,052	-2,928	-3.5%
SHARED CYBERINFRASTRUCTURE					
Shared Cyberinfrastructure	95,071	101,220	112,629	11,409	11.3%
Total	95,071	101,220	112,629	11,409	11.3%
INFORMATION TECHNOLOGY RESEARCH (ITR)					
Information Technology Research (ITR)	213,770	199,430	218,110	18,680	9.4%
Total	213,770	199,430	218,110	18,680	9.4%
Total, CISE	$589,291	$584,260	$604,650	$20,390	10.3%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
ENGINEERING					
BIOENGINEERING AND ENVIRONMENTAL SYSTEMS					
Bioengineering and Environmental Systems	$49,452	$47,910	$51,020	$3,110	6.5%
Total	49,452	47,910	51,020	3,110	6.5%
CHEMICAL AND TRANSPORT SYSTEMS					
Chemical and Transport Systems	68,331	66,200	68,920	2,720	4.1%
Total	68,331	66,200	68,920	2,720	4.1%
CIVIL AND MECHANICAL SYSTEMS					
Civil and Mechanical Systems	63,229	64,360	67,170	2,810	4.4%
Total	63,229	64,360	67,170	2,810	4.4%
DESIGN, MANUFACTURE, AND INDUSTRIAL INNOVATION					
Design, Manufacture, and Industrial Innovation	64,000	61,910	65,810	3,900	6.3%
Small Business-Industrial Innovation	90,923	101,150	103,590	2,440	2.4%
Total	154,923	163,060	169,400	6,340	3.9%
ELECTRICAL AND COMMUNICATIONS SYSTEMS					
Electrical and Communications Systems	73,046	70,760	74,580	3,820	5.4%
Total	73,046	70,760	74,580	3,820	5.4%
ENGINEERING EDUCATION AND CENTERS					
Engineering Education and Centers	132,722	124,280	134,040	9,760	7.9%
Total	132,722	124,280	134,040	9,760	7.9%
Total, ENG	$541,702	$536,570	$565,130	$28,560	5.3%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
GEOSCIENCES					
ATMOSPHERIC SCIENCES					
Atmospheric Sciences Research Support	$147,943	$151,100	$156,780	$5,680	3.8%
National Center for Atmospheric Research	83,348	78,820	82,000	3,180	4.0%
Total	231,291	229,920	238,780	8,860	3.9%
EARTH SCIENCES					
Earth Sciences Project Support	115,378	109,160	119,580	10,420	9.5%
Instrumentation and Facilities	31,937	35,100	32,000	-3,100	-2.1%
Total	147,315	144,260	151,580	7,320	5.1%
OCEAN SCIENCES					
Ocean Section	117,980	115,760	120,450	4,690	4.1%
Integrative Programs Section	110,260	104,080	118,080	14,000	13.5%
Marine Geosciences Section	84,980	93,900	84,210	-9,690	-3.1%
Total	313,230	313,740	322,740	9,000	2.9%
Total, GEO	$691,836	$687,920	$713,100	$25,180	3.7%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
MATHEMATICAL AND PHYSICAL SCIENCES					
ASTRONOMICAL SCIENCES					
Astronomical Research	$187,074	$183,070	$196,550	$13,480	7.4%
Total	187,074	183,070	196,550	13,480	7.4%
CHEMISTRY					
Chemistry Research	181,609	181,710	185,220	3,510	1.9%
Total	181,609	181,710	185,220	3,510	1.9%
MATERIALS RESEARCH					
Materials Research	241,386	246,120	250,890	4,770	1.9%
Total	241,386	246,120	250,890	4,770	1.9%
MATHEMATICAL SCIENCES					
Mathematical Sciences	178,785	201,870	200,410	-1,460	-0.7%
Total	178,785	201,870	200,410	-1,460	-0.7%
PHYSICS					
Physics Research	224,502	217,500	227,670	10,170	4.7%
Total	224,502	217,500	227,670	10,170	4.7%
MULTIDISCIPLINARY ACTIVITIES					
Research Project Support	27,341	31,000	30,770	-230	-0.7%
Total	27,341	31,000	30,770	-230	-0.7%
Total, MPS	$1,040,697	$1,061,270	$1,091,510	$30,240	2.8%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES					
SOCIAL AND ECONOMIC SCIENCES					
Social and Economic Sciences	$71,007	$83,920	$81,020	-$2,900	-3.5%
Total	71,007	83,920	81,020	-2,900	-3.5%
BEHAVIORAL AND COGNITIVE SCIENCES					
Behavioral and Cognitive Sciences	62,315	71,120	68,500	-2,620	-3.7%
Total	62,315	71,120	68,500	-2,620	-3.7%
SCIENCE RESOURCES STATISTICS					
Science Resource Statistics	25,305	26,700	26,150	-550	-2.1%
Total	25,305	26,700	26,150	-550	-2.1%
OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING					
Office of International Science and Engineering	39,973	30,000	28,120	-1,880	-6.3%
Total	39,973	30,000	28,120	-1,880	-6.3%
Total, SBE	$198,599	$211,740	$203,790	-$7,950	-3.8%
UNITED STATES POLAR RESEARCH PROGRAMS	$255,407	$261,860	$274,080	$12,220	4.7%
UNITED STATES ANTARCTIC LOGISTICAL SUPPORT ACTIVITIES	$68,552	$68,070	$68,070	$0	0.0%
INTEGRATIVE ACTIVITIES	$97,859	$132,450	$144,140	$11,690	8.8%
Total, RESEARCH AND RELATED ACTIVITIES	$4,054,433	$4,106,360	$4,251,360	$145,000	3.5%

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
EDUCATION AND HUMAN RESOURCES					
MATH & SCIENCE PARTNERSHIP					
Math & Science Partnership	$144,070	$200,000	$139,170	-$60,830	-30.4%
Total	144,070	200,000	139,170	-60,830	-30.4%
EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)					
Experimental Program to Stimulate Competitive Research (EPSCoR)	89,210	75,000	94,440	19,440	25.9%
Total	89,210	75,000	94,440	19,440	25.9%
ELEMENTARY, SECONDARY AND INFORMAL SCIENCE EDUCATION [1]					
Instructional and Assessment Materials Development	28,780	28,990	28,820	-170	-0.6%
Teacher & Student Development	134,080	115,460	121,310	5,850	5.1%
Informal Science Education	60,440	50,000	62,130	12,130	24.3%
Total	223,300	194,450	212,260	17,810	9.2%
UNDERGRADUATE EDUCATION					
Curriculum, Laboratory and Instructional Development	99,700	71,740	93,200	21,460	29.9%
Workforce Development	72,850	70,360	62,300	-8,060	-11.5%
Total	172,550	142,100	155,500	13,400	9.4%
GRADUATE EDUCATION					
Graduate Student Support	139,500	156,880	155,950	-930	-0.6%
Total	139,500	156,880	155,950	-930	-0.6%
HUMAN RESOURCE DEVELOPMENT					
Undergraduate/ Graduate Student Support	60,760	62,970	68,370	5,400	8.6%
Research & Education Infrastructure	22,740	25,200	32,330	7,130	28.3%
Opportunities for Women and Persons with Disabilities	15,980	15,240	15,150	-90	-0.6%
Total	99,480	103,410	115,850	12,440	12.0%
RESEARCH, EVALUATION AND COMMUNICATION					
Research	54,270	54,560	54,240	-320	-0.6%
Evaluation	12,500	11,640	11,570	-70	-0.6%
Total	66,770	66,200	65,810	-390	-0.6%
Total, EHR	$934,879	$938,040	$938,980	$940	0.1%

[1] FY 2003 Actual and FY 2004 Estimate have been restated for the purposes of the FY 2005 Budget Request to reflect all funds for the Teacher Professional Continuum (TPC) in th ESIE Subactivity, including those previously shown in DUE (FY 2003, $6.71 million; FY 2004 Estimate, $6.48 million).

LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

PROGRAM	FY 2003 ACTUAL	FY 2004 REQUEST	FY 2004 ESTIMATE	CHANGE FY 2004 Req/FY 2004 Estimate AMOUNT	PERCENT
MAJOR RESEARCH EQUIPMENT AND FACILITIES CONSTRUCTION	$179,029	$202,330	$154,970	-$47,360	-23.4%
Total, MREFC	$179,029	$202,330	$154,970	-$47,360	-23.4%
SALARIES AND EXPENSES	$189,423	$225,700	$218,700	-$7,000	-3.1%
Total, S&E [1]	$189,423	$225,700	$218,700	-$7,000	-3.1%
NATIONAL SCIENCE BOARD	$2,876	$0	$3,880	$3,880	#DIV/0!
Total, NSB	$2,876	$0	$3,880	$3,880	#DIV/0!
OFFICE OF INSPECTOR GENERAL	$8,697	$8,770	$9,940	$1,170	13.3%
Total, OIG	$8,697	$8,770	$9,940	$1,170	13.3%
TOTAL, NATIONAL SCIENCE FOUNDATION	$5,369,338	$5,481,200	$5,577,830	$96,630	1.8%

Totals may not add due to rounding.

[1] FY 2003 includes an Appropriations Transfer from the Department of State in the amount of $13.14 million for an award to the U.S. Civilian Research and Development Foundation. ($12.83 million in SBE and $315,436 in S&E)

QUANTITATIVE DATA TABLES

NATIONAL SCIENCE FOUNDATION
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$3,390,984	$3,519,424	$3,623,410
Applied Research	217,620	210,729	220,748
Development	0	0	0
Subtotal, Conduct of R&D	3,608,604	3,730,153	3,844,158
R&D Facilities			
Land, Building and Fixed Equipment	18,528	17,248	17,510
Major Equipment	316,716	329,558	364,035
Subtotal, R&D Facilities & Major Equipment	335,244	346,806	381,545
Total, Support of R&D	3,943,848	4,076,959	4,225,703
Non-Investment Activities	524,255	571,458	655,082
Education and Training	901,235	929,413	864,215
TOTAL	$5,369,338	$5,577,830	$5,745,000

Totals may not add due to rounding.

RESEARCH AND RELATED ACTIVITIES
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$3,266,593	$3,389,104	$3,498,410
Applied Research	200,882	203,722	214,248
Development	0	0	0
Subtotal, Conduct of R&D	3,467,475	3,592,826	3,712,658
R&D Facilities			
Land, Building and Fixed Equipment	18,528	17,248	17,510
Major Equipment	136,334	174,588	150,765
Subtotal, R&D Facilities & Major Equipment	154,862	191,836	168,275
Total, Support of R&D	3,622,337	3,784,662	3,880,933
Non-Investment Activities	288,806	321,080	330,022
Education and Training	143,290	145,618	241,355
TOTAL	$4,054,433	$4,251,360	$4,452,310

Totals may not add due to rounding.

EDUCATION AND HUMAN RESOURCES
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$124,391	$130,320	$125,000
Applied Research	16,738	7,007	6,500
Development	0	0	0
Subtotal, Conduct of R&D	141,129	137,327	131,500
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	1,353	0	0
Subtotal, R&D Facilities & Major Equipment	1,353	0	0
Total, Support of R&D	142,482	137,327	131,500
Non-Investment Activities	34,453	17,858	17,000
Education and Training	757,945	783,795	622,860
TOTAL	$934,880	$938,980	$771,360

Totals may not add due to rounding.

MAJOR RESEARCH EQUIPMENT FACILITIES CONSTRUCTION
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$0	$0	$0
Applied Research	0	0	0
Development	0	0	0
Subtotal, Conduct of R&D	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	179,029	154,970	213,270
Subtotal, R&D Facilities & Major Equipment	179,029	154,970	213,270
Total, Support of R&D	179,029	154,970	213,270
Non-Investment Activities	0	0	0
Education and Training	0	0	0
TOTAL	$179,029	$154,970	$213,270

Totals may not add due to rounding.

SALARIES AND EXPENSES
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$0	$0	$0
Applied Research	0	0	0
Development	0	0	0
Subtotal, Conduct of R&D	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D	0	0	0
Non-Investment Activities	189,423	218,700	294,000
Education and Training	0	0	0
TOTAL	$189,423	$218,700	$294,000

Totals may not add due to rounding.

OFFICE OF INSPECTOR GENERAL
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D		(Dollars in Thousands)	
Conduct of Research and Development			
Basic Research	$0	$0	$0
Applied Research	0	0	0
Development	0	0	0
Subtotal, Conduct of R&D	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D	0	0	0
Non-Investment Activities	8,697	9,940	10,110
Education and Training	0	0	0
TOTAL	$8,697	$9,940	$10,110

Totals may not add due to rounding.

NATIONAL SCIENCE BOARD
Research and Development Special Analysis

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate
Support of R&D	(Dollars in Thousands)		
Conduct of Research and Development			
Basic Research	$0	$0	$0
Applied Research	0	0	0
Development	0	0	0
Subtotal, Conduct of R&D	0	0	0
R&D Facilities			
Land, Building and Fixed Equipment	0	0	0
Major Equipment	0	0	0
Subtotal, R&D Facilities & Major Equipment	0	0	0
Total, Support of R&D	0	0	0
Non-Investment Activities	2,876	3,880	3,950
Education and Training	0	0	0
TOTAL	$2,876	$3,880	$3,950

Totals may not add due to rounding.

About the Cover

Macrophage and Bacterium 2,000,000X

Watercolor by David S. Goodsell, 2002

Macrophages circulate through the blood, searching for bacterial infection. When bacteria are found, macrophages engulf and digest them. This series of three paintings shows a macrophage engulfing a bacterium. Only a portion of the two cells, where a pseudopod of the macrophage is extending over the bacterium, is shown. The original paintings are 1 meter tall--at this magnification, the macrophage would fill most of a building.

These paintings, which are on display in the Center for Integrative Molecular Biosciences at the Scripps Research Institute in La Jolla, include all of the macromolecules in the two cells and in the surrounding blood serum. The small organic molecules and water, which fill all the space between the macromolecules, are omitted. In the paintings, the cell membranes and their associated proteins are colored green, the cytoplasm is colored blue and purple, and the nuclear material is colored red and orange. The blood serum proteins are in yellow and brown.

Goodsell's watercolor placed second in the illustrations category of last fall's inaugural 2003 International Science & Engineering Visualization Challenge co-sponsored by the National Science Foundation and the journal *Science.* The competition recognized outstanding achievements by scientists and engineers in the use of visual media to promote understanding of research results. Captivating scientific images help promote public engagement in the scientific concepts that are integral to our everyday lives.